José García-Alonso
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Gerontechnology

Second International Workshop, IWoG 2019
Cáceres, Spain, September 4–5, 2019
Revised Selected Papers

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Preface

The International Workshop on Gerontechnology (IWoG) aims to promote research and scientific exchange related to Gerontechnology, and to bring together researchers and practicioners from various disciplines of academia, public administrations, and industry in order to tackle emerging challenges in the Gerontechnology applications and associated technologies, as well as to assess the impact of these technologies on society, media, and culture.

This volume contains the full research papers (field, statistics, technical, and vision works) and short research papers presented at the Second International Workshop on Gerontechnology (IWoG 2019), held in Cáceres, Spain, during September 4–5, 2019.

IWoG 2019 accepted contributions related to different dimensions of Gerontechnology: use of technology to improve functional ability and promote healthy aging; health interventions to support caregivers of elderly people; the effectiveness of public health initiatives and clinical interventions for prevent, reverse, or mitigate decreases in physical and mental abilities; solutions for active aging, social integration, and self-care; monitoring and management of chronic and non-chronic diseases in ambient assisted living; learning, training, and coaching systems to promote healthy life in ambient assisted living environments; smart homes and sensor networks for ambient assisted living; context-awareness in ambient assisted living environments; use of context and location information in user interfaces; elderly nutrition; health, wellness, and disease monitoring; knowledge management for health (context, cognition, behavior, and user modeling); health ecosystems (frameworks, models, and methodologies); and smarts technologies and algorithms for health.

This workshop was organized by the Program Committee (PC), with a senior PC composed of well-known experts from the field in charge of monitoring the work and animating the discussions of the broader regular PC. This made it easier to run the virtual PC meeting of the full research papers track and the discussion about each paper.

The program for IWoG 2019 was versatile and multifaceted. In this workshop there were only full papers and we selected 35 out of 77 submissions, resulting in an acceptance rate of 45,45%.

This excellent and comprehensive program would not have been possible without the help of those who contributed to the success of the event. We would like to thank all the different chairs for their hard work. Our thanks also go to Christine Julien who gave the main talk of the workshop. We also want to thank Fabio Casati who gave a keynote during the workshop.

We are grateful to our local organizers the 4IE team of the University of Extremadura and the University of Evora for their logistical support, and to Springer for publishing this volume. In addition, we want to thank the PC members, the additional reviewers, and the student volunteers for their effort to make IWoG 2019 a very special event, both in terms of academic ambition as well as practical arrangements.

Finally, we want to thank you, authors and the IWoG community, for taking the time and effort to participate in IWoG 2019.

December 2019

José García-Alonso
César Fonseca

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Contents

Smart Technologies and Algorithms for Health

Solutions for Active Aging, Social Integration and Self-care

Monitoring and Management of Chronic and Non-chronic Diseases

Health Interventions to Support Caregivers of Elderly People

Public and Other Health Initiatives

Smart Technologies and Algorithms for Health

YourPantry: Food Monitoring Through Pantry Analysis Using the Smartphone and Making Use Machine Learning and Deep Learning Techniques

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Abstract. Food is one of the fundamental pillars of our lives, and that of the elderly as well. In many cases, elderly people do not follow a balanced diet according to their vital needs. Nowadays, there are technological solutions that help in the daily activities of the elderly and indicate which foods they should eat. But all of these solutions require attention and manual registration. Therefore, we propose an application for smartphones that assists in feeding the elderly through the realization of a photograph of their pantry. This application uses Artificial Intelligence techniques such as Machine Learning and Deep Learning.

Keywords: Elderly · Smartphone · Food-inatake monitoring

1 Introduction

At present, the world is experiencing population-aging, a trend that is both pronounced and historically unprecedented. Over the past six decades, countries had experienced only a slight increase in the share of people aged 65 years and older, from 8% to 10%. However, in the next four decades, this group is expected to rise to 22% of the total population, a jump from 800 million to 2 billion people [1].

This trend is even more worrying in rural regions, for example, Extremadura in Spain or Alentejo in Portugal. This kind of regions have lower population density than the average, and they keep losing its young population to more socioeconomically developed regions. Therefore, they have a higher-than-average aged population while being economically disadvantaged with a fragile cultural and socioeconomic context. Additionally, due to low population density and youth migration to richer regions, elders frequently live alone [2].

Aging in these regions is not a problem by itself, at least not directly. However, as people become older, they are more prone to diseases such as cognitive impairment, diabetes, hypertension, and cardiovascular problems. Different studies indicate that a significant number of these diseases related to aging have their origin in deficient nutrition [3].

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Elders are a particularly disadvantaged group with respect to nutrition, especially if compared with the rest of the population in developed countries [3]. Frequently, the elderly suffer changes in their nutritional patterns that, in some cases, can cause significant damages to their physical condition. For instance, some older people change their dietary habits, increasing their intake of greasy and salty food, or decreasing the total ingested food. This change of patterns usually leads to important-nutrient losses that directly influence the health of older people [4]. Deficient eating habits can cause serious problems in the function and cognitive status of elders, in addition to a higher rate of mortality, such as due to cardiovascular problems or anorexia episodes [5].

During the last few years, important research efforts have been devoted to various aspects related to feeding, not only for aging populations but also for the general population, addressing different nutritional disorders. One of the main objectives of the scientific community is to precisely monitor and identify nutritional patterns and ingested by elderly people. Different studies have shown that elders' nutritional patterns are a valid parameter for predicting their quality of life [6–8]. Specifically, there are approaches in this area to propose new algorithms, techniques, or systems for improving food-intake monitoring.

Food-intake monitoring is intended to acquire information, such as the number of vitamins, minerals, and other substances ingested by a person [9]. This information is then used for the identification of nutritional patterns and the detection of nutritional problems. Most works in this field focus on the state of nutrition and their relationship with different diseases, such as obesity [10], Alzheimer's disease [11], depression [12], and metabolic syndrome [13].

In general, these approaches propose to periodically carry out different surveys to the elderly in order to know their food-intake patterns, what their illnesses are, and the evolution of both. In this process, the prevalent method of diet monitoring is manually recording survey results [14–16]. However, this is a tedious process that ends with a low adherence rate, reducing its long-term effectiveness [17,18]. To address the problem presented by manual recording, numerous technological solutions have been proposed. These solutions introduce the use of a wide range of devices, technologies, and algorithms to automatically identify different aspects of the food-intake process, like the type of food being eaten and the amount of ingested calories, or identifying the person ingesting the food.

However, food-intake monitoring solutions have additional difficulties when taking into account the circumstances of an aging population, particularly when the monitored elders live in rural environments like the ones mentioned above. The lack of infrastructure, the low average technical skills of people living on these regions, the loneliness of elders, etc. hinder the deployment and use of food-intake monitoring systems. A study of the existing proposals is necessary to know if they can be deployed in these environments.

Continuous nutrition monitoring is essential to influence positively the nutrient content of the food supply and meet the changing nutrition needs of the population. Nutrition scientists in the food industry use nutrition monitoring data in a variety of ways that include developing nutrition communications for consumers and health professionals, guiding product development and reformulation, and applying research applications [19].

In this paper, a application making use machine learning and deep learning techniques for food-intake monitoring is presented focused on the coverage of the requirements the elderly living in rural and low populated regions. This research is part of an European project (International Institute for Research and Innovation in Aging - 0045-4IE-4-P) granted to improve the quality of life of elder people living in rural environments.

The rest of the paper is structured as follows. Section 2 presents the motivation for food-intake monitoring of aging populations in rural areas. Section 3 describes the proposed solution for food-intake monitoring making use a smartphone. And finally, Sect. 4 concludes this work.

2 Motivation

Monitoring food-intake in an aging population is important for detecting nutritional problems and, thus, be able to prevent related diseases. As mentioned above, one of the cheapest and less intrusive ways to perform this monitoring is through technological solutions, because methods relying on external supervisors can be complex, expensive and inaccurate, as the supervisors themselves are not involved in the eating activity and mostly rely on visual observation.

Existing monitoring systems usually focus on technical aspects related to automating the monitoring process, and improving precision in food and intake detection. Aspects like overall user impression, social acceptance, or system outputs are often considered. However, most works do no take into account the specific context in which the systems are deployed. This is particularly relevant in the case of elders living in rural regions, since several aspects have to be taken into account to make them viable for these environments.

3 Proposed Solution

The details related to the design and development of the proposed application will be detailed below. The architectural aspects of the software application, the navigation diagrams, the visualization screens and the details of the development of the solution proposal will be detailed below.

3.1 Architectural Design

As can be seen in Fig. 1, the architecture is composed of three layers: Presentation layer, Domain Logic layer and Data Source layer.

The three-layer architecture is a type of architecture used in the large majority of systems. It is usually used in systems that implement a business model such as an online store, an application to manage certain data, etc.

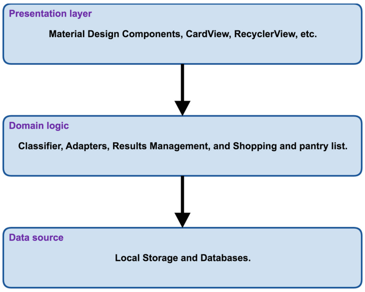

Fig. 1. Architectural design

The complete data management system will have a database to store that data and a user interface that will be the interface with which users interact. In addition, a part of the system will be in charge of processing the data and managing what is done with it. The three-layer architecture divides the system into three distinct parts, so that each layer only communicates with the lower one.

- **Presentation Layer**. All kinds of utilities offered in Android will be used in order to have a clean and minimalist user interface. Basically it constitutes the whole visual part of the application. Its only function is to pass the user's actions to the business layer.
- **Domain Logic**. This layer manages the application logic. It is where they say what to do with the data. It will carry out the business logic of the application, where it will communicate the user interface with the data needed for the application. This will be reflected in the Classifier (will be responsible for analyzing the image and processing before showing them), will also perform a results management (edit, delete and insert) as well as a management of the pantry and shopping list. Other elements will also appear here such as the adapters that will help us to show the data in the different lists of the application through (in this case) the RecyclerViews. It will be connected to the persistence layer in order to perform its functions.
- **Data Source**. This layer is in charge of saving the data. It will be where you manage everything related to the database and the creation, editing and deletion of data from it. The application will have local persistence, we will store all the information of the pantry and the shopping list in a database.

3.2 Navigation Diagram

Next, as can be seen in Fig. 2, the navigation diagram is detailed, that is, the different screens that the application will have:

- *Home screen*: it is the main screen of the application and from it the user can access the other screens through the different buttons.

- *Analysis screen*: in this screen, the results obtained by the classifier are shown, in this screen we will be able to edit the results if there was some error, before inserting it in the pantry or in the shopping list.
- *Pantry contents screen*: the contents of the pantry are shown in a list.
- *Shopping list contents screen*: this screen shows in a list, the contents of the shopping list, each product will contain a check to mark the products we have purchased and have a control.

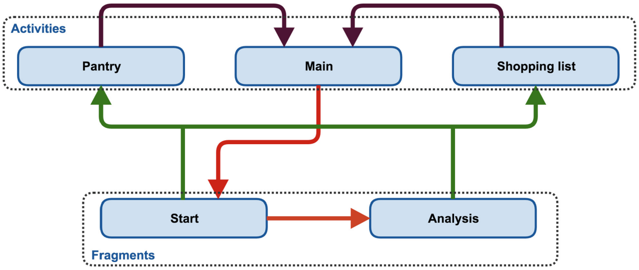

Fig. 2. Navigation diagram.

3.3 Visualization Screens

Next, as can be seen in Fig. 3, the screens of the YourPantry application are shown following the navigation diagram shown above. The application's interface is simple and intuitive for anyone, including seniors, can use it.

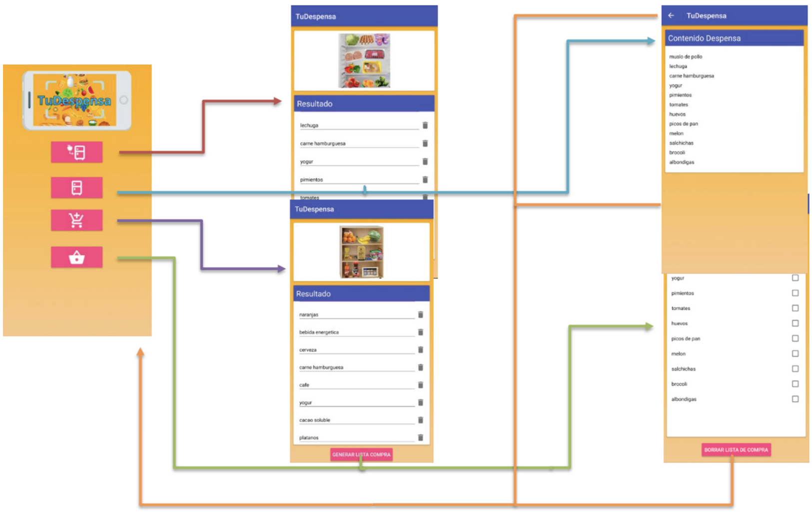

Fig. 3. Visualization screens.

3.4 Development Solution

Once we have described the system architecture, the navigation diagram and the screen visualization of the application, we will proceed to detail the development process. In which a process of preparation, training and optimization of the Deep Learning model has been carried out with Tensorflow.

The current image recognition models have millions of parameters. Training them from scratch requires a lot of training data and a lot of computing capacity (hundreds of hours of processing with a GPU).

In the same way, Transfer Learning is a technique that greatly simplifies this training process by taking a model that has already been trained and reusing it in a new one.

For this work we will reuse the feature extraction capabilities of the powerful image classifiers trained in ImageNet (MobileNet in this case) and form a new classification layer at the top for our purpose.

To start training the model, it is necessary to have a set of images so that it can be trained, in this work, following the proposed requirements, the model must recognize a considerable amount of food products.

The images used in this work have been obtained from ImageNet. For the retraining of the MobileNet model a script has been used that provides us with Tensorflow in a Codelab.

Once the model has been re-trained, the mobile application is generated with this model, and then the comparison is made with the images taken from the camera.

4 Conclusions

Today, society's food consumption is losing quality. The diet followed by people does not follow the recommendations of health experts, leading to different diseases, such as diabetes or cardiovascular disease. And in the elderly sector it is no different.

This paper presents an application for smartphones for the food monitoring and for the recommendation of diets according to the needs of each elder, making use Machine Learning and Deep Learning techniques.

The project is in the verification and validation phase, although satisfactory results have already been obtained with the first tests carried out.

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Use of Innovative Technologies in Group-Based Reminiscence Interventions in Older Adults' with Dementia: A Scoping Review

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Abstract. Background: Reminiscence therapy (RT) emerges in the literature as a non-pharmacological intervention commonly implemented in groups of older adults with dementia, and which has significant positive results in outcomes such as cognition and depressive symptomatology. Simultaneously, we witness the gradual addition of innovative technologies in non-pharmacological interventions in this population segment. However, no studies have synthesized the main contributions of the use of technology in group-based RT sessions. **Aim:** To map the available evidence on group-based RT sessions/activities aided by technological innovations, and critically discussed the potentialities and weaknesses of its use. **Methods:** Scoping review following the Joanna Briggs Institute methodology. Two independent reviewers analyzed the relevance of the studies, extracted and synthesized data. **Results:** Seven studies were included. Overall, the use of technological aids potentiates the interaction and communication between older adults with dementia, staff, and relatives. Nevertheless, issues related to ergonomics, connectivity, and intention of use emerge as recurrent pitfalls. **Conclusion:** While technological aids can foster a more personalized and dynamic group-based RT session, the development of such innovations must follow an user-centered approach that involves older adults with different stages of dementia in order to create solutions with significance and applicability to its end-users.

Keywords: Reminiscence Therapy · Older adults · Dementia · Technology

1 Introduction

The aging of the world's population is a reality that, in the last decades, has undergone an exponential increase, being considered one of the most significant tendencies of the

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21st century. As aging is an achievement both for individuals and for societies, being a consequence of economic, social and biomedical progress, it is necessary to analyze the challenges that emerge from this achievement and resulting societal requirements [1].

The World Health Organization (WHO) in the World Health Report 2015 recognized the increase in the number of older adults as an opportunity that should result in serious social investment, encouraging an open debate in the search for health answers more sustainable in the face of this reality [2]. Early detection and intervention in chronic disease and cognitive decline are crucial; therefore, older adults and their relatives should not be deprived of support during or after formalizing a diagnosis, as this may represent an even more abrupt worsening of its disease conditions [3].

The cognitive decline associated with aging affects a significant segment of the population worldwide and represents the main risk factor for the development of neurodegenerative disorders. Therefore, in recent decades, special attention has been paid to non-pharmacological interventions integrated into therapeutic decisions aimed at people with cognitive decline. Non-pharmacological interventions have thus attracted attention in care contexts because they are presented as safe and low-cost alternatives and whose therapeutic effects are confirmed in areas such as cognition and neuropsychiatric symptomatology [4].

In this sense, Reminiscence Therapy (RT) emerges as a technique of cognitive stimulation that resorts to the systematic recall of significant moments in the individual's life. RT constitutes a normative process that favors the integration of the past and the present in a sense of continuity, reinforcing the identity of the individual, and increasing their self-esteem, through the attribution of a path and meaning to life [5]. In the process of remembering, rather than the perfect location in time, RT intends for the person to focus on their personal memories in an environment of stimulation, communication, and socialization. RT opens the way for people to access the content of autobiographical memories that are a kind of memory with many sensopercetive details that allows to "navigate" in the past [6].

As a technique, RT uses past objects as "triggers" to activate the systematic recall of autobiographical memories and allows for older adults to share and value their experiences. Stimuli can have a multisensory basis and typically, photographs, newspapers, and significant objects that have been part of people's experiences over time are used. However, specific care settings and/or older adults may not possess such objects from past times, hindering the dynamics of RT sessions. To contradict this apparent limitation, the use of technology can be a process facilitator. Thus, various forms of technology and multimedia can be used to enhance by providing a greater capacity for participants to appropriate the conversation, increasing the depth and meaning of memory recall [7, 8].

After extensive review of the literature performed in the JBI Database of Systematic Reviews and Implementation Reports, the Cochrane Database of Systematic Reviews, and in the International prospective register of systematic reviews, no studies were found that synthesize the use of technological aids in group-based RT sessions, neither identifying inherent potentialities nor weaknesses in its use. For this reason, a scoping review was conducted, guided by the methodology proposed by the Joanna Briggs Institute for Scoping Reviews [9]. This review intends to answer the following questions: What kind of technological innovation is there for group-based RT sessions? *What are the potentialities and weaknesses of the use of technology to aid memory recall during group-based RT sessions or activities with older adults with dementia?*

2 Review Method

The synthesis of evidence is at the center of evidence-based practice [9]. Alternative review questions entail the development of innovative review methods that allow for more effective and rigorous evidence synthesis [9].

This review were conducted under the scoping review approach, given its intent on mapping the existing evidence behind a research area and identify gaps in the existing evidence [9]. For this purpose, the Joanna Briggs Institute methodology [9, 10] and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses for Scoping Reviews Extension for Scoping Reviews (PRISMA-ScR) checklist [11] were used.

Using the **Participants, Concept, and Context (PCC) strategy**, this scoping review included studies that focused on: (a) as participants, older adults with a formal diagnose of neurocognitive disorder, condition referred to as [12]; (b) as the concept, studies focusing on group-based RT programs or sessions aided by innovative technological aids; (c) all clinical and geographic settings were included as the context.

The search strategy included published and unpublished studies and was composed of three steps: (i) restricted search in MEDLINE (via PubMed) and SciELO to identify articles on this topic, followed by the analysis of text words in titles and abstracts and index terms used to describe these articles; (ii) a second search using all keywords and index terms identified in the included databases; (iii) the reference list of all articles and reports found in the search were analyzed to identify supplementary studies. Boolean logic was used with search terms, including: "reminiscence"; "technol*"; "innov*"; "digital"; and "ICT" (widely used acronym for Information and communications technology). The search strategy was adapted to each of the included databases due to their differences in terms of vocabulary. Studies written in English, Spanish, French, and Portuguese were considered for inclusion in this review, regardless of the year of publication. The final database search was conducted on June5th, 2019.

Regarding the search strategy and study identification, the following online databases were searched: JBI Database of Systematic Reviews and Implementation Reports, MEDLINE (via PubMed), SciELO, and Cochrane Central Register of Controlled Trials. The search for unpublished studies was performed by searching the Scientific Open Access Repository of Portugal (RCAAP) and OpenGrey.

In order to assort study relevance, two independent reviewers (IG and PC) confronted the information provided in the title and abstract with the outline inclusion criteria. Whenever the reviewers had reservations about the relevance of a study, the full-text version was obtained for analysis. Two reviewers (IG and PC) independently revised the full-text version of the articles to understand if the inclusion criteria were met. Disagreements among the reviewers were decided through discussion with a third reviewer (JA). A same approach was employed to the studies identified after the analysis of the reference lists.

Data extraction was conducted by two independent reviewers (IG and PC) using an instrument specifically designed by the research team. The instrument was designed to retrieve data in line with the objective and review question. Whenever necessary, the authors of primary studies were contacted with the intent of obtaining further information or clarify data.

3 Presentation and Interpretation of Results

The search identified 318 potentially relevant studies. Of these, 30 were excluded for being duplicates. The remaining 288 articles were screened by title and abstract. Of these, 35 articles were included for full-text analysis by two independent reviewers. Overall, 28 studies were excluded, mainly due to the type of intervention (individual RT sessions) not matching the inclusion criteria. Therefore, seven studies were included for data extraction and synthesis (Fig. 1).

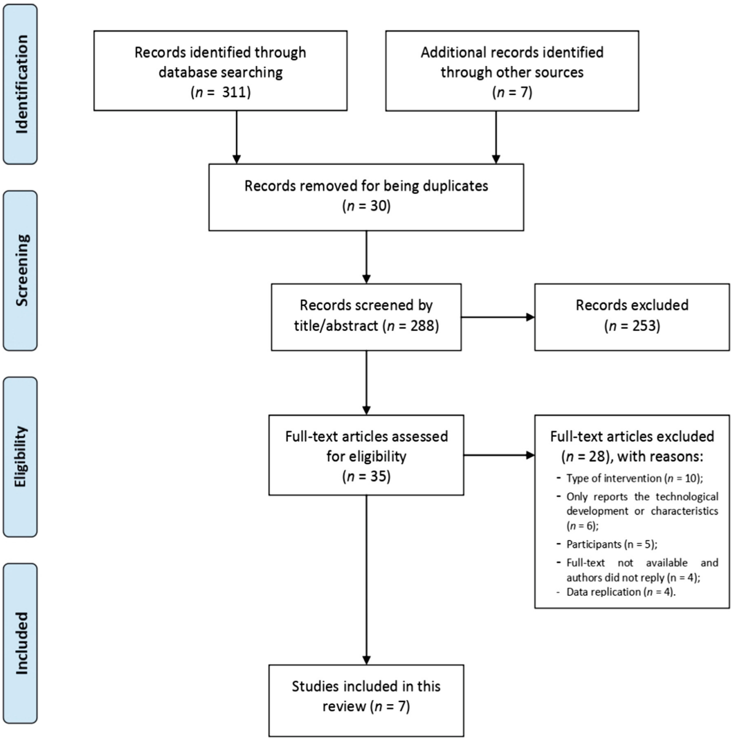

Fig. 1. Flowchart depicting the search process.

Of the included studies, two studies were conducted in Germany [13, 14] and two others in the United Kingdom [15, 16]. Singular studies were also conducted in Turkey [17] and Ireland [18]. Additionally, one of the included studies was multicenter, which included older adults from settings in the United Kingdom (in pairs), in Norway and Finland (in a group) [19]. The included studies were published between 2004 [19] and

2019 [14, 17], which may reflect that the use of technology in group-based RT is a relative recent concern.

Study Design and Methods

The included studies varied in design and intent, with the vast majority report to exploratory studies with qualitative analysis using interviews, focus groups and non-participant observation to report participants' reactions regarding well-being, reminiscence, and technology acceptance [13, 14, 16]. Moreover, one study focused on the impact of the implemented technology in older adults' mood and social interaction but did not use any reliable/validated measures to do so [19]. Positive and negative technology-related outcomes were identified by staff, who also rated older adults' mood and social interaction in a scale ranging from very negative to very positive. In a similar approach, another study used a post-trial usability and user experience questionnaire that focused on the facilitators' perceptions regarding the usability, learnability, efficiency to access information, response time, aesthetics and satisfaction using the implemented software system [18].

Moreover, two experimental studies were included for review. Using a pre and post-interventional study design, Astell and colleagues [15] focused on older adults' cognition (Addenbrooke's Cognitive Examination-III), quality of life (Quality of Life in Alzheimer's disease Scale), and Health Status (EuroQol – Five Dimensions) as study outcomes. Additionally, Manav and Simsek [17] carried a randomized controlled trial (double-arm), focusing older adults' cognitive functions (Standardized Mini-Mental State Examination test) and enjoyment of the individual's hobbies and activities in daily life (Apathy Rating Scale). Manav and Simsek [17] were the only authors to refer to the validity and reliability studies of each instrument used.

Participant's Characteristics

Overall, a total of 474 older adults with dementia participated in reminiscence activities and/or sessions aided by the use of technology, ranging from 19 [19] and 161[15] participants per study.

Although all studies focused on implementing technology in reminiscence interventions with older adults with dementia, four of the included studies did not indicate any eligibility or diagnostic criteria [13, 14, 16, 18]. In contrast, two studies included older adults diagnosed by a physician according to the criteria outlined in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition. On the other hand, Topo and colleagues [19] used only the Mini-Mental State Examination (MMSE) to determine the severity of dementia, without indicating the selected cutoff score.

Characteristics of the Group RT-Based Intervention/Activity with Technological Aids

As shown in Table 1, the interventions developed varied greatly among the included studies. Four of the included studies focused solely on group-based RT interventions aided by technology [15–18]. On the other hand, Bejan and colleagues [13] compared the acceptance and reminiscence potential of one of the implemented technologies (virtual mixed reality aquarium with sound) in individual and group sessions. Interestingly, the authors reported a higher level of activation in the group setting, with the social interactions and group dynamics between the older adults with dementia leading to a livelier atmosphere. Topo and colleagues [19] implemented the Picture Gramophone (PG) multimedia program across international settings, which influenced its dynamics due to the characteristics of the different institutions involved. For this reason, the results were reported from individual sessions, in pairs, and in groups.

Most of the included studies reported the use of technologies in RT sessions and activities with a standardized duration and frequency [13–16, 18]. However, some authors did not disclose full data on session duration and/or frequency [14, 16, 18]. On the other hand, Topo and colleagues [19] aimed for a spontaneous engagement and use of the PG multimedia program, without stipulating standard sessions with a rigid duration or frequency. Interestingly, only one study used the technological aids in a structured RT program, with sessions that span the older adults' life path from their infancy to marriage, children, and celebrations [17]. On the contrary, one study based their RT sessions in the topic preferences and/or requests of the older adults during the activity, as a prompt for engagement and group interaction.

Characteristics of the Implemented Technology

The majority of the included studies do not identify previous stages of development of the implemented technologies [15–17, 19]. Nevertheless, three studies report an overview of the User-Centred Design Process conducted [13, 14, 18]. In the study by Bejan and colleagues [13], the stages of technological development are conducted using interviews only with professional experts and caregivers. In its turn, Huber and colleagues [14] and Yang and colleagues [18] included older adults with dementia (end-user) in the different development stages, using diverse approaches such as contextual designs, exploratory interviews, low-fidelity prototype testing (using case walkthrough), and field assessment.

Interestingly, the included studies implemented technologies of varied nature. Among the selected studies, the implementation of interactive navigation software was a popular choice [15, 18]. As an example, the REMPAD software uses intelligent classifiers to recommend online content that suits the participants' profile (Fig. 2).

Other studies presented multiple technological aids to be implemented in RT sessions and activities. As an example, Bejan and colleagues [13] tested the effects of technologies that aimed for active/touch and object interaction such as a virtual 3D aquarium with sound (a natural user interface program). The authors used a sensor kit to add object interaction via an augmented fish food can (to feed the fish) and hand clapping (to scare the fish). The aquarium's system was designed according to the REAFF design principles (responding, enabling, augmenting, and failure-free) applied to the reality of older adults with dementia (Fig. 3). Moreover, Bejan and colleagues [13] developed a virtual personalized 2D photo book (with fitting sounds), which was displayed in a touchscreen that allowed for "real-life" interactions by the older adults (e.g. turning pages).

Additionally, the authors also focused on the use of tablet computers to display self-filmed or online movies [13]. In a similar approach by Manav and Simsek [17], computers were also used to display internet-based videos. Notably, the use of portable computers was also verified in the study conducted by Upton and colleagues [16], with the facilitators using iPads to prompt older adults' engagement and interaction with several existing apps from areas such as movies (e.g. Youtube), photography, drawing

Table 1. Characteristics of studies included for review.

Study Reference	Description of the technology used	Frequency and duration	Group size	Facilitators
Bejan et al. [13]	**3 multimedia ICT interventions**: Group 1: Virtual mixed reality Aquarium with sound, through a 40" surface computer (Active/touch and object interaction) Group 2: Digital photobook, through a 40" surface computer (Active/touch interaction) Group 3: Movies (from Youtube and others), through a 9.7" tablet and 32" TV (passive/watching)	Group 1: 15 sessions, 5 min each Group 2: 29 sessions, 7–45 min each Group 3: 50 sessions, 15 min each	Group 1: 16 participants Group 2: 5 participants Group 3: 12 participants	The caretaker instructed and prompted the older adults to use the technology
Huber, Berner, Uhlig, Klein, Hurtienne [14]	**Pyramid:** 3D-printed which contained speakers and a square 10" screen in its base as output channels. The pyramid had position sensors and a turnable top **Interactive chest of drawers:** four smoothly sliding drawers (80 × 40 × 40 cm), with four iPad minis integrated in the front of each drawer. These contained several tangible objects (like photographs or animal figurines). LED strip integrated to raise attention **Jukebox:** rectangular box (45 × 45 × 23 cm size) with a retro design, equipped with a speaker, a display and six large hardware buttons in the front. The display showed pictures with each song that were thought to support the song's meaning	Pyramid: four group sessions, for 1–1.5 h Drawers: 1 group session, duration not mentioned Jukebox: seven group sessions over two days, duration not mentioned	80 participants Pyramid: 2–8 participants per session Drawers: 5 participants Jukebox: 8–12 participants (first session); 2–6 participants (remaining sessions)	Sessions were guided by the caregivers

(continued)

Table 1. (*continued*)

Study Reference	Description of the technology used	Frequency and duration	Group size	Facilitators
Astell, Smith, Potter, & Preston-Jones [15]	**CIRCA** (multimedia database) and **CIRCA-WB** (replication of CIRCA with web-based service that allows for interaction and navigation with the contents)	Twice a week, for over 4 weeks, 60 min per session	161 older adults in groups of 3–6 participants	One facilitator from the research team, interacting with CIRCA(WB)
Upton, Upton, Jones, Jutlla, & Brooker [16]	**Touchscreen portable computer (iPad)**, using several existing apps (e.g. 150 years of history)	The number of sessions and duration is not fully reported. However, the authors indicate a study period of 6 months, and one-hour sessions using the iPad	149 participants	Staff from the care home commanded the iPad and engage with older adults. Family members were also invited to participate
Manav & Simsek [17]	**Computer** with Internet-Based Videos	Technology group: 60 min a day once a week for 3 months Control group: 25 to 30 min sessions once a week	Technology group:16 participants Control group: 16 participants	Specialist Psychiatric Nurse
Yang et al. [18]	**REMPAD** is a software system that uses intelligent classifiers to recommend publicly accessible videos from the Internet (e.g. YouTube) based on the group participants' profile, interests, and hobbies. REMPAD has two hardware components: tablet computer (for the RT facilitator) and a TV monitor which displays the video clips to the group members	54 sessions, in 6 different locations over a period of several weeks	Not disclosed	Activity coordinators with nursing, counseling or social care qualifications (n = 7)
Topo et al. [19]	**Picture Gramophone** (PG) multimedia program, used through a computer with a touch screen and CD-ROM drive. An Editor feature was also included, requiring a keyboard and computer mouse	Flexible use during 6 months (data only presented for the first 3 weeks) Session duration was also flexible according to participant engagement, ranging from 15 min to over an hour per session	UK Group: 4 participants Norwegian group: 3 participants Finnish Group: 12 participants	Staff from the dementia care units prompted older adults to interact with PG and monitored study outcomes

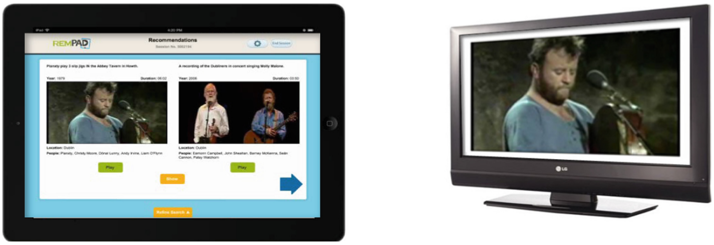

Fig. 2. The REMPAD system: facilitator view on tablet PC (left) and therapy participants view on large TV monitor (right) (Source: Yang et al., 2013, p. 2)

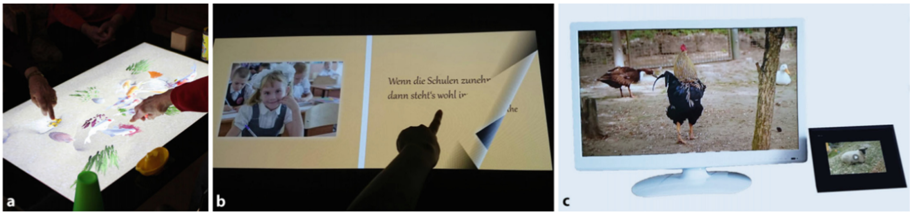

Fig. 3. An aquarium program (left), a personalized digital photo book (center), and a television display and tablet computer. (Source: Bejan et al., 2017, p. 2)

and painting (e.g. Melodala, Pollock, Doodle Buddy), news and lifestyle (e.g. BBC News), or interactive games (Simon Says, Talking Tom, Swirlicity lite).

With a slightly different approach, Huber and colleagues [14] integrated four iPad minis in a cabinet with four drawers, which contained several tangible objects inside (e.g. photographs or animal figurines). The iPads were used as personalized picture frames to advertise the inside content of each drawer. The authors stipulated that viewing the pictures and interacting with the content should trigger (autobiographic) memories and evoke positive emotions (Fig. 4). Complementarily, Huber and colleagues [14] developed a 3D-printed prototype of a pyramid with integrated speakers and a square 10 “screen in its base, which was tested in group-based RT sessions. The pyramid’s position sensors (up to a 90º angle) and turnable top allowed the older adult to navigate between different thematic domains (e.g. gardening, animals, traveling, local monuments), changing the associated pictures and sounds. The pyramid’s design allowed the older adult to navigate through its content from a seated as well as a lying position.

Furthermore, the authors also developed a rectangular jukebox equipped with a speaker, a display and six large hardware buttons. Each button corresponded to a pre-defined playlist of folk songs with and without vocals, popular hits of the past, church songs, choral music, and lullabies. For each song, one or two pictures were shown to support the song’s meaning. Remarkably, Topo and colleagues [19] also implemented a similar technological aid in their RT sessions, using a karaoke-like multimedia program in a computer with a touch screen.

Potentialities and Weaknesses of the Technologies Used

Overall, the majority of the older adults with dementia, relatives, and staff involved in

Fig. 4. The pyramid (left); the interactive drawers (center); and jukebox (right). (Source: Huber, Berner, Uhlig, Klein, & Hurtienne, 2019, p. 4)

the included studies reported mainly **positive experiences** during the group-based RT sessions and/or activities. The use of technological aids assisted older adult's recalling of past memories through the active **interaction with different stimuli** alluding to previous time periods [13–19]. As an example, Huber and colleagues [14] identified that older adults enjoyed the tangible experience of grasping the pyramid and even found pleasure in the unintended heat radiation. This result is of paramount importance in the facilitation of group-based RT sessions, since: (i) physical objects from past times are not always available in care institutions/home-settings for older adults to manipulate; (ii) older adults may not possess personal photographs or objects at their disposal to share with a group; (iii) physical objects can potentiate or mitigate interaction and engagement based on the older adults' preferences.

Furthermore, technological aids have shown to **increase interpersonal interactions** both directly – through activities involving the device/system - and indirectly – by talking about the device/system [16]. Despite the recurrent use of touch technologies and dynamic software interfaces, one study found that even through the majority of older adults reported to have no **previous ICT experience** (96%), this **was not a barrier to their interaction** with the implemented software [15]. Such interactions were shown to happen between older adults during group dynamics, but also with staff and relatives [13–19]. Interestingly, one study highlighted that staff/relatives from younger generations and the older adults with dementia bonded over the use of technology during RT sessions, **constituting a channel for intergenerational communication** [16]. These results demonstrate that the integration of technological aids in RT group sessions should be mediated by a trained facilitator, who involves the person in their use. As an example, although Huber and colleagues [14] found that older adults interacted most intuitively with the drawers, they **only opened them when prompt** to do so. This result was considered lackluster, since the drawers were placed in common passage sites, and strips of LED lights were used to signal their presence.

For RT facilitators such as health professionals and carers, having **technological aids that are readily able to incorporate contents** from different countries and cultural groups and labeling with multiple languages (e.g. CIRCA-WB, REMPAD) constituted an advantage. While traditional memory triggers can be considered inexpensive when strictly comparing costs per unit (e.g. supplies for crafts), the constant use and discard during each session results in a considerable expenditure of material, with economic and ecological impact for the care institutions. Additionally, the use of objects from the past requires that facilitators waste their time to collect and arrange the items (carrying around bulky materials with them) as well as storage capacity [18]. Therefore, over time, **customizable technological aids can decrease costs and time** during the preparation and implementation of group-based RT sessions [15, 18].

Overall, **common difficulties and gaps** related to using the technology during RT sessions were also noted, especially with regard to **ergonomics and usability**. Bejan and colleagues [13] highlighted that technologic aids may be unfit for group-based RT sessions and/or activities when not adjusted to the needs and dementia levels of the individuals. In their study, participants with severe dementia had impaired sensorimotor abilities and could not correctly position the objects to activate their underlying usage metaphors. This was also highlighted by Topo and colleagues [19] and Upton and colleagues [16] who identified that the **size, reflective surface, and sensitivity of the touchscreens** used in their RT sessions differed according to the manufacturers' specifications, which conditioned older adults engagement due to the deterioration of their fine motor skills. Moreover, the **weight of current technological hardware** such as iPads was considered as a barrier to their use by older adults.

Connectivity issues were also common across studies. Yang and colleagues [18] identified that the use of technological aids connected to the Internet may pose a barrier for facilitators since its functionality is dependent on the strength of the wireless connection. In their study, the low Internet connection in three of the locations meant that in some situations the videos took time to load and the therapy participants would lose interest. Likewise, Upton and colleagues [16] highlighted that corporate issues related to **problems getting WiFi access** weakened the use of iPads during RT sessions.

The benefits of using technological aids with auditory stimulation through sounds and music were not consensual. While the majority of the older adults enjoy listening to music and relaxing sounds, some even being prompt to dance in pairs or individually, **volume inconsistencies** can pose an obstacle to the facilitation of RT sessions [18]. For example, Topo and colleagues [19] identified that some participations display a **low motivation** to independently use the music-based multimedia program, although this was not associated with the severity or type of dementia. In Huber et al.'s study [14] the use of a jukebox with a touchscreen displaying thematic pictures did not provide any additional value and for people sitting close to it. Likewise, the authors reported that **choosing an optimal volume was not easy in groups dynamics**, since it was considered to be too loud to have a conversation (when seated closer to the jukebox), and too quiet to properly understand lyrics when sitting farther away.

While a select number of studies identified the need to train professionals in the use of technologies prior to their implementation, Upton and colleagues [16] highlighted that **staff** was concerned that their **own limited skills** could have a negative impact on the older adults' own experience.

Finally, although not the focus of this review, some of the "direct" therapeutic results regarding the use of technology in RT sessions will be addressed. In the study by Astell and colleagues [15] the older adults with dementia that participated in the eight RT group sessions using CIRCA significantly improved their cognitive function and quality of life, as well as an increase in their health status scores (although these were not statistically significant). Resulting from their randomized controlled trial, Manav and Simsek [17] identified that the intervention group (RT sessions with technology) significantly improved older adults' cognitive scores after the intervention ($p < .01$), although this did not happen with the control group ($p > .05$). Moreover, cognitive function post-test scores of the intervention group were also significantly higher than those of the control group ($p < .01$). Regarding older adults' enjoyment of the individual's hobbies and activities in daily life, the mean apathy post-test scores were significantly higher in the intervention group ($p < .01$).

4 Conclusion

The mapped evidence points to a huge clinical potential for the integration of technological aids into group-based RT sessions and activities. However, there is an evident need to develop structured interventions that integrate technology with clear intent, facilitated by professionals with training in RT and group dynamics. Moreover, in order to facilitate the older adults' interaction with technological aids during RT sessions, the facilitators should be virtuous in dealing with technology and/or display high levels of digital literacy.

Although a select number of technological innovations outlined in this review allow their customization according to the needs and preferences of the older participants, this is not common for all the technologies found in the literature. Therefore, recognizing that a significant number of the older adults with dementia included in the studies have cognitive, functional and sensory weaknesses, it is urgent to develop technologies based on a user/person-centered design process. In order to achieve this goal effectively, it is crucial to assess the feasibility of the technological product. The older adults with dementia should be included in the different stages of development of these technologies, from idea conception to testing, in order to create innovative solutions with meaning and applicability in care contexts.

Finally, the design and methodological quality of the studies found in this thematic scope emerge as barriers to the discussion of the true effectiveness of the use of technological aids during group-based RT sessions. Although most studies have reported qualitative indicators regarding the satisfaction and interaction of older adults with dementia and the technology implemented, future studies should focus on their effectiveness in outcomes such as cognition, depressive symptomatology, or quality of life, when compared to traditional memory triggers used in group-based RT sessions.

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Innovative Devices for Bedridden Older Adults Upper and Lower Limb Rehabilitation: Key Characteristics and Features

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Abstract. Older adults are often bedridden as a consequence of acute disease that leads to hospitalization. Immobilization in a bed for a long period can affect negatively the function of many body systems, especially when talking about skeletal muscle. Lower limbs are strongly affected which will difficult the achievement of independence and will slow down the discharge moment. This study aims to identify the current patents of medical devices that allow for physical rehabilitation of bedridden patients, particularly of upper and lower limbs. Also, the scope of this patent review is to describe the key characteristics and features of the identified devices. A patent review was conducted between May 2019 and July 2019, identifying 39 devices for physical rehabilitation of bedridden patients. The majority of the devices are designed for lower or lower/upper limbs rehabilitation, which allows for early prevention or even reversion of main immobilization complications like physical disability. Modularity, flexibility, and automation are important features of the developed mechatronic solutions and seem to be able to enrich and promote a more efficient rehabilitation program in hospitals and nursing homes.

Keywords: Self-help devices · Exercise · Bed rest · Rehabilitation · Aged · Aged, 80 and over · Mechatronic system · Bedridden elderly people

1 Introduction

Institutionalized older adults are often confined to a bed for many days, weeks or even months. Only after the 1950s, bed rest effects on the human body started to be studied in depth [1] since previously, bed rest was a common recommendation for the majority of traumatic events that lead a person to a hospital.

Either the case, in acute, subacute or chronic disease, bed rest is highly probable as a therapeutic method. Although being a way to promote a systematic recovery, immobilization is not devoid of major complications, like loss of muscle mass, lower limb weakness, respiratory and cardiovascular system atrophy, pressure ulcers, deep vein thrombosis (DVT), urinary tract infections (UTI) and pneumonia [1, 2].

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Therefore, hospitalized older adults due to acute or subacute diseases can experience long-term disability symptoms, having a high probability to develop new disabilities, compared to the pre-hospitalization phase [3–5]. This is true, since the lack of muscle and bone stimulation damage their function, particularly in the lower limbs [6].

Early mobilization, particularly in this kind of patients, is very important to prevent or reverse complications [7, 8], which, when present, might delay the discharge moment, increase family and patient's anxiety, increase institutional costs and other long-term negative outcomes.

Some authors [9], after studying a group of stroke patients, report that physical sequels are the most prevalent after institutionalization periods, namely 'hemiparesis' and 'inability to walk without assistance'. Another study [10] also reports this, stating that physical complications, like 'upper extremity weakness', are primary contributors to prolonged disability.

Also, there is an important geriatric syndrome distinct from disability [11], which is frailty. The decline in functionality during and after an acute hospitalization is a severe output and there are some studies [12] that indicate that multicomponent exercise interventions might reverse this decline.

In fact, early mobilization is good for the health of skeletal muscle [13–15] and is particularly important to reverse frailty [11].

Considering that nurses have an important responsibility in preventing complications related to immobility, by delivering proper physical care to promote and maintain muscle tone and skeletal density in upper and lower limbs in bedridden patients, it would be an advantage to develop more efficient ways to perform this.

In this sense, it is an advantage, if efficient and secure to both the professional and to the patient, to use a device that allows for active and/or passive mobilization, without the necessity to rise from bed.

Thus, this study aims to identify the current patents of medical devices that allow for physical rehabilitation of bedridden patients, particularly of upper and lower limbs. Also, the scope of this patent review is to describe the key characteristics and features of the identified devices.

2 Method

A patent review was conducted between May and July 2019 with recourse to the following databases: European Patent Office (EPO) for patents registered in the European Region and Google Patents for patents registered outside of Europe, namely in the United States.

The following descriptors were used: *"self-help devices"; exercise; "bed rest"; rehabilitation; aged; "aged, 80 and over"; "mechatronic system"; "bedridden elderly people"*.

The inclusion criteria for the medical devices were being registered in the above-mentioned databases, having a summary of the invention and the respective objects available in the patent description, allow upper, lower or both limbs exercises.

The exclusion criteria for the medical devices were: devices that allow exercise in patients, except bedridden.

3 Results and Discussion

This review allowed for the identification of 45 novel medical devices (Fig. 1), which were specifically designed for physical exercise of patients and were registered between 1949 and 2018.

After the review of the devices' descriptive documents, the research team excluded 2 documents because they were duplicated and 4 documents because they described devices that did not allow for exercise in bedridden patients (exclusion criteria).

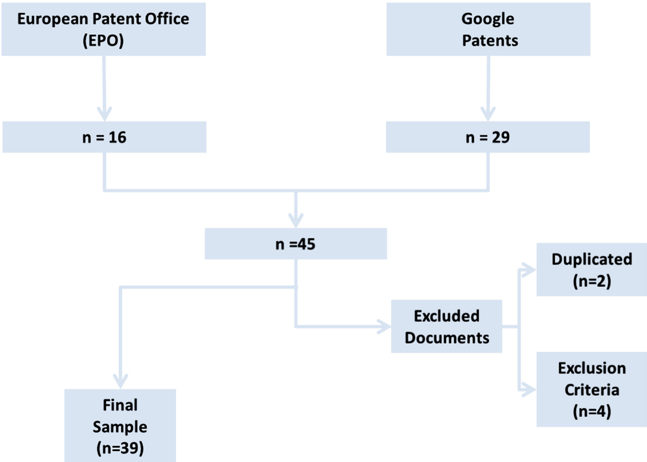

Fig. 1. Patent review process flowchart. The initial sample was constituted by 45 articles, from which 6 were excluded, either by being duplicated or met exclusion criteria. The final sample gathered 39 documents of registered patents.

The final sample ($n = 39$) is representative of the devices for physical exercise and rehabilitation of bedridden patients in the last 70 years. The main key characteristics and features can be found in Table 1.

Of the 39 devices identified, 36% ($n = 14$) were patented in the European Region and 64% ($n = 25$) in the United States. All of the devices are indicated for the physical rehabilitation of bedridden patients, by means of different physical exercises, positions, and interactions between components (Table 1).

From the 39 devices, 38% ($n = 15$) only describe the possibility to exercise lower limbs (D1, D4, D5, D6, D7, D9, D10, D16, D18, D29, D30, D31, D34, D36, D38), 3% ($n = 1$) only exercises upper limbs (D23), and 26% ($n = 10$) are able to exercise both upper and lower limbs (D15, D17, D19, D21, D24, D26, D28, D32, D33, D39). This means that 64% ($n = 25$) are able to rehabilitate lower limbs, which is consistent with the literature, that states that lower limbs are more damaged with bedrest [6]. Along the last 70 years, the effort was in developing lower limb rehabilitation devices, rather than upper limbs. In fact, upper limbs are not strictly ignored by the programs to be developed. For example, D1 describes the possibility to operate the pedals using the arms, which also promotes the person's independence in its self-care.

Table 1. Key characteristics and features of medical devices (n = 39) for physical exercise in bedridden patients.

Year	No.	Name	Patent	Key characteristics
1949	D1	Exercising device	US2484153	Lower limbs; Pedals (can be operated by the upper extremities); Massages for the sides of the legs; Modular; Attachable to a bed
1956	D2	Exercising Apparatus	US2772881	Hand and foot control; Exercises joints and muscles; Able to attach to a bed or wheelchair; Simple to operate
1972	D3	Exercise apparatus and method for paralytic patients	US3693614	Circular or rotary motion in vertical planes; Indicated for the arms and legs of paralytic patients' subject to muscle spasms; Physiotherapy; Motor and pedals; Modular
1973	D4	Spring Type Leg Exercise Device	US3749400	Lower limbs; Longitudinal movements with resistance; Attachable to bed and wheelchair
1975	D5	Patient Lift and Exercise Apparatus	US3877421	Able to lift the patient and exercise his lower limbs; Motor; Adjustable; Minimal nursing effort
	D6	Exercise Apparatus for Bedridden Patients	US3887180	For bed only; Adjustable for patient's position; Prevention of blood clots by stimulating blood stimulation in lower limbs; Patient operated
	D7	Therapeutic Foot Rest	US3901228	Lower limb exercise; Restriction to upright position
	D8	Foot Exercising Device	US3917261	Both foot exercises with a pedal; Motor; Active and passive exercise; Self-controlled or motor controlled; Prevention of thromboembolism of bedridden patients; Can be used in prone or sitting positions

(*continued*)

Table 1. (*continued*)

Year	No.	Name	Patent	Key characteristics
1979	D9	Led Exercising Apparatus	US4159111	Lower limbs; Normal walking mimic; Prone or sitting positions; Able to prevent varicose veins or thrombosis; Light in weight
1983	D10	Portable multiple use exerciser	US4422635	Promotes blood circulation; Light exercise of weakened muscles; Able to be used while in a chair or lying in bed; Lower limbs
1986	D11	Horizontal force exercise apparatus	US4614338	Weight lifting
	D12	Motorized Exercise Apparatus for Mounting on Hospital Bedrail	US4615335	Motor; Portable; Indicated for stroke patients who can't stand or sit; Rotational movements of the arm or leg while in bed
1990	D13	Bed-Mountable Leg Exercise Device	US4925184	Cycle-like device for post-operative exercise while in bed; Pedal; Minimal nursing staff effort
1991	D14	Exercise Machine for Patients Confined to Bed	US5005829	Easy active exercise for patients; Elements in good reach; Resistance exercises
	D15	Orthopaedic Exercise Frame	US5035233	Lower and upper extremity; Motor-driven; Modular
1996	D16	Exercise machine	US5518474	Pedals; Air pump/resistance; Modular; Sitting position; Multi-tasking; Lower limbs
2000	D17	Adjustable resistance exercise device	US6036626	Adjustable; Strings; Different exercises; Resistance; Portable; Upper and lower limbs
	D18	In-Bed Exercise Machine and Method of Use	US6152855A	Portable; Lower limbs strength training; Closed kinetic chain in concentric and eccentric modes and for isometric, isotonic and isokinetic exercise

(*continued*)

Table 1. (*continued*)

Year	No.	Name	Patent	Key characteristics
2001	D19	Bed Exercise Machine	US6241642	Ropes; Upper and lower limbs; Adjustable; For patients with missing limbs; Easy installation; Light in weight; Portable; Blind people (force adjustments without visual confirmation); Small increments in range of motion
2005	D20	Means and Method of Exercising Feet and Legs of Bedridden Patient	US6935991	Shoe-attachable unit; Passive exercise; Exercise with shoes
	D21	Self-exercise device for limited mobility patients and method of exercise	US20050119095A1	Auto-mobilizations; Modular; Strands; Decrease pain; Lower and upper limbs
2011	D22	Multipurpose stretching/exercise cane	US7967021	Multipurpose: walking, muscle stretching, exercising; Light weight
	D23	Variable-resistance exercise device	US20110237407A1	Portable; Variable-resistance exercise; Lightweight; Adjustable; Data storage (e.g., number of repetitions) to an external computer; Upper limb
2013	D24	Exercise Apparatus and a Brake Mechanism	US8602943	Upper and lower limbs; Resistance; Braking system; Motor.
2014	D25	Rehabilitation training frame for bedridden patients	CN203090356	Elastic bands; Modular; Simple structure; Neurosurgical patient.
	D26	Limb exercise recovery device for bedridden patients	CN203777600	Adjustable; Indicated for amputations or partial limb paralysis; Upper and lower limbs; Simple structure; Low cost; Modular
	D27	Simple self-help exercise bed for bedridden patients	CN203989708	Simple; Modular; Low cost; Muscle of the arms, legs and waist can be exercised at the same time

(*continued*)

Table 1. (*continued*)

Year	No.	Name	Patent	Key characteristics
2015	D28	Limb exercise device for bedridden patients	CN204447140	Adjustable; Sliding; Indicated for early stroke recovery; Upper and lower limbs; Simple structure; Low cost
	D29	Lower limb function exercise device	CN104586607	Solves the problems of chicken tissue atrophy, tissue adhesion, joint stiffness and poor blood circulation; Improves quality of life
	D30	Ring type leg exerciser	CN105147502	Lower limbs; Only allows passive movements by the professional
	D31	Bed lower limb vertical exerciser	CN204106959	Vertical motion; Lower limbs; Simple structure
	D32	Limb exercise device for bedridden patients	CN204447140	Adjustable; Sliding; Indicated for early stroke recovery; Upper and lower limbs; Simple structure; Low cost
	D33	Patient support apparatuses with exercise functionalities	US9125785	Closed chain exercise functionalities; Upper and lower limbs
2016	D34	Leg exercise bed	CN105310857	Lower extremities; Promotes blood circulation; Standing function; Low cost Simple structure
	D35	Bedridden patient exercise device	CN105943304	Massage manipulator; Motor; Automatic exercise; Prevents lung infection, muscle atrophy, thrombosis
2017	D36	Lower limb rehabilitation treatment device	CN106963610	Lower limbs; Air pump for resistance; Vertical movement; Improves venous blood flow stagnation; Avoids deep vein thrombosis and atrophy of muscle; Reduces feeling of joint stiffness; Shortens rehabilitation period

(*continued*)

Table 1. (*continued*)

Year	No.	Name	Patent	Key characteristics
2018	D37	Medical bed rest patient rehabilitation device	CN108607198	Sliding; Treadmill
	D38	Lower limb rehabilitation device for bedridden patient and using method thereof	CN108743278	Lower limbs; Motor; Cam; Patient's foot can be at rest and massaged by fixing the patient's sole and performing all-round compression; Promotes blood circulation in the patient's foot and accelerates the recovery of the patient's foot
	D39	*Medical body rehabilitation exercise device*	*CN108888902*	Slider; Upper and lower limbs

Some devices describe a specific way to promote limb health, either by allowing a massage (D1, D35, D38), exercising muscles and joints differently (D2), allowing different types of motion (circular or rotative) in vertical planes (D3, D31, D36), horizontal planes (D28, D32, D37) or complex planes (D12). Flexibility in these kinds of devices seems to be an important factor to allow for different types and forms of rehabilitation programs, which will also allow the healthcare professional to design a specific program.

There are devices that allow for differentiated exercises, which may imply the introduction of progression in the physical exercise programs to be implemented. Actually, the inventor of patent D18 - In-Bed Exercise Machine and Method of Use, Robert C. Dean, which, together with the inventors of D3 (Kenneth A. Schon), D20 (Denise F. Mangino), D21 (Will Kramer) and D38 (unidentified authors), describes a method to be used along with the novel device. The author identifies seven principles of in-bed exercises to be accounted for:

1. Overloading of the muscles must occur through voluntary muscular actions;
2. Intensity during exercises is required to increase the power output of the muscles and not just their ability to overcome maximal resistances;
3. Training volume is a measure of the total work performed over a time period;
4. Periodization refers to incorporating variation in training volume and intensity;
5. Progressive overloading of the muscles is required to produce gains in strength and power;
6. Rest periods between sets of an exercise, between exercises and between training sessions are essential to the success of a program;
7. Specificity means that each muscle group requiring strength must be trained in a fashion similar to that required during use.

Moreover, along with these seven principles, three criteria should be met before starting any program: (i) A means of providing forces up to body weight and a bit beyond; (ii) A means of joining any bed and the exercise machine into a single exercise unit that is capable of safely supporting said body-weight-level forces and the reaction forces from the patient; (iii) A means of providing said forces in a manner that simulates weight-bearing and functional activity.

In fact, devices like D4, D14, D16, D17, D23, D24 and D36 allow for resistance training, by presenting air pumps/compartments or having components like elastic bands, which contribute to adding difficulty to the exercise performed. This type of training has a positive effect on functioning maintenance, improving physical fitness and functionality of older adults [16].

Many devices are designed specifically for a particular group of patients or pathologies like paralytic patients subject to muscle spasms (D3), blood circulation deficits (D6, D8, D9, D10, D29, D34, D35, D36, D38), stroke patients (D12, D28, D32), post-operative patients (D13), amputation contexts (D19, D26), blind people (D19) and neurosurgical patients (D25).

Only two inventors – Cicero C. Brown (D5) and Howard P. McJunkin (D13) – refer directly the possibility to minimize the effort of the nursing staff, while others, indirectly, refer a way to perform active exercises (D8 and D14), auto-mobilizations (D21) or automatic exercise (D35). It would be important to increment this outcome since it's a significant motivation for the development of these novel devices.

Restriction of movements and/or positions should be avoided, by promoting structural flexibility, like the devices described until now. There is one device (D30) that does not contribute to the reduction of workload, by restricting its function to passive movements performed only by the professional. The independence of the bedridden older adults is an important achievement [17] and activities of daily living (ADLs) should be associated with the device in use.

Some devices promote long-term independence in several ADLs by early exercising lower limbs for walking activities (D9 and D22). Also, some devices foresee an attachable function to a wheelchair (D2 and D4), which is an interesting feature, if the professional starts an early transition to walking training. Other devices are able to exercise while in a sitting position (D8, D9, and D16), which will also contribute to the long-term outcome achievement of a complete orthostatic position and its maintenance.

There also seems to be a general concern about usability and ergonomic features like portability (D10, D12, D17, D18, D19, and D23), low cost (D26, D27, D28, D32, and D34), and lightweight (D9, D19, D22, and D23), together with a description of quality of life (QoL) improvement (D29), either by relaxation (e.g., applying a massage, as seen previously) or reducing pain (D21).

Despite these important features, none of the devices drew attention to safety measures, which could be implied by some descriptions or device drawings. Nevertheless, it's a necessary component of any novel device and medical intervention [18] and should be introduced when developing or upgrading such works.

4 Conclusion

The development of novel solutions to improve physical rehabilitation programs for bedridden patients, by means of efficacy and safety of the devices, has a heterogeneous evolution through the last 70 years.

The majority of the devices are designed for lower or lower/upper limbs rehabilitation, which allows for early prevention or even reversion of main immobilization complications like disability. Modularity, flexibility, and automation are important features of the developed mechatronic solutions and seem to be able to enrich and promote a more efficient rehabilitation program in hospitals and nursing homes.

In this sense, nurses can contribute to the prevention of complications related to immobility in a more effective way, also involving the patient in the rehabilitation process, with positive health outcomes, thus increasing quality of life.

The limitation of this study is related to the restriction of patent review from EPO and Google Patent databases, which might imply that similar devices were missed from this review.

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FoodScan: Food Monitoring Through Purchase Tickets Analysis Using the Smartphone

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Abstract. Using applications in Smartphones and other smart devices that improve or help people's lives and nutrition is getting more and more common. And this also happens in the elderly. There are several applications in the market related to the control of people nutrition in order to lose weight, follow a certain diet, etc. However, these applications may be very tedious as users have to introduce by hand all the aliments they have consumed along the day. This paper proposes an mobile App oriented to elderly in order to control their nutrition, scanning the items that exist on the purchase ticket, making use their smartphone. This solution can make recommendations in what users should eat based on a recommended diet.

Keywords: Elderly · Smartphone · Scan tickets

1 Introduction

At present, the world is experiencing population-aging, a trend that is both pronounced and historically unprecedented. Over the past six decades, countries had experienced only a slight increase in the share of people aged 65 years and older, from 8% to 10%. However, in the next four decades, this group is expected to rise to 22% of the total population, a jump from 800 million to 2 billion people [1].

This trend is even more worrying in rural regions, for example, Extremadura in Spain or Alentejo in Portugal. This kind of regions have lower population density than the average, and they keep losing its young population to more socioeconomically developed regions. Therefore, they have a higher-than-average aged population while being economically disadvantaged with a fragile cultural and socioeconomic context. Additionally, due to low population density and youth migration to richer regions, elders frequently live alone [2].

Aging in these regions is not a problem by itself, at least not directly. However, as people become older, they are more prone to diseases such as cognitive impairment, diabetes, hypertension, and cardiovascular problems. Different studies indicate that a significant number of these diseases related to aging have their origin in deficient nutrition [3].

Elders are a particularly disadvantaged group with respect to nutrition, especially if compared with the rest of the population in developed countries [3].

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Frequently, the elderly suffer changes in their nutritional patterns that, in some cases, can cause significant damages to their physical condition. For instance, some older people change their dietary habits, increasing their intake of greasy and salty food, or decreasing the total ingested food. This change of patterns usually leads to important-nutrient losses that directly influence the health of older people [4]. Deficient eating habits can cause serious problems in the function and cognitive status of elders, in addition to a higher rate of mortality, such as due to cardiovascular problems or anorexia episodes [5].

During the last few years, important research efforts have been devoted to various aspects related to feeding, not only for aging populations but also for the general population, addressing different nutritional disorders. One of the main objectives of the scientific community is to precisely monitor and identify nutritional patterns and ingested by elderly people. Different studies have shown that elders' nutritional patterns are a valid parameter for predicting their quality of life [6–8]. Specifically, there are approaches in this area to propose new algorithms, techniques, or systems for improving food-intake monitoring.

Food-intake monitoring is intended to acquire information, such as the number of vitamins, minerals, and other substances ingested by a person [9]. This information is then used for the identification of nutritional patterns and the detection of nutritional problems. Most works in this field focus on the state of nutrition and their relationship with different diseases, such as obesity [10], Alzheimer's disease [11], depression [12], and metabolic syndrome [13].

In general, these approaches propose to periodically carry out different surveys to the elderly in order to know their food-intake patterns, what their illnesses are, and the evolution of both. In this process, the prevalent method of diet monitoring is manually recording survey results [14–16]. However, this is a tedious process that ends with a low adherence rate, reducing its long-term effectiveness [17,18]. To address the problem presented by manual recording, numerous technological solutions have been proposed. These solutions introduce the use of a wide range of devices, technologies, and algorithms to automatically identify different aspects of the food-intake process, like the type of food being eaten and the amount of ingested calories, or identifying the person ingesting the food.

However, food-intake monitoring solutions have additional difficulties when taking into account the circumstances of an aging population, particularly when the monitored elders live in rural environments like the ones mentioned above. The lack of infrastructure, the low average technical skills of people living on these regions, the loneliness of elders, etc. hinder the deployment and use of food-intake monitoring systems. A study of the existing proposals is necessary to know if they can be deployed in these environments.

Continuous nutrition monitoring is essential to influence positively the nutrient content of the food supply and meet the changing nutrition needs of the population. Nutrition scientists in the food industry use nutrition monitoring data in a variety of ways that include developing nutrition communications for consumers and health professionals, guiding product development and reformulation, and applying research applications [19].

In this paper, a smartphone application for food-intake monitoring is presented focused on the coverage of the requirements the elderly living in rural and low populated regions. This research is part of an European project (International Institute for Research and Innovation in Aging - 0045-4IE-4-P) granted to improve the quality of life of elder people living in rural environments.

The rest of the paper is structured as follows. Section 2 presents the motivation for food-intake monitoring of aging populations in rural areas. Section 3 describes the proposed solution for food-intake monitoring making use a smartphone. And finally, Sect. 4 concludes this work.

2 Motivation

Food-intake monitoring in an aging population is important for detecting nutritional problems and, thus, be able to prevent related diseases. As mentioned above, one of the cheapest and less intrusive ways to perform this monitoring is through technological solutions, because methods relying on external supervisors can be complex, expensive and inaccurate, as the supervisors themselves are not involved in the eating activity and mostly rely on visual observation.

Existing monitoring systems usually focus on technical aspects related to automating the monitoring process, and improving precision in food and intake detection. Aspects like overall user impression, social acceptance, or system outputs are often considered. However, most works do no take into account the specific context in which the systems are deployed. This is particularly relevant in the case of elders living in rural regions, since several aspects have to be taken into account to make them viable for these environments (Fig. 1).

Fig. 1. Smartphone App.

3 Proposed Solution

The proposed solution is composed of different modules, which are related to each other. These modules are: the OCR algorithm, the food ontology, the database where the purchase tickets are stored, and the functions of the results graph.

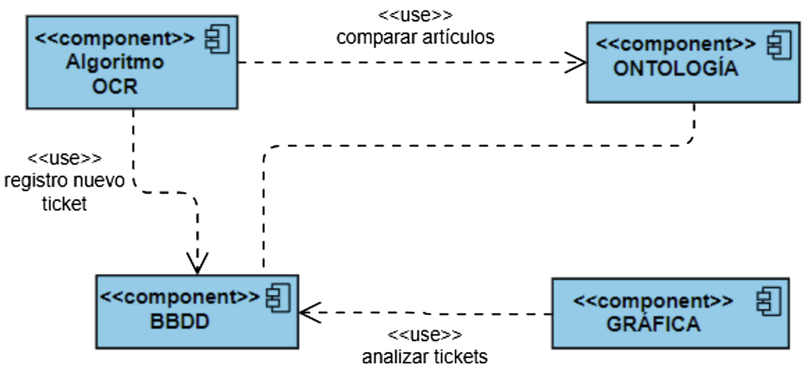

Fig. 2. Diagram of the different application modules.

The connection between the different modules can be seen in the Fig. 2. Next, each of the modules that make up the proposed application will be described in more detail:

3.1 OCR Module

This module requires to be connected to the food ontology module, as it requires to compare each of the items obtained from the scan of the purchase ticket. In addition, the result of the OCR algorithm of the purchase ticket scan will be stored in the database, so both modules must also be connected (Fig. 3).

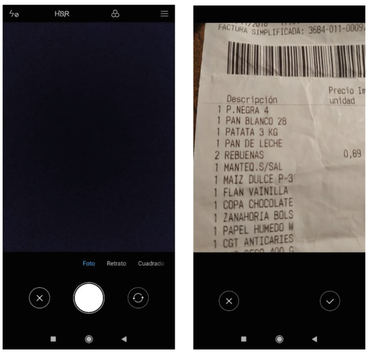

Fig. 3. OCR algorithm.

3.2 Food Ontology

This module formally defines the types of foods, their properties and the relationship between both (Fig. 4).

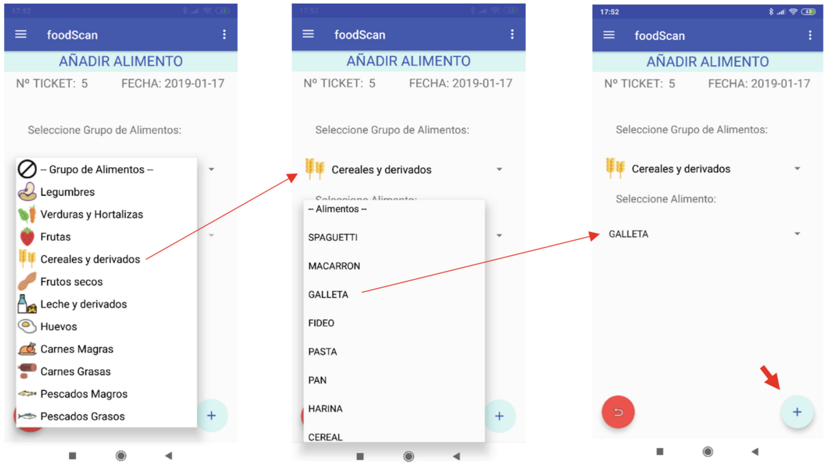

Fig. 4. Ontology.

3.3 Tickets Database

This module stores all the application data. With it, you can add new records, delete existing ones or query such data (Fig. 5).

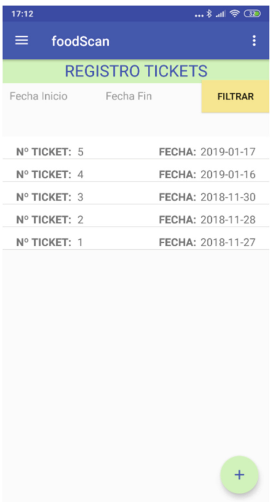

Fig. 5. Tickets database.

3.4 Charts Functions

This module generates the results of the analysis for the recommendations of diets to the users, making use of the data extracted from the database. As far as we can tell, this module is connected to the database module (Fig. 6).

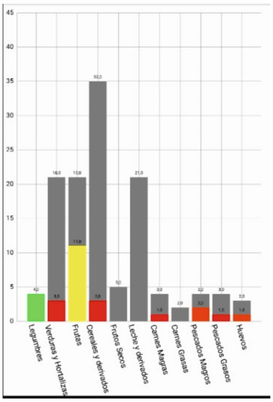

Fig. 6. Charts.

4 Conclusions

Today, society's food consumption is losing quality. The diet followed by people does not follow the recommendations of health experts, leading to different diseases, such as diabetes or cardiovascular disease. And in the elderly sector it is no different.

This paper presents an application for smartphones for the food monitoring and for the recommendation of diets according to the needs of each elder, making use of the data extracted by scanning the purchase tickets.

The project is in the verification and validation phase, although satisfactory results have already been obtained with the first tests carried out.

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Internet Use Among Informal Caregivers of People with Dementia: Results of an Online Survey

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Abstract. Informal caregivers (IC) of people with dementia (PWD) possess a greater risk of developing physical and psychological health problems. The internet was considered a promising modality to provide resources aimed at minimizing negative outcomes from caregiving. This descriptive study aims to determine the prevalence of internet use for health and caregiving-related purposes by former and current IC of PWD; and to explore caregiver and care receiver-related factors that might facilitate such use. Cross-sectional primary data was collected through a web-based survey (N = 97). The frequency of internet use for health and caregiving-related purposes varied greatly across specific purposes. Internet was more frequently used to gather information on the disorders and care provision strategies; while it was used less often to get emotional support and learn how to manage negative effects of caregiving. Regardless of the specific purpose, a frequent internet use was never observed in more than 50% of the sample. A more frequent use of internet for health and caregiving-related purposes was reported by IC classifying the care receivers' degree of dependence as 'total' or 'severe'; or assessing their own physical health as 'much worse' or 'worse' when compared to their counterparts. IC evaluating their own psychological health as 'worse' or 'much worse' when compared to their counterparts reported a more frequent use of internet resources to learn about the disease or to provide good care, but a less frequent use to get emotional support. These findings can be used to make decisions on resource distribution to IC of PWD.

Keywords: Informal caregivers (IC) · People with dementia (PWD) · Health information · Internet use

1 Introduction

Worldwide, 47.5 million people were estimated to live with dementia in 2015 [1]. Dementia is a syndrome caused by neurodegenerative diseases affecting memory, thinking,

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behaviour and the ability to perform everyday activities. This group of disorders is, among older adults, one of the major causes of disability and dependence [2], often requiring permanent care. People with dementia (PWD) are often cared by family members and other informal caregivers. Informal caregivers (IC) are providers of unpaid and ongoing assistance to a person with a chronic illness or disability with basic or instrumental activities of daily living [3]. This form of assistance is more expressive in territories characterized by a familialistic tradition, being noticeable in Southern Europe [4]. Portugal has one of the highest rates of informal home care in Europe (12.4%) [5].

IC of PWD may experience positive intrinsic reinforcement from the experience of caring. However, these caregivers are often exposed to several stressors and possess a greater risk of developing depression and anxiety disorders when compared both with the general population and with IC of people with other chronic diseases [6]. The experience of stress and burden was associated with the increase of caregivers' harmful or abusive behaviours towards the care recipients [7]. In resemblance, caregiver's psychosocial variables, including sense of caregiver burden, caregiver's mental health status and perceived inability to provide care/self-efficacy, seem to predict the institutionalization of the care receiver [8–10]. This evidence stresses the need to reduce caregivers' stress and burden, in order to avoid undesired upshots for both the IC and the care receivers. To mediate the association between caregivers stress and important consequences, the stress process model highlights the adequate use of resources [11]. According to this perspective, higher levels of stress tend to be experienced by IC if coping resources are perceived to be beneath their demands [11]. Thus, IC typically tend to look for external resources that might support them in dealing with stress and health problems, as well as in providing the care recipients with ongoing quality care [12].

Previous research on resource use by IC have focused on services available in the community (e.g. respite services; caregiving assistance), all those being face-to-face resources [13–15]. Only a limited number of studies examined the use of health and caregiving-related internet-based resources by IC of PWD. Internet-based health resources comprise information on websites and activities resorting to information and communication technologies (ICT) [16]. In the current high-tech society, understanding the use of virtual resources is a matter of interest *per se*, but it is also relevant due to the internet potential to overcome barriers in using face-to-face resources. These barriers include time and transportation constraints, as well as geographic limitations [17]. One of the few studies on how much dementia caregivers use the internet for health and caregiving-related purposes concluded that this behaviour has become more prevalent among American IC [16]. This trend was explained by the increasing availability and adoption of the internet and technological devices; high motivation of health care consumers; positive perceptions about internet resources; and promising results of internet-based approaches [16]. Interestingly, another study by DiZazzo-Miller reported an increase use of internet-based health resources according to the stage of the disease, i.e. internet use increased from 14% in IC of people living in the early stage of the disease, to 100% in late stage [18]. Also, the caregivers' subjective evaluation of their own stress and health status was pointed as an important factor to identify health-related internet users [16]. In spite of these reports, when compared to the general public, lower levels of health-related internet use by IC of PWD were found, whereas similar to those in caregivers of people with other health conditions [16]. IC of PWD reported to feel uncomfortable or miss the necessary experience to use a device and/or the internet [18]. Information overload when searching by resources, and uncertainties on how reliable is the information available online, arose as barriers for health-related internet use [18].

Evidence-based practice in what concerns resource provision to IC of PWD requires more data to support it as there is a lack of information on how much and how do dementia caregivers use the internet for health and caregiving-related purposes. In the Portuguese context this is an even more pressing need considering that the country is positioned above the OCDE average, and in the fourth place, in what concerns dementia prevalence [19], together with a great reliance on IC to provide care to PWD.

This paper presents the preliminary results of a study aiming to characterize the use of internet-based resources for health and caregiving-related purposes, by Portuguese former and current IC of PWD. Moreover, building on clues provided by the few literature produced on this topic, this study explore the use of those resources by IC of PWD with lower and higher levels of perceived dependence; and by IC showing better and worse perceptions of their own physical and psychological health.

2 Methods

2.1 Design

This descriptive study uses cross-sectional primary data collected through a web-based survey. The data collection strategy was selected taking into account both respondent features – the study targets IC of PWD having digital skills –, and the survey features – as the survey instrument required complex branching. Based on the existing literature, a questionnaire was designed for self-completion. To understand the caregivers' profile regarding general internet activity, the frequency of internet use for *any purpose* was first assessed, and it could be classified according to the Eurostat classification of internet use into (a) everyday; (b) at least once a week; (c) at least once a month; and (d) less than once a month. Internet use for health and caregiving-related purposes was classified in a 4-points nominal scale (1 "never"; 2 "rarely"; 3 "sometimes" and 4 "frequently"). The IC were questioned about their use of the internet to gather information and resources on eight health and caregiving-related topics: (a) disorders features (e.g. causes, types, symptoms, diagnoses, progression, intervention/treatment); (b) strategies to provide good quality care; (c) professional care services for the person with dementia; (d) support services targeting the caregiver (e.g. counselling, intervention programs); (e) strategies to manage negative psychological effects that might emerge from providing care (e.g. anxiety); (f) legal, fiscal and financial support issues and measures; (g) experiences of other caregivers, shared on social media (e.g. Facebook pages, blogs), which can be bi-directional in the sense of mutually sharing experiences; and (h) ICT-based interventions for IC of PWD. Sociodemographic information regarding both the caregiver and the care receiver, as well as information concerning the provision of care, was collected. Participants were asked to subjectively classify the level of dependence of their care receiver as (a) total; (b) severe; (c) moderate; or (d) mild; and assess their own physical and psychological health, in comparison with individuals of the same sex and age, as (a) much worse, (b) worse; (c) equivalent; (d) better; or (e) much better.

The questionnaire was programmed in a fill-in form using the open source survey tool *LimeSurvey*, and the data hosted in the servers of the University of Porto, Portugal. The survey was carried in the second quarter of 2019. It was distributed through multiple channels including: (1) the website and social media channels of the national Alzheimer's association; (2) mailing list with subscribers gathered from dissemination actions taken in the national project "Café Memória" [Memory Café]; (3) Facebook pages on the topic on caring for PWD or elders (n = 6); and (4) social media channels and mailing lists of intervention projects with IC of PWD existing in the community - national projects were previously mapped at the request of the Portuguese Ministry of Labour, Solidarity and Social Security [20], and this list was used to establish dissemination partnerships. The respondents remained anonymous, as a link was provided to access the questionnaire and the e-mail addresses were never revealed. The study information was given to the participants in an introductory page of the questionnaire.

For descriptive data analysis, SPSS version 25 (IBM, Somers, NY, USA) was used.

2.2 Sample

The web-based questionnaire targeted Portuguese adults, self-declaring to be current or former IC of PWD. IC of PWD were defined as persons who provided, at the time of participation in the study or in the past, unpaid care or assistance to anyone living with dementia. Trial questions opened the questionnaire, in order to exclude paid caregivers and IC of people with other health conditions.

During the survey period, the questionnaire was accessed by 191 potential participants. Around 25.7% (n = 49) of participants did not continue to fill the questionnaire after the starting page, and 7.9% (n = 15) were automatically stopped due to the answers given to the trial questions (6 participants were not IC of people with dementia; and 9 were paid caregivers). After checking for plausibility of answers, 1 additional record was removed. 25 participants did not answered to the set of questions posed to address the research question approached in this paper, and 4 cases were excluded from the analysis based on listwise deletion across the variables under examination. This resulted in a total sample of 97 participants, constituting 50.8% of questionnaire accesses.

Regarding the sample characteristics (see Table 1), at the time of the survey 68% (n = 66) of participants were current IC of individuals with dementia and 32% (n = 31) were former IC. The participants age ranged from 18 to 79 years old (mean 49.3 years; SD 12.1) and the majority of IC were female (96.9%; n = 94). According to the NUTS II territorial classification, the northern Portuguese region was the most represented in the sample (50.5%; n = 49). The education level was rather high (median 16 years), with only a few IC reporting to have stopped studying after the elementary school (n = 5). Most IC were in a relationship (53.6%; n = 52) and were employed (62.9%; n = 61). Among the unemployed IC, 41.7% (n = 15) stated to be in this situation to care for the person with dementia. Most IC were sons or daughters of the person being cared for (72.2%; n = 70), and lived with him/her (72.2%; n = 70).

On average, current IC reported to be caring for 5.4 years (SD 3.5) while spending 59.5 h per week (SD 58.3) on this activity. Former IC took care for 7 years on average (SD 4.1), stop caring 2.99 years ago on average (SD 3.52), and spent 65.5 h per week on average providing care (SD 61.1). Former IC (n = 31) stop caring for different reasons,

Table 1. Sociodemographic and caregiving-related characteristics of IC and care receivers.

Variables	Current informal caregivers (n = 66)	Former informal caregivers (n = 31)	Total (N = 97)
Description of the caregiver			
Age (years), mean (SD)	50.4 (10.8)	47 (14.5)	49.3 (12.1)
Gender, n (%)			
Male	2 (3.0)	1 (3.2)	3 (3.1)
Female	64 (97.0)	30 (96.8)	94 (96.9)
Residence area, n (%)			
North	32 (48.5)	17 (54.8)	49 (50.5)
Center	13 (19.7)	3 (9.7)	16 (16.5)
Lisbon and Vale do Tejo	17 (25.8)	7 (22.6)	24 (24.7)
Alentejo	1 (1.5)	2 (6.5)	3 (3.1)
Algarve	1 (1.5)	n/a	1 (1.0)
Autonomous region - Madeira	1 (1.5)	1 (3.2)	2 (2.1)
Autonomous region - Azores	1 (1.5)	1 (3.2)	2 (2.1)
Education Level, median (range)	15 (4–23)	17 (4–26)	16 (4–26)
Marital status, n (%)			
Single	16 (24.2)	10 (32.3)	26 (26.8)
Married/living together	39 (59.1)	13 (41.9)	52 (53.6)
Divorced	10 (15.2)	4 (12.9)	14 (14.4)
Widower/widow	1 (1.5)	4 (12.9)	5 (5.2)
Employment status, n (%)			
Employed	40 (60.6)	21 (67.7)	61 (62.9)
Unemployed	26 (39.4)	10 (32.3)	36 (37.1)
Relationship with the care receiver, n (%)			
Husband/wife	11 (16.7)	3 (9.7)	14 (14.4)
Mother/father	47 (71.2)	23 (74.2)	70 (72.2)
Brother/sister	n/a	n/a	n/a
Mother/father in law	2 (3.0)	n/a	2 (2.1)
Friend	n/a	n/a	n/a

(*continued*)

Table 1. (*continued*)

Variables	Current informal caregivers (n = 66)	Former informal caregivers (n = 31)	Total (N = 97)
Other	6 (9.1)	5 (16.1)	11 (11.3)
Cohabitation, n (%)			
Yes	48 (72.7)	22 (71.0)	70 (72.2)
No	18 (27.3)	9 (29.0)	27 (27.8)
Description of the care provision			
Caregiving duration (years), mean (SD)	5.4 (3.5)	7.0 (4.1)	5.8 (3.4)
Caregiving hours (per week), mean (SD)	59.5 (58.3)	65.5 (61.1)	39.5 (31.5)
Shared caregiving, n (%)			
Yes	38 (57.6)	26 (83.9)	64 (66.0)
No	28 (42.4)	5 (16.1)	33 (34.0)
Description of the person with dementia			
Age (years), mean (SD)	78.9 (10.3)	77.5 (9.2)	78.5 (10)
Gender, n (%)			
Male	16 (24.2)	13 (41.9)	29 (29.9)
Female	50 (75.8)	18 (58.1)	68 (70.1)
Type of dementia, n (%)			
Alzheimer's disease	41 (62.1)	12 (38.7)	53 (54.6)
Vascular dementia	15 (22.7)	7 (22.6)	22 (22.7)
Lewy body dementia	n/a	n/a	1 (3.2)
Frontotemporal dementia	6 (9.1)	5 (16.1)	11 (11.3)
Unknown	3 (4.5)	4 (12.9)	7 (7.2)
Other	1 (1.5)	2 (6.5)	3 (3.1)
Time since diagnosis (years), mean (SD)	6.85 (6.1)	7.23 (3.9)	7.0 (5.4)
Dependence level, n (%)			
Total	24 (36.4)	21 (67.7)	45 (46.4)
Severe	18 (27.3)	6 (19.4)	24 (24.7)
Moderate	18 (27.3)	3 (9.7)	21 (21.6)
Mild	6 (9.1)	1 (3.2)	7 (7.2)

being the most frequent one the death of the person with dementia (83.9%; n = 26), followed by the delegation of care provision to a formal caregiver or institution (16.1%;

n = 5). Most IC share/shared the care provision with other carer(s) (66%; n = 64), either informal (51.6%; n = 33) or paid (48.4%; n = 31). IC sharing the care provision with paid caregivers choose either specialized (48.4%; n = 15) and non-specialized (51.6%; n = 16) care professionals.

The mean age of the individuals with dementia being cared for was 78.5 years (SD 10) and the majority were women (70.1%; n = 68). Most were diagnosed with Alzheimer's disease (54.6%; n = 53). Current IC take care for individuals diagnosed 6.85 years ago on average (SD 6.1), while former IC stop providing care when the person had a 7.23 years diagnosis of dementia (SD 3.9). The care receiver degree of dependence was subjectively classified by the IC, with a predominance of total and severe dependence levels being found for both current (63.7%; n = 42) and former IC at the time they stop caring (87.1%; n = 27).

3 Results

3.1 Frequency of Internet Use for Health and Caregiving-Related Purposes

The great majority of the respondents (90.7%; n = 88) reported, as expected, a very frequent, i.e. daily use, of the internet for any purpose (see Table 2). Only five respondents (5.2%) reported to use the internet less frequently, but at least once a week, and four participants reported an occasional internet use for any purpose.

The frequency of internet use for health and caregiving-related purposes varied greatly according to the specific purpose. Internet-based resources are more frequently consulted by the IC with the purpose of gathering information on the disorders, with the great majority of the participants reporting to do it, regardless of the frequency (93.8%; n = 91), and almost half of the participants (49.5%; n = 48) reporting a frequent use of the internet with this purpose. Concerning the use of the internet to get information on strategies to provide good quality care, most IC reported to do it, regardless of the frequency (92.8; n = 90), and most do it "sometimes" (45.4%) or frequently (40.2%; n = 39). In resemblance, the internet is used by most IC to find resources on professional care services for the person with dementia (90.7; n = 88), but a frequent use for this purpose is less reported than for the previous issues (33%; n = 32). Also less reported is the overall use of the internet to access resources on legal, fiscal and financial support issues, with 20.6% (n = 20) of the participants stating that they never did it.

Concerning the obtainment of emotional support for the caregiver him/herself, the frequency of internet-based resources use tends to decline. In particular, 16.5% of participants reported to never have used the internet to find support services targeting them (e.g. counselling, intervention programs), and only 26.8% (n = 26) reported to use it frequently. Also, 19.6% (n = 19) have never used internet-based resources to find strategies to manage the negative psychological effects from providing care, and only about a quarter of the sample reported to use it frequently with this purpose (25.8%; n = 25).

Among the analysed health and caregiving-related purposes for using internet-based resources the less frequent ones were to get information from or share experiences with other IC, and to access or get information on ICT-based interventions for IC. Most IC reported to have never used the internet to know about/share experiences with other IC (44.3%; n = 43) and only 11.3% (n = 11) reported to do it frequently. Also, most IC

Table 2. Use of health and caregiving-related internet-based resources by IC of PWD.

Variables	Total (N = 97)	By level of dependence		By perceived physical health		By perceived psychological health	
		Total/Severe (n = 69)	Moderate/Mild (n = 28)	Worse (n = 46)	Better/equivalent (n = 51)	Worse (n = 59)	Better/equivalent (n = 38)
Frequency of internet use, n (%)							
Everyday	88 (90.7)	64 (92.8)	24 (85.7)	43 (93.5)	45 (88.2)	54 (91.5)	34 (89.5)
At least once a week	5 (5.2)	2 (2.9)	3 (10.7)	3 (6.5)	2 (3.9)	3 (5.1)	2 (5.3)
At least once a month	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Less than once a month	4 (4.1)	3 (4.3)	1 (3.6)	n/a	4 (7.8)	2 (3.4)	2 (5.3)
Frequency of internet use - health and caregiving-related purposes, n (%)							
Information on disorders							
Never	6 (6.2)	6 (8.7)	n/a	1 (2.2)	5 (9.8)	4 (6.8)	2 (5.3)
Rarely	7 (7.2)	2 (2.9)	5 (17.9)	1 (2.2)	6 (11.8)	3 (5.1)	4 (10.5)
Sometimes	36 (37.1)	23 (33.3)	13 (46.4)	13 (28.3)	23 (45.1)	19 (32.2)	17 (44.7)
Frequently	48 (49.5)	38 (55.1)	10 (35.7)	31 (67.4)	17 (33.3)	33 (55.9)	15 (39.5)
Strategies to provide quality care							
Never	7 (7.2)	6 (8.7)	1 (3.6)	2 (4.3)	5 (9.8)	5 (8.5)	2 (5.3)
Rarely	7 (7.2)	3 (4.3)	4 (14.3)	2 (4.3)	5 (9.8)	3 (5.1)	4 (10.5)
Sometimes	44 (45.4)	29 (42.0)	15 (53.6)	16 (34.8)	28 (54.9)	20 (33.9)	24 (63.2)
Frequently	39 (40.2)	31 (44.9)	8 (28.6)	26 (56.5)	13 (25.5)	31 (52.5)	8 (21.1)
Professional care services							
Never	9 (9.3)	8 (11.6)	1 (3.6)	5 (10.8)	4 (7.8)	8 (13.6)	1 (2.6)
Rarely	21 (21.6)	12 (17.4)	9 (32.1)	8 (17.4)	13 (25.5)	10 (16.9)	11 (28.9)
Sometimes	35 (36.1)	24 (34.8)	11 (39.3)	13 (28.3)	22 (43.1)	18 (30.5)	17 (44.7)
Frequently	32 (33.0)	25 (36.2)	7 (25.0)	20 (43.5)	12 (23.5)	23 (39.0)	9 (23.7)
Support services for the caregiver							
Never	16 (16.5)	10 (14.5)	6 (21.4)	9 (19.6)	7 (13.7)	12 (20.3)	4 (10.5)
Rarely	26 (26.8)	18 (26.1)	8 (28.6)	10 (21.7)	16 (31.4)	16 (27.1)	10 (26.3)
Sometimes	29 (29.9)	21 (30.4)	8 (28.6)	11 (23.9)	18 (35.3)	13 (22.0)	16 (42.1)
Frequently	26 (26.8)	20 (29.9)	6 (21.4)	16 (34.8)	10 (19.6)	18 (30.5)	8 (21.1)
Strategies to manage negative effects							
Never	19 (19.6)	14 (20.3)	5 (17.9)	10 (21.7)	9 (17.6)	15 (25.4)	4 (10.5)
Rarely	23 (23.7)	16 (23.2)	7 (25.0)	7 (15.2)	16 (31.4)	11 (18.6)	12 (31.6)
Sometimes	30 (30.9)	20 (29.9)	10 (35.7)	14 (30.4)	16 (31.4)	18 (30.5)	12 (31.6)
Frequently	25 (25.8)	19 (27.5)	6 (21.4)	15 (32.6)	10 (19.6)	15 (25.4)	10 (26.3)
Legal, fiscal, financial issues							
Never	20 (20.6)	14 (20.3)	6 (21.4)	9 (19.6)	11 (21.6)	15 (25.4)	5 (13.2)
Rarely	30 (30.9)	21 (30.4)	9 (32.1)	13 (28.3)	17 (33.3)	15 (25.4)	15 (39.5)
Sometimes	22 (22.7)	14 (20.3)	8 (28.6)	10 (21.7)	12 (23.5)	15 (25.4)	7 (18.4)
Frequently	25 (25.8)	20 (29.9)	5 (17.9)	14 (30.4)	11 (21.6)	14 (23.7)	11 (28.9)

(*continued*)

Table 2. (*continued*)

Variables	Total (N = 97)	By level of dependence		By perceived physical health		By perceived psychological health	
		Total/Severe (n = 69)	Moderate/Mild (n = 28)	Worse (n = 46)	Better/equivalent (n = 51)	Worse (n = 59)	Better/equivalent (n = 38)
Experiences of other caregivers							
Never	43 (44.3)	30 (43.5)	13 (46.4)	19 (41.3)	24 (47.1)	28 (47.5)	15 (39.5)
Rarely	21 (21.6)	11 (15.9)	10 (35.7)	8 (17.4)	13 (25.5)	11 (18.6)	10 (26.3)
Sometimes	22 (22.7)	20 (29.9)	2 (7.1)	12 (26.1)	10 (19.6)	15 (25.4)	7 (18.4)
Frequently	11 (11.3)	8 (11.6)	3 (10.7)	7 (15.2)	4 (7.8)	5 (8.5)	6 (15.8)
ICT-based interventions							
Never	47 (48.5)	33 (47.8)	14 (50.0)	22 (47.8)	25 (49.0)	30 (50.8)	17 (44.7)
Rarely	29 (29.9)	21 (30.4)	8 (28.6)	12 (26.1)	17 (33.3)	17 (28.8)	12 (31.6)
Sometimes	15 (15.5)	11 (15.9)	4 (14.3)	8 (17.4)	7 (13.7)	9 (15.3)	6 (15.8)
Frequently	6 (6.2)	4 (5.8)	2 (7.1)	4 (8.7)	2 (3.9)	3 (5.1)	3 (7.9)

(48.5%; n = 47) have never used the internet to access or get information on ICT-based interventions for IC of PWD, and only 6.2% (n = 6) reported to do it frequently.

3.2 Health and Caregiving-Related Internet Use by Care Receivers' Dependence

IC subjectively classifying the degree of dependence of the person they care for as total or severe (n = 69) reported a more frequent use of all health and caregiving-related internet resources than IC classifying the person with dementia as moderately or mildly dependent (n = 28), with the exception being the search/use of ICT-based interventions (see Table 2). This difference is greater for gathering information on the disorders, with 55.1% (n = 38) of IC of people considered totally or severely dependent reporting to do it, by contrast with 35.7% of IC of those moderately or mildly dependent.

3.3 Health and Caregiving-Related Internet Use by Perceived Physical and Psychological Health Status

When subjectively comparing themselves with individuals of the same sex and age in what concerns physical health, 47.4% of participants (n = 46) perceived it as worse or much worse, while (52.6%; n = 51) considered their physical health to be equivalent, better or much better than the one of their counterparts. By another hand, the participants' psychological health was, in general, worse self-evaluated. When subjectively comparing themselves with individuals of the same sex and age in what concerns psychological health, 60.8% (n = 59) of IC perceived it to be worse or much worse, while 39.2% (n = 38) perceived their psychological health as equivalent, better or much better than the one of their counterparts.

IC assessing their own physical health as much worse or worse than the one of their counterparts, reported a more frequent use of all health and caregiving-related internet resources than IC assessing it as equivalent, better or much better. A frequent use of some resources is twice as much for the IC perceiving themselves has having a worse physical health, which is the case for gathering information on the disorders (67.4% vs. 33.3%), find strategies to provide quality care (56.5% vs. 25.5%), or share experiences with other IC (15.2% vs. 7.8%). With regards to the subjective evaluation of their own psychological health status in comparison to their counterparts, IC assessing it as worse or much worse reported a more frequent use of some health and caregiving health related resources than IC assessing their psychological health as equivalent, better or much better. This was the case for finding information on the disorders (55.9% vs. 39.5%); on strategies to provide good quality care (52.5% vs. 21.1%); on professional care services (39.0% vs. 23.7%); and on support services for the caregiver (30.5% vs. 21.1%). However, IC assessing their own psychological health as equivalent, better or much better reported a more frequent use of resources aimed at finding strategies to manage negative psychological effects from caregiving (25.4% vs. 26.3%); on legal, fiscal and financial support issues and measures (23.7% vs. 28.5%); on experiences of other IC (8.5% vs. 15.8%); and on ICT-based interventions (5.1% vs. 7.9%).

4 Discussion

This descriptive study provided a characterization of internet-based resources for health and caregiving-related purposes by IC of PWD, in a Portuguese sample. Participants in this study were, as expected when employing the method of online surveying, mostly very frequent overall internet users. However, a frequent use of the internet to specifically access health and caregiving-related resources was only reported by, at most, half of the sample. Kim [16] found similar trends in a larger sample, with only 59.1% of IC being identified as health-related internet users. In this study, the frequency of internet use for health and caregiving-related purposes varied greatly according to the specific purpose. IC participating in this study showed a preference for using internet to improve their knowledge on the disease, to learn on how to provide good quality care or to find specialized support for providing care. However, the use of internet-based resources for the own benefit of the caregiver, namely to find or access support services, to learn about strategies to manage the negative psychological effects of caregiving, to share experiences with other IC or to access ICT-based interventions, is found only on about or less than one quarter of the sample. This is an interesting result, especially when considering that a substantial amount of participants perceived their physical and/or psychological health as worse or much worse than the one of their counterparts. In this study, a greater use of most internet-based resources was found in IC perceiving themselves as having a worse physical and/or psychological health in comparison with their counterparts. This finding is in accordance with previous research [16]. However, IC reporting a worse/much worse psychological health than their counterparts, do not report a greater use of resources aimed at reducing the negative effects of caregiving, such as support services for IC, peer support or ICT-based interventions. Additional insights are needed to understand if IC are less prone to search for resources for their own benefit/well-being, prioritizing knowledge-base and practical resources, or if the former are searched in the face-to-face environment, but not in the virtual one.

A greater use of the internet for health and caregiving-related purposes, was, in this study, more observed in IC reporting higher levels of dependence for their care receivers.

This finding is aligned with previous studies [18], reporting that the care receivers' level of dependence, subjectively evaluated by the caregiver, seem to influence the IC use of internet-based resources. IC of individuals in the initial stage of the disease and less dependent may reveal a preference for using very structured and complete resources offered by local Alzheimer's Associations, such as training programmes [18].

Findings discussed in this paper are preliminary and its discussion is limited by the descriptive nature of the analysis. However, due to the fast evolving nature of the internet potentials and usage - internet research is one of the most fast changing research fields - it is imperative to broadcast study findings to the scientific community. Methodological limitations of this study include the limited generality due to the use of a convenience sampling method; possible volunteer bias due to the recruitment via advertising; and possible responder bias due to the use of self-reported data. Moreover, this study purposely targets IC who have enough ICT skills to use internet resources. However, this captures a specific profile of IC, typically more educated, as the education level was identified as a predictor of internet use. Ongoing work includes the sample extension in order to perform more complex and powerful statistical analysis. In particular, a deeper study of which sociodemographic and caregiving-related factors are associated with health and caregiving-related internet use in IC of PWD is needed, given the scarce scientific production on this topic. Still, limited inference of causality will be always a limitation of this study given its cross-sectional design.

5 Conclusion

In the modern society, internet-based resources may play an important role in providing information and support to IC of PWD, especially considering the current challenges in scaling health and support services against an aging society. This study adds to existing knowledge on the prevalence of internet use for health and caregiving-related purposes by IC of PWD. It also provides clues on IC and care receivers' factors that might be related to internet use for those purposes. The subjective evaluation of IC about the care receivers' level of dependence, as well as the perception about their own physical and psychological health, were found to be interesting factors to explore further with more sophisticated statistical analysis. Resorting to a Portuguese sample, the study offers interesting contributions to a field characterized by the scarcity of research produced so far. These contributions might be used by both practitioners and policy makers to make decisions on resource distribution through the internet, to IC of PWD.

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Technologies to Increase the Quality of Life of the Elderly Population

Digital Avatars for Older People's Care

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Abstract. The continuous increase in life expectancy poses a challenge for health systems in modern societies, especially with respect to older people living in rural low-populated areas, both in terms of isolation and difficulty to access and communicate with health services. In this paper, we address these issues by applying the Digital Avatars framework to Gerontechnology. Building on our previous work on mobile and social computing, in particular the People as a Service model, Digital Avatars make intensive use of the capabilities of current smartphones to collect information about their owners, and applies techniques of Complex Event Processing extended with uncertainty for inferring the habits and preferences of the user of the phone and building with them a virtual profile. These virtual profiles allow to monitor the well-being and quality of life of older adults, reminding pharmacological treatments and home health testings, and raising alerts when an anomalous situation is detected.

Keywords: Gerontechnology · Social Computing · People as a Service · Digital Avatar · Complex Event Processing

1 Introduction

The progressive growth in life expectancy comes together with increasing population aging, in particular in Western societies. Despite elder adults are nowadays more active and in better health and physical conditions than anytime in the past, their health requires assiduous supervision and care: regular medical revisions and tests, pharmacological treatments, and many other therapies. This poses a challenge for the health systems in those aging societies, especially with respect to older people living in rural and low population areas. Gerontechnology [1] is an interdisciplinary field that brings together gerontology and technology for creating technological environments for inclusive, innovative, and independent living and social participation of older adults. Its concerns deal with matching technological environments to health, housing, mobility, communication, leisure and work of elder people [2].

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Our approach to Gerontechnology advocates for making intensive use of the sensoring, computing and storing capabilities of smartphones for improving the well-being and quality of life of older adults. Indeed, current mobile phones have more capabilities than ever before [3]. We intend to use these capabilities for developing a framework in which to apply complex techniques of data processing and manipulation based on the *People as a Service* (PeaaS) model [4]. PeaaS provides a conceptual framework for application development focused on the smartphone as a representative and interface to its owner. By employing the capabilities of the phone' sensors, we are able to infer the routines and preferences of its owner a build with them her virtual profile. This information can then be offered to third parties to generate value-added services or to interact with the user's IoT environment in an automated way. All the information is stored locally in the smartphone, guaranteeing that its owner keeps full control over which data is being shared and whom.

At the same time, we apply Complex Event Processing (CEP) [5,6] to process the information obtained from the smartphone, in order to take complex decisions according to the data perceived. The processing of events will take place in the device of the user itself, avoiding the need of a server for data processing purposes and reducing the amount of online communication. This allows us to generate better and more appropriate responses to the situations encountered by users, increasing the interactivity and efficiency of their applications.

In the context of the research project *Digital Avatars: A Framework for Collaborative Social Computing Applications* (2019–2021) in which the authors of this paper are currently involved, we are extending virtual profiles with behavioral rules that govern their inference, evolution, and use. This combination of rules and data related to a particular user and her environment is what we call her Digital Avatar.

In this paper, we introduce our proposal for applying Digital Avatars to the Gerontechnology field. After this introduction, we present a motivating example for illustrating our proposal (Sect. 2), and we give an extensive description of the framework (Sect. 3), describing its architecture, how we obtain and treat the necessary data, and how uncertainty is addressed in the proposal. Some related works are presented in Sect. 4, while Sect. 5 discusses both the benefits and risk of the approach. Finally, Sect. 6 concludes the paper.

2 Older People in Rural Areas

In order to illustrate the application of Digital Avatars to Gerontechnology, in this section we present a motivating scenario of an older person living in a relatively isolated rural environment.

María is an older person living in a small village in a rural and almost deserted area. After her husband died, and with her children living away, María started feeling lonely and considered moving to a nursing home. However, she finally decided to stay in her lifelong house while she was able to help herself *properly. After all, she is fully autonomous, and only needs her sugar levels and blood pressure to be checked regularly, as she now suffers from diabetes.*

In order to avoid recurrent and cumbersome trips to the primary healthcare center, which is located in another town, the regional health services have provided María with some smart gadgets that can be connected to the smartphone she uses for talking with her children and for texting with her grandson. A glucose meter and a blood pressure monitor send their data by Bluetooth Low Energy (BLE) to her phone. These measurements are recorded there, together with relevant information about her daily activities, such as patterns of movements inside her house and within the village, and phone usage records (phone calls, app execution). Bluetooth is also used to detect proximity to other smartphones, particularly to those of her contacts, which enables detecting patterns of visits and social relations between María and her neighbors.

This way, both the healthcare center and María's children are aware of her health conditions, well-being, and even of her mood. For example, abnormal sugar levels in her blood, or the fact that she is not visiting her neighbor one afternoon, as she always does on Tuesdays, can be easily detected. In case that something seems to be wrong, the smartphone would request some interaction for checking with María whether everything is ok, or raise an alert to the appropriate contact person or to the emergency services.

In this scenario, the smartphone plays a central role in capturing, processing and storing information about its owner. With that purpose it monitors the sensors of the phone and also the devices in María's environment: movements detected by the phone accelerometer, GPS readings, usage of mobile apps, and BLE signals from IoT healthcare devices. The rules for processing all this information and detecting that any significant event has likely occurred are also stored in the phone, and managed by the Digital Avatar. Note the importance of dealing with confidence levels (i.e., aleatory uncertainty) when making decisions, given that all sensed data is subjected to deviations and potential measurement errors (e.g., a sensor may stop working properly for a short period of time), as well as María's variations in their regular habits due to uncertain environmental conditions (e.g., bad weather) or unexpected situations (e.g. a surprise visit from a relative) that may cause changes in her daily habits but do not represent any challenge to her health.

3 Framework Description

In this section we describe our proposal for applying Digital Avatars for older people's care. In particular, we discuss the requirements and expected functionality of the system, we describe the architecture of the framework, and we explain how a CEP engine will be used for generating, storing and processing in the smartphone the virtual profile of the user.

3.1 Functionality

The functionality of the system is primarily aimed at three types of active users: older adults living alone in small villages away from medical resources (older people), their social relationships and informal caregivers, usually close relatives or neighbours, and the staff (physicians, nurses) of the public health system.

The main goal of the system is to monitor the health and well-being of older people. The scenario presented in Sect. 2 represents independent older adults living alone. Thus, their smartphones are the main source of information about them, through their sensors (accelerometer, GPS, etc.), and also the health devices connected to them by Bluetooth, such as scales, blood pressure monitors or glucometers.

One of the functions of the system is to remind the older person to take the doses of their medications, which are fixed by the health professionals. At the time set, the smartphone alerts the elder to take the dose prescribed. If the user does not react to the alarm, the system may send a warning to the caregivers.

Another important function concerns the control of the elder's health parameters (e.g. weight, blood pressure, blood glucose level, etc.) Similarly, the system periodically reminds the user to measure them. The health device is connected via BLE and the measurement is transferred to the smartphone. If the values indicate an unhealthy condition, an alarm can be sent to health professionals, who can then consult the system for the latest measurements stored in the phone.

The mood and activity of older people are also monitored. Sudden changes in habits can be inferred from their use of telephones and how they interact with their neighbors. On the one hand, GPS readings are used to detect physical activities such as walking. On the other hand, Bluetooth detection of other smartphones indicates that users have made or received a visit, or have attended an event. One way to detect a change of mood is to check the use of the phone to call, and also social networks and text applications. Finally, the system may request the user to confirm whether it is fine when the phone has not been used or moved for a certain period of time. With all this information, the system infers patterns of behavior and health, which describe the regular development of user routines and the values of their health parameters. If an anomalous condition is detected, the Digital Avatar alerts neighbors, family or health system, depending on the severity of the situation.

3.2 Architecture

Present day smartphones have enough capabilities to run demanding applications, such as video games, manage all our social profiles, and work with office applications that required desktop computers not so long ago. This way, smartphones have become the most popular device for accessing computing resources and services. In this section, we present the architectural of our proposal, which builds on our previous work on the Internet of People [7] and PeaaS [4] models. The Digital Avatars architecture is deployed at the application level due to the restrictions of the operating system of the smartphone. Thus, all the modules of the architecture rely on OS calls to access any particular functionality or resource of the smartphone. The architecture is illustrated in Fig. 1. It represents the set of software elements required to build, populate, and share in a controlled way the user's information stored in the smartphone.

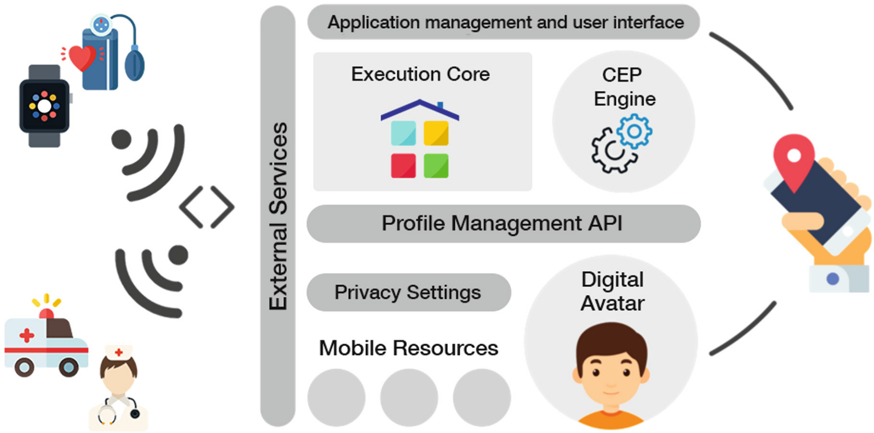

Fig. 1. Digital Avatars Architecture.

The digital avatar is the core element of the architecture. It consists in the user virtual profile and the privacy settings, which define the permissions to access that information. Virtual profiles are represented as JSON documents, and stored in the phone with Couchbase Lite, which offers NoSQL database storage for smartphones. The profile stores both the historic records of events of interest detected, chronologically ordered, and the higher-level virtual profile containing meaningful information about the user. In our case, this information will be mainly related with health: blood pressure and other health parameters, activity and rest time, and even the places the user has been to, or the people she has been with. The virtual profile can be offered as a service, allowing both other applications installed in the phone or external third parties to access it. Privacy concerns are addressed by the Privacy Settings, which define the access privileges to the user's information.

The digital avatar is built by an inference CEP engine capable of processing the raw data collected by the sensors in the smartphone and through other smart devices connected to it. The CEP engine extracts meaningful information from the raw data coming from different sources (built-in sensors, connected smart devices, etc.), by applying a set of rules and patterns. The engine performs two main tasks: detection of alarm conditions and inference of higher-level knowledge. From the first task, we are able to detect particular situations to derive some actions or changes in the system. For example, if the user suffers from an early stage of cognitive impairment and the smartphone detects that he has got lost, it will immediately alert a caregiver [8]. The inference task consists on the analysis of the information stored in the avatar for deriving added-value facts. For example, we can infer the regular activities of the user and the places she visits to predict where she will be at a certain moment [9]. This high level contextual information of the user is stored back in the profile. One of the main advantages of CEP is that it works in realtime, reducing latency in the decision-making process. Hence, it is very appropriate for asynchronous and realtime systems which must react quickly to changing or unusual situations.

The Profile Management API is the module that provides the operations to deal with the information in the profile and make some systems calls. It prevents unauthorized access to the virtual profile, and gives an unique and easy-to-use point of interaction with it. The API takes into account the Privacy Settings to allow or deny access to third party applications. For example, health professionals will have access only to the parts of the profile concerning health issues, not to other personal-related data.

The Mobile Device Resources layer is the element of the architecture that represents all the sensors available in the smartphone. Wearables and other devices connected to the smartphone are not represented here but they are accessed through the External Services module. This module gives support to the interactions of the smartphone with other external sources of information, like wearables, home assisting devices, or public web services offering contextual information like weather conditions, public transport, air quality, etc. Furthermore, this module manages the communications with third parties when a critical event is detected by the inference engine. For example, if a dangerous high blood pressure episode is detected, it will send an alarm to the emergency services.

Finally, the Execution Core module is where the front-end application is running. All the components of the architecture reside in the smartphone. Third parties will be able to access the digital avatar from the outside, provided they have the corresponding permissions. The traditional client/server approach breaks down into a decentralized architecture in which each smartphone node acts as server of its own produced data.

3.3 Data Collection

The raw data for feeding the digital avatar comes from several sources. The main source is the smartphone itself, which provides basic data on the use of the phone, such as the battery level or whether it is connected for charging. In addition, by means of the accelerometer it is possible to infer the activity of the user (if he carries it, obviously) and recognize different types of activities, such as typing, walking, driving, etc. We can also detect how much time has passed since the last time the user handled the device. The movements of the user can be monitored using the phone's GPS in conjunction with network detection via Wi-Fi, inferring if the user leaves home and the distance travelled during walks or visits to other places or people. In this sense, we can also detect if the user interacts with other people (who use Digital Avatars on their phones) since their phones will read BLE signals coming from other smartphones and detect the close presence their owners. In this way, it is possible to analyze if the user is accompanied or if she is related to other people in her everyday environment.

One step further is being able to detect the mood of the user. For that, we will observe the activity with the smartphone, analyzing the record of calls and their frequency, the use of various applications, programmed alarms etc. This data is available on most smartphones.

Finally, other sources of information are health devices that communicate with the smartphone to send their data. Today, most home medical devices communicate via BLE with their smartphone applications. Examples of such data can be provided by glucose meters or blood pressure monitors that are commonly and easily used in a domestic environment.

3.4 Extending CEP with Uncertainty

Complex Event Processing [5,6] is a form of information processing whose goal is the definition and detection of situations of interest from the analysis of low-level event notifications [10]. CEP allows the analysis of large amounts of data from different sources to detect significant information and react to a new situation in real time. CEP engines have typically been run on servers or desktop computers to detect domain-specific critical situations. However, our proposal integrates CEP in the Digital Avatars architecture, with the aim of building in the smartphone a complex virtual profile with high level information on health and habits of the user. This approach is known as mobile CEP [11] and has advantageous implicit characteristics, as there is no need to implement communication between the engine and the sensors. Everything relies on the smartphone, keeping the system information private and correlated.

When dealing with physical systems, sensors, and networks, as in our case, events received are not free from uncertainty. Uncertainty is the quality or state involving imperfect and/or unknown information and applies to predictions of future events, estimations, physical measurements, or unknown properties of a system. Measurement uncertainty is a kind of uncertainty that refers to the inability to know with complete precision the value of a quantity, an intrinsic aspect of any physical setting. Measurement uncertainty can be due to various causes, such as unreliable data sources and communication networks; tolerance in the measurement of the physical elements values; estimates due to the lack of accurate knowledge about certain parameters, or the inability to determine whether a particular event has actually happened or not.

The explicit representation and management of measurement uncertainty is a crucial issue in any faithful model of a given physical system. We have started working on the representation of measurement uncertainty in software models [12,13] and in CEP systems [14], using a probabilistic approach (instead of employing fuzzy logic or possibility theory). Our solution is presented in the form of a library that can be added to existing CEP engines. Note that the focus will be on measurement information (also known as epistemic uncertainty) and the confidence we have in the data we handle, and on the rules that determine the behavior of the digital avatars (aleatory uncertainty).

In particular, we plan to detect and incorporate measurement uncertainty in the events received by the different sensors, in the information stored in the digital avatars, as well as in the system of rules managing the generation of new complex events and alarms. In this way the models and applications will be more realistic by incorporating the uncertainty that exists in the real world.

As previously mentioned, we keep data and computations on the smartphone and avoid using a centralized server as much as possible. Hence, we need a fast, lightweight CEP engine that processes events directly on mobile devices. In this sense, Sebastian et al. [15] worked on a mobile CEP prototype of the Esper CEP engine for Android, named Esper-Android. At the present time, there is not an updated version of Esper-Android compatible with current smartphones, as its maintenance has been suspended due to dependence on third-party libraries not compatible with Android.

Instead, we plan to use Siddhi [16] which is a feature-rich stream processing platform from WSO2, successfully ported to Android devices and Raspberry Pi. The SiddhiQL query language is very similar to Esper's EPL (SQL-based) and includes the main types of operators needed to build the rules: select, filter, window, aggregations, group by, having, join and pattern. Combining these operators, we are able to build rules that implement the functional requirements described in Sect. 3: rules that infer a person's behavior and habits, rules that trigger alarms when a person's biometric values are outside the healthy range, etc.

4 Related Works

The amount of data available about users and their context is quite large, due to the number of integrated sensors available in smartphones, wearables and other devices found in our environment. In this regard, Ambient Intelligence has emerged as a discipline with the aim of making everyday environments sensitive and responsive to people's needs [17].

The main reason to gather information about the users of a system is to learn from them. With this knowledge we can proactively meet their needs to minimize their manual intervention. Contextual data is used to infer virtual profiles with more specific information about the users [18,19]. These profiles may be used to learn important aspects of the user's habits and health condition such as diets, movements, exercise habits and specific health information: heart rate, blood pressure or glucose levels among others. Currently, there are different approaches to create these virtual profiles [20–22].

Many existing solutions related to the monitoring of older people focus on geopositioning the user. Keruve and Neki[1] are two of the best-known enterprise solutions that allow the caregiver to locate the user in real time. However, the GPS devices that these and other companies sell are expensive, limiting their universal accessibility. In contrast, there are economic solutions based on mobile

[1] http://www.keruve.es/ *and* https://neki.es/.

applications like Cerqana and Tweri[2]. However, none of them offer any further information other than GPS positioning. We can provide a greater quantity and quality of knowledge by tapping into all the data the sensors in the smart devices have to offer, which allows us to infer the user's routines, movements and health, giving higher level appreciations. Several studies [23,24] relate the performance of outdoor activities, smartphone use and sleep routines with the probability of suffering depression. All of these indicators could be extracted from the data recollected by the sensors available in the smartphone. Moreover, there is also a good amount of studies about detecting the emotions of the users [25,26], where in many of them the smartphones have a great influence, since the users interact quite frequently with them, and the capabilities of phones such as being able to take pictures of the users facilitate this task.

The idea of transferring CEP processing from a centralized server to the smartphone is proposed in [15], using the sensors embedded in the device as a source of simple events. A similar idea is proposed in [27], where smartphone resources are used as part of the processing of the events generated by their sensors. However, none of the proposals analyzed incorporate the treatment of uncertainty in the data collected or processed.

5 Discussion

In this paper we have presented a research project that explores an alternative model for Social Computing, and applies it to the care of older adults. The benefits of this model are offered at three levels: for the the older persons, for their close caregivers, and for the public health system. The main benefits of the model are as follows:

- **Collaborative model**. We adopt a model based on a peer-to-peer architecture based on smartphones, as opposed to a more common client-server architecture. In this way, the Digital Avatars become a collaborative tool where the users may decide with which other avatars to share their data, and which external data they want to incorporate into their own avatar.
- **Control of the data**. The definition of an alternative paradigm in the area of Social Computing, where the exploitation of people's information can be owned and controlled by the people themselves, instead of being used or commercialized by third parties—without neither transparent control nor clear benefits to the data owners.
- **User safety**. The system is focused on monitoring the user's health: reminding them of their healthy guidelines by means of warnings, generating alarms for their caregivers or healthcare professionals, monitoring their habits and their state of mind.
- **Managing uncertainty**. The applications and models we propose manage the uncertainty that occurs in the real world, incorporating this uncertainty in the data obtained from sensors and devices, in the rules of the CEP engine and in the complex events that are generated.

[2] https://cerqana.com/ *and* http://www.tweri.com/.

- **Permanent contact with caregivers**. Digital avatars facilitate continuous contact and monitoring of older people's well-being by their caregivers. If authorized to do so, the caregiver can request health data for user monitoring and, in any case, receive warnings and alerts as soon as they occur.
- **Communication with health professionals**. Finally, for the Public Health System, our proposal allows health professionals to be informed of older people's health conditions in sparsely populated environments, avoiding complicated displacements that occur very spaced in time. Digital Avatar immediately communicates any health alarm and regularly transmits the biometric parameters that the family doctor deems necessary.

On the other hand, the project confronts some challenges and risks:

- **Smartphone storage capacity**. Data collected in real time from different sources can generate a very large volume of information and its storage can exceed the capacity of a smartphone. A solution is to store simple data for a limited time (e.g. one month) or to aggregate the information at various levels and to store only this aggregated information in the long term.
- **Smartphone processing performance**. If the number of CEP rules and patterns to be processed is high and the data collection is performed at a very high sampling rate, the smartphone may not be able to properly process all this information. There are several solutions to this problem: data can be collected at a certain frequency that is not constant, or a first level of data filtering can be carried out where events of little significance, erroneous, or disabled are discarded.
- **CEP engine for smartphones**. CEP engines require high processing power and are oriented to run on servers or in the cloud. There are few alternatives for direct execution on smartphones as indicated in Sect. 3.4.
- **Access to health devices**. Most of these devices communicate with their own smartphone applications via Bluetooth. However, these applications are usually closed and it is not common to be able to access the data they supply by means of a public API.
- **Evolution of Android versions**. The trend in the recent OS versions is to close access to their internal data, sensors and background applications. The applications we propose are based on these data sources that must be provided by the smartphone. Restricted access to them would greatly hinder their development and implementation.
- **The older does not use the smartphone**. Finally, a non-technological risk is that the user may not be using the smartphone. For a number of reasons, the user may not always carry the smartphone with them. Among them, forgetting, being uncomfortable with it, a certain reluctance to technology, or being out of battery, among many other possibilities.

6 Conclusions

This work is targeted to study the feasibility of using mobile smartphones to increase the quality of life and autonomy of elder people who live on their own in small villages. Specifically, we intend to empower these people by reducing their dependence, increasing the amount of personal data processing done on the smartphone itself.

In this way, the architecture of the system looks like to what is known as fog system. The smartphone acts as a fog device, processing primitive data obtained from sensors and connected health devices, and generating complex information with added value, which can be transmitted to remote nodes hosted on the network. This information is shared with remote nodes hosted in the cloud. In our case study, these remote nodes contain the elder person's monitoring applications and are managed by the healthcare professionals concerned.

Furthermore, this project will allow us to explore the limits of the use of CEP tools in current mobile devices, such as data storage capacity, processing performance, accuracy of the data collected by sensors and connected medical devices, and reliability of complex data generated by CEP tools. For addressing the two last issues, we integrate in the project the concept of uncertainty in the data collected and in the CEP patterns and rules.

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Socially Assistive Robots in the Aging Population: End Users' Involvement on Their Development Process

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Abstract. There is an urgent need for efficient solutions that can promote healthy aging, with quality of life and well-being. Technological solutions might be strong allies in the promotion of active aging, to allow for the older adult to adapt and fulfill daily living activities at home. When applying technology to healthcare, particularly in the older population, socially assistive robots are found to be an important emerging research topic, being promising in preventing diseases related to aging and frailty, contributing to healthy aging. Human-centered design appears as a methodology to involve the user in the development process. Unfortunately, in the revision we made, only in few robots' development, the authors reported the involvement of end users in the process.

Keywords: Socially assisted robots · Older adults · End users · Human-centered design

1 Introduction

Aging is a global phenomenon on the demographic trajectory and the proportion of older adults has increased rapidly in most countries, including in Portugal [1–4]. In fact, Portugal is the sixth-oldest country in the world [1]. The last Portuguese Census identified that 19% of its population were part of the demographic group aged 65 or over [3], and the projections estimated that older adults will constitute 32.3% of the Portuguese population in 2060, 13.3% of those aged 80 years and above [2]. Similarly, according to the United Nations, 21% of current Western Europe's population is over the age of 60 years, and this population segment is expected to rise to 33% by 2030 [5]. This aging trend is associated with several challenges and demands, given its implications in the sphere of ethics, politics, socio-economic, as well as physical and mental health. In this context, the World Health Organization proposed a policy framework for *Active Aging*, with the main purpose of optimizing the opportunities for health, participation, and security, ensuring the quality of life as people age [6].

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Despite the effort on *Active Aging* promotion, normal aging is associated with a decline in several cognitive functions [7], which are also linked with lower levels of functionality in performing activities of daily living [8]. Moreover, the prevalence of chronic diseases (such as cardiovascular disease, diabetes, and cancer), neurodegenerative disorders (such as dementia) and mental health conditions (such as depression) is increasing in the aging population [6], and this is commonly associated with generalized functional decline [9].

Not less importantly, rising ageing trends are associated with an increment of frailty and morbidity rates, causing dependency on others [10]. According to current projections, the old-age dependency ratio in the European Union (EU) is projected to increase from 29.6% in 2016 to 51.2% in 2070 [11]. In fact, Portuguese Census identified that more than 50% of the population with 65 years-old or more presented some sort of difficulty in activities of daily living [3]. Also, the *Study of Aging Profile of Portuguese Population* [12] recognized the group with 75 years-old or older as having twice the probability of functional dependence than younger groups. In fact, a study involving 686 participants also identified the 75 years-old as a strong predictor of functional decline [13]. In this study, health variables also showed higher predictive power for functional incapacity, namely the higher number of comorbidities and the musculoskeletal conditions, as well as cognitive functioning and depressive symptoms.

In the EU, a large fraction of long term care is provided by informal caregivers such as family members and friends [11]. Nonetheless, providing informal care is becoming more challenging than ever. Factors such as the ageing trends of the informal caregivers, the shifts in family structure and roles, and the economic burden on family budgets challenge the concept of home-based long term care [10]. Complex and demanding scenarios of informal care can lead to a negative impact on the caregivers' health status, reducing their ability to care and to participate in the labor market [14]. This reality often results in the nursing home placement of the older adults, depriving them of their social network integrity, environmental landmarks and higher quality of life [15, 16].

Given this reality, the global market is witnessing the growing development of new technologies and devices that can assist older adults in their daily living, as an option to prevent or delay institutionalization in sheltered or nursing homes. Nowadays, information and communications technologies (ICT) and robotics are developing rapidly, resulting in products that have the potential to play an important role in assisting older adults in areas such as social isolation, mood, cognition, as well as offering an important support to the process of caregiving, which enhances the provision of home-based care.

1.1 Socially Assistive Robots (SAR) for the Care of Older Adults

Originally, research and engineering focused their efforts on the development of assistive technology for physical disabilities and impairments, such as smart wheelchairs or exoskeletons. These rehabilitation devices focused on the physical training and personal assistance of the older adults in respect to their activities of daily living [17]. However, following the paradigm shift around aging, focusing on the human dimensions and needs of the older adults, the technological development in this area has also changed its application. In this sense, global markets witnessed the emergence of socially assistive robots in the provision of care to older adults.

These robots are perceived as social entities with communication abilities that mediate social interaction. According to the International Classification of Functioning (ICF), these robots are supposed to accomplish several tasks in domains such as general activities and demands, communication, interpersonal interactions and relationships, and recreation and leisure [18]. Social Assistive Robots (SAR) are defined as robots with a certain degree of autonomy and an inherent social capability, with intentional bodily movement to fully developed social capabilities, by which the robot can express itself while carrying out certain assistive functions [19]. These SAR aim to support older adults' independent living at home, and usually include service type robots that have purely assistive function (focused on daily activities) and companion type robots that combine assistive functions with social interaction (e.g., pet-like companionship robots, whose main purpose is to enhance health and psychological well-being) [17, 18].

Since 2009, there have been published several literature reviews on SAR, including those regarding the general potential use of SAR in older adults and dementia care, and those specifically focused on qualitative and quantitative evidence of their effects and effectiveness or their acceptance by older adults. Although several studies reported positive effects of SAR on physiological and socio-psychological outcomes [20, 21], their specific effects and effectiveness in older adults' care has not been proven comprehensively [18, 22].

Regarding their main purpose or functions, several literature reviews pointed out that the ultimate goal of these robots is to improve the older adults' well-being. However, well-being is a multifaceted concept and there is a need of a better conceptual operationalization of the outcomes that should be considered in their assessment [21]. For example, Broekens et al. (2009) concluded that the majority of the studies found a positive effect of SAR on older adults' care, specifically in domains such as mood, loneliness, and social interactions [17]. Despite this, the authors recognized several methodological concerns on the studies reviewed, raising questions regarding potential outcome bias. One of the major limitations pointed in several literature reviews is about the suboptimal and unstructured control of the intervention carried in each study, due to small number of participants, the absence of standardization in the way the robots were used by the older adults or the short duration of the interventions [17, 18]. The expected added value of those robots needs to be proved by qualitative and qualitative outcomes, through randomized controlled trials with specific and standardized intervention protocols that contemplate robot usage, with large enough populations and significant study duration, allowing for the generalization of potential benefits [21]. In fact, the majority of the studies were exploratory in nature [19].

Additionally, several reviews stated that SAR-aided interventions need to be defined according to the robots' specifications, target groups, and their environmental contexts (e.g., the majority of studies were done in Japan and with animal-like robots) [17, 18, 21]. Also, in several reviews highlighted that only a small number of studies were conducted in home-based settings, which is contradictory to the main purpose of these robots - support older adults to live independently at home and prevent/delay nursing home placement [21, 23].

1.2 SAR Development Guided by the Human-Centered Approach

One important focus of research in this field is the older adults' acceptance of SAR according to their appearance [24], which brings the need to involve older adults as users in development process of SAR. In fact, in several studies, older adults were not consensual regarding their SAR design preferences, since opinions diverged in favor of a more human-looking robot, a machine-looking robot, or a combination of both [19]. Facing this, it is imperative to consider the involvement of all actors in older adults' care practice in the design, implementation and use of SAR [19], which is particularly important to reduce potential barriers to SAR acceptance by older adults [23].

Person-centered care needs to be included in the design of SAR [21]. In fact, Robinson and colleagues (2014) claim that the robots' developers need to be aware of the main difficulties reported by older adults [23]. Likewise, SAR developers often rely on their own representations of a potential robot use when creating their design concepts, which are not always neutral and in accordance to older adults' preferences [19].

According to Pollack (2005), SAR can support older adults with cognitive impairment, ensuring they are safe and able to perform their activities of daily living, and also assist the older adult in their activities of daily living, compensating for their cognitive impairment (which can be also assessed by some of the existing robots) [25]. In the review by Abdi and colleagues (2018), the authors found five SAR roles: affective therapy, cognitive training, social facilitator, companionship and physiological therapy. Despite this, according to older adults' perceptions, SAR constitute devices that help them with physically demanding tasks, a safety system, cognitive assistance or a source of entertainment [19].

Accordingly, Bemelmans and colleagues (2012) claimed that interventions using SAR must take into consideration the socio-psychological needs of the older adults and their caregivers, in order to provide care with meaning and adjusted to the reality of life of those involved [22]. Moreover, as previously outlined, this person-centered approach is detrimental when referring to the use of robots in older adults' care, since the physical appearance and key-characteristics of the robots can potentiate or mitigate older adults' acceptability and engagement [23, 24]. However, to the best of our knowledge, no review has been conducted that summarizes and critically analyzes the development process of the existing robots, which hinders any attempts of developing meaningful and adjusted SAR, not only in respect to older adults' needs but also considering the (in)formal caregivers' needs.

2 Objective

Given the identified gap, this review aims to search for studies that reflect the development process of the most commonly referenced SAR in the existing literature focused on older adults' care. Moreover, this review will also focus on the users' (older adults, formal and informal caregivers) involvement in the development and design process of these robots.

3 Method

After a comprehensive search of the existing literature reviews in the outline thematic scope, the most commonly referenced SAR used in older adults' care were highlighted and included for analysis (Table 1). Subsequently, for each of the SARs reported on those literature reviews, a wide-ranging search of published studies was conducted in order to analyze the development processes of those robots.

Table 1. Identification of SARs on the existing literature reviews.

	Studies N	SARs	
		N	Identification
[17]	43	8	AIBO, Pearl, Robocare, Care-O-bot, Homie, iCat, Paro, Huggable
[18, 22]	41	4	NeCoRo, Bandit, AIBO, Paro
[26]	21	6	Simmy, Biscuit, Ifbot, AIBO, Paro, NeCoRo
[21]	37	13	AIBO, Bandit, Healthbot, iCat, Ifbot, Noding Kabochan, Nabaztag, NeCoRo, PaPeRo, Paro, Pearl, Robovie, Wonder
[23]	25	23	MOVAID, AILISA, Ri-man, Care-O-Bot, Guido, HRIB, Hector, Pearl, Wakamary, Hopis, Cafero, IRobiQ, Ifbot, Teddy, Robobear, Paro, AIBO, NeCoRo, Tama, Wandakun, Huggable, Homie, iCat
[20]	33	11	AIBO, Bandit, CuDDler, Jack and Sophie, JustoCat, Mero, NAO, NeCoRo, Nodding Kabochan, Silbot, Paro
[19]	23	9	Nabaztab, Karotz, Kompaï robot, Care-O-bot, Tangy, Karotz, CompanionAble, iRobi, RobuLab

4 Results

The search identified 44 potentially relevant SAR. Of these, 21 were excluded due to the absence of publications about their development, 3 were excluded because they referred to a wide-range project for SAR' development and didn't implies a specific robot. The AILISA is a project to promote experimental platforms in France to evaluate technologies for remote monitoring and assistance to elderly people at home [27]. The MOVAID project intended to propose and validate some innovative concepts for the design and development of a modular robotic solution to the problem of personal assistance, by implementing a mobile robotic system and dedicated interfaces to standard appliances [28]. The CompanionAble project addresses the issues of social inclusion and home assistance of elderly people suffering from mild cognitive impairment, living alone at home, by using assistive technologies [29].

As shown in Table 2, the remaining 20 studies on SAR development were published between 2001 and 2016, and only a few reported the users' involvement in the development process.

Table 2. Development of SARs: Users' involvement

SAR	Study	Inclusion of users on development		
		Older adults	Caregivers	Health professionals
1. AIBO	[30]	–	–	–
2. Bandit	[31]	–	–	–
3. Care-O-bot	[32]	–	–	–
4. CuDDler	[33]	–	–	–
5. Healthbot	[34]	✓ (older people in a retirement village for pilot testing)	✓	✓ (nurses and other health professionals)
6. Homie	[35]	✓ (prototype and concept evaluation by elderly people)	–	–
7. Huggable	[36]	–	–	–
8. iCat	[37]	–	–	–
9. Ifbot	[38]	–	–	–
10. Kompaï robot	[39]	✓ (usability testing with elderly persons with Mild Cognitive Impairment and cognitively healthy)	–	–
11. Nabaztag	[40]	–	–	–
12. NeCoRo	[41]	–	–	–
13. PaPeRo	[42]	–	–	–
14. Paro	[43]	–	–	–
15. Pearl	[44]	✓ (older people in a retirement commitment for preliminary testing)	–	–
16. Ri-man	[45]	–	–	–
17. Robocare	[46]	–	–	–
18. Robovie	[47]	–	–	–
19. RobuLab	[48]	✓ (older adults involved at the early stage of development)		✓ (medical staff also involved at the early stage of development)
20. Wonder	[49]	–	–	–

5 Discussion

Robots that are capable of enhancing broader aspects of older adults' well-being have become progressively studied in the last few years. In fact, as Vandemeulebroucke, de Casterlé and Gastmans (2018) stated, the use of SAR in older adults' care is an emerging research area that continues to grow rapidly [19]. In fact, the current trends regarding the aging population and the need for caregivers seem to contribute to this new research focus, strongly influenced by the gerontology and robotics sciences, in order to develop intelligent solutions to manage emergent challenges, such as dementia care. In specific clinical conditions, such as dementia, these robots can constitute an important tool for therapeutic interventions [26].

Human-centered design (HCD) appears as a methodology to involve the user in the development process, and is being largely used in medical devices development process. This HCD model defines four phases in the evaluation process, namely: (i) identify the user and specify the context of use; (ii) specify the user requirements; (iii) produce design solutions; and (iv) evaluate design solutions against requirements. This model has been proved extremely useful to accomplish some of the International Organization for Standardization (ISO) norms, which emphasizes the need to evaluate usability, defined as the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specific context of use [51, 52]. Unfortunately, in the revision we made, only in few SARs' development, the authors reported the involvement of end users in the process [5, 6, 10, 15, 19]. And in the few studies that reported end users' involvement, it isn't always understandable their specific roles in the whole processes of designing and development a robot.

Despite this, Robinson and colleagues (2014) highlight that, to a certain extent, currently existing SAR are designed as a solution for a specific problem or limitation in older adults daily living, being frequently used in nursing homes and not in the older adults' own home. Therefore, it is essential that future developments in this field consider the likely impact that SAR may have on decline prevention and promotion of healthy lifestyles [23]. Regarding this, is important to note that the few studies that consider end users' involvement in the development process were done with older adults in nursing care facilities [5, 15]. In other studies, reporting the involvement of older adults, isn't clear if they are in those institutions or at their own home [6, 10, 19]. Wada and colleagues (2004) identified that the use of SAR in older adult's care routine in daycare units decreased nursing staff's burnout [50]. Despite this evidences, in a few development studies, the authors reported the involvement of health care professionals on robots' development process [5, 19].

Incipient legal and ethical questions need to be addressed when the potential effects of SAR use in older adults' care become more clearly outlined. Specifically, using SAR in older adults' care requires supervision and careful planning, since such devices are not meant to replace human contact. There is a clear need to develop appropriate guidelines on SAR use in therapeutic interventions aimed for older adults (with or without dementia), in order to ensure the rights and dignity of this population [26].

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Sensors as a Technological Solution for a Successful Ageing

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Abstract. There is a growing need to implement and evaluate technological solutions that allow early detection of age-related adverse outcomes, like frailty, and enable assessment of lifestyle habits that can be maintained or improved to prevent such adverse outcomes. In this study, the sample is composed by older adults aged 65–80 years, recruited from the community, and who agreed to use an electronic device ACM Kronowise® 2.0. This electronic device allows a proactive and continuous monitoring of circadian health, physical activity, and sleep and eating habits. The participants used the ACM Kronowise® 2.0 during a period from seven to ten days. In the end, the participants were invited to share their experience and satisfaction with the device's use and functionality and to express their awareness of healthy habits and usefulness of technologies in health. Data obtained can be used as a set of guidelines in the selection of suitable technological equipment for older adults. Understanding seniors' perceptions about the use of technology are crucial to optimize design and application and improve educational strategies that may reduce caregiver burden. In our view, the implications of this study' findings for clinical practice include the possibility to develop and validate tools to improve older' people lifestyle and timely prevention of frailty progress.

Keywords: Ageing · Frailty · Circadian health · Citizen engagement · Technology · Lifestyle · Ageing in place

1 Introduction

In the ageing society, it's necessary to develop solutions that can maximize older people functionality, independence, and autonomy for as long as possible. This is considered a priory goal for several entities, including the World Health Organization (WHO) and the European Innovation Partnership on Active and Healthy Ageing (EIP on AHA) [1, 2].

The majority of older people intend to age in place, which is, living in their own dwelling after retirement [3]. Sometimes, some adjustments in the older people life-styles

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and habits of daily living are sufficient to improve their quality of life and maintain their autonomy and independence in their own home, controlling or reverting at least some of adverse health-related outcomes. More than having active, healthy and participative ageing, older people need to have successful ageing. This includes the possibility to have the maximum functioning in their physical, psychological and social dimensions, regardless of existing health comorbidities [4].

Technological solutions, including wearable sensors, such as the one presented in this paper, could help older people (especially those living alone in a community setting) to control their health status and take on a lifestyle that allows living independently, alleviating the pressures on their caregivers [5]. Trough wearable sensors it's possible to obtain data that have high rates of accuracy and reproducibility, which facilitates clinical diagnosis and prediction of health-related outcomes. It's an easy and fast way to monitor older people health status at a distance, and make recommendations on how to improve their health status to obtain a successful age-ing. The wearable devices eliminate physical barriers between seniors and health professionals and, in addition, promote the trend of older people to understand their own physiological data, giving them the possibility to engage in the management of their health outcomes.

The present study has the main objective to understand the perceptions and experiences of the older people in the use of wearable sensors, namely in the use of the ACM Kronowise® 2.0.

The study presented in this paper is a part of the pilot project ModulEn that aimed to establish a predictive model for frailty as a possible modulator of ageing in health. This pilot project is funded by the Fundación General CSIS in the context of the "Interreg España – Portugal" program and involves several partners from Spain and Portugal, including Institute of Health Carlos III, ISCIII as a coordinator, Chronobiology Laboratory, University of Murcia and Nursing School of Coimbra. All the information presented in the sections of Methods and Results refers to the work carried out in Portugal.

2 Methods

2.1 Study Design

A mixed-methods study was conducted to examine the experience of older people in the use of technology (ACM Kronowise® 2.0) to maintain or improve their health status.

2.2 Sample

This study included 96 participants (77.1% female), aged 65–80 years (72.14 ± 4.89), who lived in the community and who didn't present moderate or severe cognitive decline. Older people were recruited at senior universities, cultural or recreational associations, primary health centers and day centers in the Central Region of Portugal. All participants p signed an informed consent with the study's objectives, procedures, risks, costs, and benefits and they were informed about procedures to ensure confidentiality and anonymity of their identity.

2.3 Data Collection

Initially, the eligible participants answered few questions about their sociodemographic, anthropometric and clinical data (including usual medicines intake that can influence the sensors register). Then, they used the device ACM Kronowise® 2.0 over a period of 7–10 days. On the same day that older people initiated the experience with the device, the person responsible for data collection provided all necessary explanations and instructions, showed a short explanatory video and exemplified how to interact with the sensor. The instructions were also delivered to participants in a written form. The ACM Kronowise® 2.0, used as a wristwatch, integrates sensors for activity, position, skin temperature and exposure to light, with the objective to monitor the user's ambulatory circadian state. In the end, participants were invited to share their experience and evaluate their satisfaction with the device use and the results obtained. All participants received a health report with personalized recommendations to improve their health status.

2.4 Instruments

2.4.1 Screening Assessment

To integrate this study, all participants were evaluated with the 6-item Cognitive Impairment Test (6CIT) [6], validated for Portugal [7]. This screening test is composed of six simple questions that assess time-space orientation, attention, and short-term memory. The test application time is 5 min. It is used to screen cognitive impairment, according to the education level. The test scoring is reverted, with the possibility of cognitive impairment being indicated by score $\geq$4 in seniors with seven or more years of formal education, score $\geq$10 in older adults with three to six years of formal education, and score $\geq$12 being in older people with two or fewer years of formal education [8].

In addition to this test, the authors asked to older people more two open-ended questions that evaluated their health status and autonomy in daily living activities. These two questions were given with an objective to obtain complementary data on the participant's functional status. This data was used to differentiate older adults with mild cognitive decline from those who presented moderate to severe impairment.

2.4.2 Frailty

The assessment of frailty was based on the phenotypic model proposed by Fried [9]. The participants respond to five direct questions regarding fatigability, resistance, ambulation, illness, and loss of weight.

2.4.3 End-User Experience

The 96 older adults participating in this study were invited to respond to a semi-structured interview about their experience with the ACM Kronowise® 2.0. The interview included 11 open-ended questions organized in the following sections: ease of device's use, functionality, awareness of healthy habits and perception of the usefulness of technologies in health. Each interview lasted approximately half an hour. Firstly, the participant was asked about the experience of use technology in their daily living, the ease of use technology and the positive and negative aspects of their experience. Further questions addressed awareness of healthy habits and usefulness of technologies and health reports in health. A final question explored the need to use this technology if the participant would recommend and why.

2.4.4 Electronic Device ACM Kronowise® 2.0

It contains sensors that record sleep patterns, physical activity, body position, peripheral body temperature and environmental light exposure (for more details see https://www.um.es/cronobiologia/en/what-we-do/applied-research/). The participants used the device from 7 to 10 days and, during this time, they were asked to mark some relevant events, such as physical activities, waking and falling asleep hours, meal times and taking medication.

2.5 Data Analysis

Data obtained through questionnaires were analyzed using the IBM SPSS Statistics 24.0. The data were analyzed taking into account the characteristics of the participants. For this purpose, a descriptive analysis of the variables was performed. The contingency between the classifications of qualitative variables was analyzed through the Chi-square test or Fisher's exact test. Data collected in interviews are analysed using standard method of thematic analysis.

2.6 Ethical Considerations

The implementation, evaluation, and documentation of the study were carried out in accordance with the Declaration of Helsinki. All participants were informed, orally and in a written form, of the objective and procedures of the study. The participants signed informed consent, being guaranteed the voluntary character of their participation, and confidentiality and anonymity of data provided. To ensure these assumptions, security measures with regard to coding, storage, distribution, and protection were taken to prevent unauthorized access to databases. These measures were taken in accordance with the specific rules for the processing of sensitive data, namely with the General Data Protection Regulation. The study was approved by the Local Ethics Committee of the Health Sciences Research Unit: Nursing (UICISA: E) of the Nursing School of Coimbra (Opinion nº 510/06-2018).

3 Results

The study included 96 older adults aged between 65 and 80 years ($M = 72.14$, $SD = 4.89$). Of those, 74 were females and 22 were males. The average formal education was of 7.59 ($\pm$4.21) years. Most of the participants were retired (97.9%), lived in urban areas (76%) and have a daily activity/occupation (72.9%), especially in the morning. In this sample, 42.7% were non-frail, 32.3% presented pre-frail state and 25% were frail.

Age (mean, SD)	72.14 (±4.89)
Gender (n, % female)	74 (77.1%)
Marital status	
Single	6 (6.3%)
Married	39 (40.6%)
Divorced	32 (33.3%)
Widower	16 (16.7%)
Other type of relationship	3 (3.1%)
Level of education (Schooling in Portugal)	
Illiterate (0 years)	4 (4.2%)
Primary studies (0–4 years)	34 (35.4%)
Complementary studies (5–9 years)	24 (25%)
Secondary studies (10–12 years)	7 (7.3%)
Higher studies (<12 years)	27 (28.1%)
Approximate mouth household income (n, %)	
0–500€	19 (19.8%)
501–1000€	30 (31.3%)
1001–1500€	22 (22.9%)
1501–2000€	13 (13.5%)
>2000€	11 (11.5)

Although most participants (95.8%) considered that the sensors are easy to use, 33.7% admitted that they cause some discomfort. The majority of the respondents (91.7%) didn't report changes in daily routines and 56.3% were sensitized to adopt healthy lifestyles. Moreover, 93.8% considered that the data obtained through sensors are useful to improve their health status and would recommend these sensors to others.

Sensors-related data accompanied by recommendations for maintenance or improvement of health status were considered the most relevant positive aspect. Sensor design, lack of utility in daily life and time of use were highlighted as negative aspects. Most of older people considered that the use of sensors and the results of the health report make possible the adoption of healthier lifestyles. However, there is a significant difference in the proportion of responses between the older adults living in rural areas and the older adults who live in an urban area ($p = 0.05$; $\Phi = -0.194$). People from urban areas are more likely to adopt healthier lifestyles.

The interaction with the sensors to mark events such as meal times, medication, waking and falling asleep hours, etc., is one of the variables that most present significant differences in the proportions of responses given between the subgroups. Namely in subgroups related to (i) living in rural or urban area ($p = 0.001$; $\varphi_c = 0.440$); (ii) level of education ($p = 0.028$; $\varphi_c = 0.272$); and (iii) frailty state ($p = 0.028$; $\varphi_c = 0.300$). Older people from rural areas, with primary (i.e. 1–4 years) and complementary (i.e. 5–9 years) studies and in pre-frail or frail states reveals a greater predisposition to forget to mark events on the sensors. All robust and pre-frail participants considered easy the experience of sensors use, while 16.7% of frail participants considered it difficult. Moreover, 12.5% of frail older people would not recommend the use of this technology.

These study results indicate that the acceptability of technologies as a way of monitoring health status is quite high, although some aspects related to the usability of these technologies need to be improved.

4 Discussion

Data obtained in this study can be used as a set of guidelines in the selection of suitable technological equipment for older adults. Understanding older people perceptions about the use of technology as a pathway to get successful ageing is crucial to optimize the electronic device and the educational strategies that can reduce caregiver burden, intending ageing in place, and minimize the frequent demand on health care system [5].

This study explores the acceptability and usability of a technological device to maintain or improve older people health status. Findings of this study supplement previous studies that investigated the experiences of older adults toward new technologies [10, 11]. Such in other studies, the majority of the sample considered that the sensors are easy to use, the electronic device doesn't promote changes in daily routine and offers important information about the health status. The recommendations on how to maintain or improve health-related outcomes, based on the device's output and provided by a health professional, were also identified as highly beneficial.

The use of wearable technology can be the fast and easy way to monitor physiological parameters that, until now, was only possible in a hospital or health center setting. When older people use these wearable devices, health professionals can monitor their health parameters and evaluated which behaviors are more susceptible to change to improve their health status. This approach seems to be promisor in pre-venting frailty states or reverting them through behaviors changes. As the older people included in this study identified, the health report and the recommendations on how to improve the health status are the most positive aspect of using wearable technology.

However, sometimes the implementation of wearable devices in health care can be difficult by the barriers to the use of technology, especially in the populations that have limited experiences in this area. The most relevant barriers identified in relation to older adults include age-related cognitive and sensorial changes, lack of knowledge, negative attitudes and the complexity of devices [12]. Some of these aspects were also identified as negative factors in this study. For examples the sensor design, the daily life utility, the difficulty for pre-frail and frail people to interact with the device and the difficulty to use this kind of the device because of the fine motricity problems. Moreover, people with a lower educational level and from rural areas seem to have more difficulties in using wearable devices. This finding is useful for improving and adapting educational strategies and promote successful ageing in place. Although preliminary, these results can be used as a set of guidelines in the selection of suitable technological equipment for older adults.

5 Conclusion

Older adults should participate more actively in the management of their health, integrating healthy behaviors to maintain their functional capacity. The inclusion of new technologies in healthcare is a promising strategy to support behaviors that maximize older functionality, autonomy and independence. Considering the probable increase in the geriatric care, it's important to develop more studies to understand the perception that seniors have about the utility of wearable devices in everyday life and adapt new technologies to their needs.

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Person in Need of Airway Cleaning and Use of Mechanical Insufflator-Exsufflator Device

Gains from Rehabilitation Nursing Intervention for People in Intensive Care

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Abstract. Airway clearance in patients under Invasive Mechanical Ventilation (IMV) or noninvasive mechanical ventilation (NIMV) is a key intervention that should be performed regularly, not only to prevent secretion accumulation, but also to prevent adverse effects that may result from this accumulation of secretions. One of the most relevant interventions in this type of patient is the use of the Mechanical Insufflator-Exsufflator device (MI-E), commonly known as Cough Assist®. On the other hand, Respiratory Functional Rehabilitation (RFR) involves a set of non-invasive procedures that ensure the release of secretions, namely the fluidization of secretions and the use of techniques that allow their mobilization, properly combined with directed and assisted cough teachings. The effectiveness of RFR associated with the use of MI-E yields gains from this conjugation, especially when the person does not collaborate, has decreased muscle strength, or cannot effectively cough. The study conducted in an Intensive Care Unit (ICU) in Portugal shows significant gains in the association of an RFR program with MI-E, with evident improvements in the level of dyspnea, which can be quantified with the implementation of the Modified Borg. At the beginning of the implementation of the RFR program the patients had mild to moderate level of dyspnea and at the end the patients did not have dyspnea. This study made clear the gains that exist for the ICU or NIMV intensive care admission person using MI-E in combination with airway cleaning techniques, in terms of ventilatory performance, airway permeability and decreased complications.

Keywords: Cleaning of the airways · Rehabilitation · Rehabilitation nursing · Mechanical ventilation · Intensive Care Unit · Mechanical Insufflator-Exsufflator device · Cough Assist · Ventilatory performance

1 Introduction

In general, the average length of stay of critically ill patients in ICU is six to 13 days. In the study by Júnior, Martinez and Neto [1], we found that the main reasons for admission to

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these units include neurological disorders (40.9%), followed by gastro-hepatic (22.7%), cardiac (13.6%) and the remaining 22.8% by various pathologies. In this same study, it is explained that about 68% of people underwent some type of sedation with an average period of two to six days. Regarding IMV, the average duration of therapy was about six to 12 days.

One of the main reasons for the abrupt decrease in natural airway defenses is endotracheal intubation. Although ventilator mechanisms have evolved greatly, the quality of air supplied decreases the capacity of lower airway defenses [2].

Airway permeability and pulmonary ventilation may be significantly conditioned by situations that cause functional changes in the airway, muco-ciliary system function, inspiratory and expiratory muscle strength, or impairment of cough efficacy. This process can also result in pathological conditions for the respiratory tract, such as atelectasis and pneumonia [3].

Airway cleaning techniques have the following benefits: reducing respiratory disease progression, optimizing muco-ciliary clearance mechanisms, preventing bronchial obstruction and accumulation of bronchial secretions, improving lung ventilation, decreasing energy expenditure during ventilation, maintaining rib cage mobility and favor greater cough effectiveness, and facilitate sputum [4]. These involve assisted and directed cough, postural drainage, accessory maneuvers, forced expiratory technique (FET), the active breathing cycle with the application of various breath control techniques, chest expansion and FET techniques, increased expiratory flow, total slow expiration with open glottis in the infra-lateral decubitus, in addition to the use of airway cleaning aids [5, 6].

In the person undergoing IMV, RFR can be used in ventilator preparation and adjustment, intubation, during IMV, ventilator weaning and extubation. RFR programs for these patients primarily involve the use of techniques to improve airway clearance, reduce psychic and muscular tension, improve lung expansion and ventilation, and prevent and correct body posture [6].

RFR techniques can be associated with the Cough Assist® or MI-E device, which is a non-invasive method of secretion mobilization. The use of this device is important to help NIMV patients, as the difficulties these patients have in adapting to the interface and the noninvasive ventilation itself are great given the excess secretions.

MI-E promotes insufflation and then rapid exsufflation. This rapid transition of pressures between insufflation (positive pressure) and exsufflation (negative pressure) provides a high respiratory flow, which aims to simulate the most natural mode of coughing, thus moving the respiratory secretions to facilitate their elimination in coughs in patients with ineffective cough [7].

Secretions are a major cause of respiratory failure after extubation. MI-E provides an efficient method for coughing up in ICU patients, either through an endotracheal tube or through a face mask. This device mobilizes abundant secretions and helps prevent orotracheal reintubation in patients who develop respiratory failure after extubation and improve the effectiveness of NIMV [8].

One of the main interventions of the nurse specialist in rehabilitation nursing is the promotion of airway cleansing through the use of fluid secretion techniques, aiding in their progression and increasing their ability to expel through cough. The use of bronchial hygiene techniques is directly related to the patient's basic clinical diagnosis, the patient's degree of collaboration and the presence of an artificial airway, Cough Assist® being an aid to the simulation of artificial cough [9].

Given the above and considering the relevance of this problem and the determining role of the nurse specialist in rehabilitation nursing in this context of care and prevention and reduction of complications, the following research question emerged: *What benefits are there for the patient in intensive care with use of the mechanical insufflator-exufflator (Cough Assist®) associated with airway cleaning techniques?*

Assuming the need to identify the gains in respiratory function resulting from the Rehabilitation Nursing intervention to people admitted to intensive care requiring airway clearance undergoing MI-E (Cough Assist®), we believe the results of this study They can be an important contribution to the reflection on this issue and the relevance of this specialized intervention in relation to the person in intensive care with ineffective airway cleaning. The implementation of intervention plans adjusted to the care needs of people by the specialist nurse in rehabilitation nursing is crucial in preventing complications and improving respiratory performance in people with assisted ventilation.

2 Method

This is a pilot study with a descriptive and cross-sectional approach. The convenience sample consisted of all patients hospitalized in the ICU between September 17 and November 25, 2018, who had the need for RFR derived from their pathology or long immobilization in the bed, being that he had to be weaned from IMV or under NIMV. These patients could not have any contraindications to the use of MI-E (Cough Assist®). As an inclusion criterion, we chose to choose people who do at least three days of Cough Assist®-associated RFR, in order to effectively understand if there were associated improvements.

Five people who met the inclusion criteria were selected, particularly not having any pathology that would contraindicate the use of MI-E.

For this study we used the Glasgow Coma Scale to assess the level of consciousness, the Numerical Pain Scale for pain assessment and the Modified Borg Scale for respiratory system assessment, namely the level of dyspnea. In addition to these scales, the study participants were characterized in relation to the variables age, gender, clinical diagnosis, reason and number of sessions.

Data was collected through direct observation in the context of care delivery. Two data collection moments were structured. The first moment before the RFR was performed by the rehabilitation nurse specialist (pre-intervention), a second moment after the RFR (post-intervention). Thus, it was possible to evaluate the interventions of the rehabilitation program implemented.

The RFR program included the following techniques: control and dissociation of breathing times, diaphragmatic rehabilitation with or without resistance, selective or global costal rehabilitation, forced expiration technique and accessory maneuvers.

For this study, the opinion of the Ethics Committee of the institution involved in the study was requested. Participants were voluntarily integrated into the study after they and their family members were informed about the research and that the data collected would be used only in the study and after signing the informed consent document.

3 Results

Most of the people included in the study are female, ranging in age from 30 to 69 years. The pathologies studied were respiratory, and three of the five people underwent IMV and four required NIMV.

Through Table 1, we can observe the characterization of the participants involved in this study.

Table 1. Sample characterization

People	Sex	Age (years)	Clinical diagnosis	Motive	No of sessions
A	Female	69	Metformin-associated severe shock and lactic acidemia	Weaning from VMI	5
B	Female	43	Pneumonia	VMNI	6
C	Female	30	Respiratory failure	VMNI	6
D	Female	51	Pneumonia	Weaning from VMI	5
E	Male	66	EAMSSST	Weaning from VMI and VMNI	5

Regarding the state of consciousness, its assessment was made using the Glasgow Coma Scale. It should be noted that as of the fourth session of the program, all patients included in this program had a score of 15 on their scale, with no change in consciousness until the end of program implementation.

As pain is the fifth vital sign, it was considered to be highly relevant during the implementation of the program, in order to identify any discomfort associated with RFR interventions or the use of MI-E (*Cough Assist*®).

The application of the Numerical Pain Scale showed that four people reported pain at the beginning of the program. Person A had level 2 pain and Person D and Person E had a pain level of 3. In these three participants, pain was associated with extubation. Person C had level 1 pain. At the end of the program, none of the participants reported any type of pain.

The following interventions were then selected for the RFR program: control and dissociation of breathing times; diaphragmatic rehabilitation with or without resistance; selective or global costal reeducation; forced expiratory technique; accessory maneuvers. All participants were able to complete the program in its entirety, uneventfully. In total, the five people included underwent twenty-seven RFR sessions. Person B was the patient with the best performance and the highest number of sets and repetitions. Person E due to his clinical pathology and with regard to accessory maneuvers were only performed vibration maneuvers, unlike other users where compressions and percussions were applied.

After the RFR exercises, the MI-E parameters were selected for each person under study, as shown in Table 2. It should be noted that the device used in the program was the Cough Assist® model E70. Person A and Person C only performed four inflation cycles, while the others performed five cycles. Everyone activated their own therapy because the device was in automatic mode. Inspiration is activated during the set inspiration time, pausing for a few seconds according to the person's tolerance, transitioning to the exhalation phase during the set expiration time. It must be decided that this procedure has to be as comfortable as possible for the patient. Therefore, you should start with lower inspiratory and expiratory volumes for better adaptation. Person B was the one who could tolerate larger volumes. Person C in the third cycle had thoracic discomfort, but willingly wanted to repeat with the previous parameters. This event took place in the first session without any further complications in the remaining sessions. Oscillations can be applied during the inspiration, expiration, and both phases. Person B had a decreased cough reflex, so we opted for the Inspiration/Exhalation oscillation mode, presenting results and in the third session was able to expel secretions through the cough reflex. Everyone else under study managed to release secretions at the end of each session. Person E was able to expel secretions at the end of the first session after intentionally programmed lower values that could tolerate.

Table 2. Parameters used in Mechanical Insufflator-Exsufflator

Person	1st cycle	2nd cycle	3rd cycle	4th cycle	5th cycle	Oscillation	Pause time	Automatic	O_2
A	Insp. +25	Insp. +30	Insp. +25	Insp. +25	–	Expiration	3 s	Yes	2 l/min
	Exp. −30	Exp. −35	Exp. −30	Exp. −30					
B	Insp. +25	Insp. +30	Insp. +30	Insp. +35	Insp. +35	Inspiration/ Expiration	3 s	Yes	4 l/min
	Exp. −30	Exp. −35	Exp. −35	Exp. −40	Exp. −40				
C	Insp. +25	Insp. +30	Insp. +30	Insp. +25	–	Expiration	3 s	Yes	3 l/min
	Exp. −30	Exp. −35	Exp. −35	Exp. −30					
D	Insp. +15	Insp. +20	Insp. +20	Insp. +25	Insp. +25	Inspiration/ Expiration	3 s	Yes	2 l/min
	Exp. −20	Exp. −25	Exp. −30	Exp. −35	Exp. −35				
E	Insp. +15	Insp. +20	Insp. +20	Insp. +20	Insp. +20	Expiration	2 s	Yes	2 l/min
	Exp. −20	Exp. −25	Exp. −30	Exp. −30	Exp. −30				

Table 3 presents the level of pre-intervention and post-intervention dyspnea according to the Modified Borg Scale.

People were asked about their sensation of dyspnea through the Modified Borg scale, and a previous explanation of the scale was performed, so that the patient could understand and collaborate to translate into a reality-compatible score. People were clearly instructed and it was in their judgment that the scores presented appeared, excluding other types of sensory factors, such as nasal or throat irritation. Person A and Person E initially presented a pre-intervention score of 3, which was moderate dyspnea. Person E reverted his dyspnea level to 0 (no dyspnea) and Person A scored 2 (mild dyspnea) after the intervention, which he said was tired. Person C and Person D initially had a

Modified Borg score of 2 (mild dyspnea), and at the end had no evidence of dyspnea. Person B reported having a score 1 (very mild dyspnea) and post-intervention reported not having dyspnea.

Table 3. Evaluation of intervention strategies by modified Borg Scale

People	Modified Borg Scale pre-intervention	Modified Borg Scale post intervention
Person A	3	2
Person B	1	0
Person C	2	0
Person D	2	0
Person E	3	0

4 Discussion

Ventilatory Performance

Mobilization and removal of airway secretions during the rehabilitation program play an important role in enhancing bronchial hygiene and gas exchange, thereby optimizing the respiratory mechanics of critically ill patients undergoing mechanical ventilation, similarly to that happened in the study by Camillis et al. [10] In this sense, the absence of correct airway clearance is associated with an increased risk of adverse effects such as ventilator-associated pneumonia and ineffective ventilatory weaning.

At first, RFR techniques were selected for adequate thoracic expansion and secretion mobilization. The techniques chosen for this program were breathing time control and dissociation exercises, diaphragmatic rehabilitation with or without resistance, selective or global costal rehabilitation, forced expiratory technique and accessory maneuvers. One of the main results obtained in the study presented by Wang et al. [11], who reported that noninvasive airway clearance techniques within the first two hours in NIMV patients were considered safe and effective when applied to patients with acute COPD exacerbation and hypercapnic encephalopathy. Intrapulmonary ventilatory percussion therapy in patients with thicker and more abundant secretions is a reasonable and safe therapeutic option [10]. This technique is part of the accessory maneuvers, but one of the patients of the program failed to perform it, despite being an asset [10].

RFR interventions were implemented to improve the ventilatory performance of the study patients, showing a favorable evolution in the series and repetitions of each exercise, as well as the use of MI-E. For optimal ventilatory performance, the optimized version MI-E, characterized by slow insufflation, is more effective in secretion mobilization compared to the conventional version of the same device (where faster insufflation is typically applied) [12].

In the study by Rose et al. [13], it has been found that patients undergoing NIMV, in combination with manually assisted coughing techniques and MI-E use, decrease the need for reentubation and tracheostomy in patients with neuromuscular disease. The rehabilitation program is strongly recommended in mechanically ventilated patients with decreased cough reflex, muscle weakness but hemodynamic stability as it prevents atelectasis, pneumonia and respiratory failure [13].

Airway Permeability

Cough is the largest and most important component of airway cleaning. The effectiveness of cough is related to the peak cough flow [14]. To increase the effectiveness of this reflex in mechanically ventilated patients, our main therapeutic target is the optimization of peak expiratory cough flow, which can be provided through the devices, which is often the reason for its use. In this process we have to take into account the various clinical conditions (decreased cough reflex, neuromuscular disease and polyneuropathies). Presence of artificial airway may influence decreased peak cough flow, reducing ability to remove secretions.

All ICU patients who were part of the airway cleaning program used MI-E tolerantly. All participants started the 1st low pressure inflation and exhaustion cycle, so that there is a gradual process in the implementation of the device, thus allowing a tolerance for all participants. Auto mode has been chosen for all. There was an increase of parameters up to +35 insufflation and −40 exsufflation, being the maximum that a person under study could achieve without presenting any type of hemodynamic instability and dyspnea. The device was parameterized with the oscillatory mode in different phases, but showed results in all of them, as all patients were able to spontaneously sputter without the need for manual aspiration.

During voluntary cough, the importance of current expiratory flow in secretion removal may be masked by the fact that peak inspiratory flow (PIF) is often lower than PEF. Nevertheless, the influence of PIF is minimized and PEF emerges as the key determinant for eliminating airway secretions [12]. The difference between PEF-PIF is referred to as the variable that best demonstrates secretion mobilization and above the reference value (17L/min) the greater the difference between PEF-PIF, the greater the amount of secretion mobilized.

The device used brings a new advantage, either for patients under IMV or NIMV, which is the oscillatory mode. This mode allows for a reinforcement of the vibration technique during insufflation, exsufflation or both, which has been shown to be of added value for releasing thicker and deeper secretions. With regard to airway cleaning, it is shown that inspiratory flow cannot be neglected especially in mechanically ventilated patients who are sedated. The use of MI-E minimizes the risk of hypersecretion after extubation when applied immediately prior to the extubation process [12].

Patients following the use of MI-E were able to expel accumulated secretions more than once, and there is no need from the time of implementation of the conventional aspiration program. The study by Coutinho et al. [14] compared the effects of MI-E vs endotracheal suction, the relationship between hemodynamic stability and respiratory mechanics, as well as the ability of each technique to remove secretions. After evaluating the effectiveness of the device use and after adjusting the parameters, the results were significantly positive, with only 17% re-incubation rate in the study group compared with 49% in the control group. However, the main result obtained from this study reveals that there is no significant difference in the amount of secretions aspirated when compared to the use of MI-E with conventional tracheal aspiration, 8.42 gr vs. 7.09 gr, respectively.

Increasing repetition of RFR techniques throughout program sessions has relationally increased the inspiratory and expiratory pressure of the MI-E device. Cough augmentation techniques that lead to increased lung volume capacity or manual or mechanical assisted cough techniques can be used to prevent and manage respiratory complications associated with chronic complications, particularly in neuromuscular diseases, in patients tracheal devices, enabling a short- and long-term increase in positive outcomes in patients with acute respiratory failure [10].

Complications

The use of MI-E was notorious in the patients in the study. Patients who used this device after extubation or even without the previous procedure had a Glasgow Coma Scale score of 14 (fourteen) or higher. Although potential complications are minor as noninvasive, NIMV is usually not recommended in patients with altered state of consciousness, with stasis of secretions secondary to cough reflex depression and risk of aspiration due to lack of protection of the airway. The ineffectiveness of NIMV is usually attributed to a reflex of ineffective cough, excess secretions, hypercapnic encephalopathy, tolerance and asynchrony [11].

In contrast to the person undergoing IMV with artificial airway, the person undergoing NIMV does not have direct access to the airways, which constitutes a disadvantage in removing secretions. Implementation of a rehabilitation program increases mucociliary clearance while using this technique.

NIMV is associated with a reduced incidence of complications (nosocomial infections or sepsis) and a shorter period of need for ventilation [11].

For dyspnea that could arise from program implementation, pre- and post-intervention assessments were performed with the Modified Borg Scale. Most participants had at first a mild or moderate dyspnea related to accumulated secretions that failed to expel. Decreased cough reflex leads to ineffective airway clearance, which is the most common cause of NIMV failure. This is considered a relative contraindication, especially in patients with altered state of consciousness and suppressed cough reflex [11].

The adoption of cough reflex augmentation techniques associated with alveolar recruitment are the most frequently used techniques. The efficacy and low number of complications in these techniques when applied to critically ill patients are recognized [13]. Patients with neuromuscular disease had a significantly low rate of re-intubation.

After the implementation of the program, most participants had a score of 0 (zero) on the Modified Borg Scale. There was a positive evolution in the level of dyspnea and well-being, and there was no negative change in hemodynamic parameters. Thus, a 100% success rate is presented in the participants of this study, relating RFR techniques to the MI-E airway cleaning device.

In addition to dyspnea, pain could be one of the most recurrent complications associated with the implementation of this RFR intervention program. Pain was analyzed throughout the sessions, and the maximum pain was 3 (three), according to the numerical pain scale, which was associated with extubation-related odynophagia. No participants reported pain associated with this program.

5 Conclusion

Intervention plans for each patient were carried out with an initial (pre-intervention) and post-intervention assessment, implemented for at least five sessions. Through rehabilitation nursing interventions, gains were obtained in minimizing dyspnea and pain. Participants with airway permeability changes after program implementation were found to be able to reduce their level of dyspnea and to tolerate higher MI-E pressures.

The results throughout the program implementation were positive, highlighting the relevance of the Rehabilitation Nurse's intervention in the ICU, with a holistic view of the person, providing excellent care and interventions in improving ventilatory performance, airway permeability and prevention of complications associated with IMV.

This study reveals, in an emerging way, the need of valorization by the health institutions, the competences and the role of the EEER in the rehabilitation process of patients with these characteristics and submitted to invasive processes.

In order to enhance EEER training, it is necessary to include training plans in the context of Intensive Care Units, in order to develop professional interventions that are critical to the critically ill patient and to optimize the use of MI-E for patients with ineffective cleaning airways in the context of ICU care. Therefore, training needs should be identified and training aspects should value the development of professional skills that enhance the intervention of RE, as a determining factor for the provision of quality health care.

The consistency of the results obtained is insufficient due to the small number of study participants and the type of study, with limited time, as well as the high vulnerability of patients in this care setting.

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Peripheral Venipuncture in Elderly Patients: Is Near-Infrared Light Technology an Option to Avoid Vein Depletion?

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Abstract. Background: Peripheral venipuncture is the minimal invasive procedure most commonly performed in acute settings. However, several publications report that health professionals perform multiple puncture attempts until a successful catheterization or blood draw is achieved. Among the patients most affected by this reality are the elderly patients, who often display a number of factors that increase difficulty. In recent years, several recent technological aids, such as the Near-Infrared Light, have emerged in the medical devices market as potential facilitators of vein selection and puncture. However, while Near-Infrared Light devices are widely studied in pediatric settings, there are no known reviews of its use and applicability with elderly patients. **Methods:** A scoping review of the literature was conducted following the Joanna Briggs Institute method. Study relevance, data extraction, and synthesis were performed by two independent reviewers. **Results:** Three studies were included in this review. The use of NIR technology may improve the number of peripheral veins located in elderly patients, as well as reduce hematoma development and patient anxiety before, during and after the procedure. Moreover, one study briefly explored health professionals' usability and technology acceptance related outcomes. **Conclusions:** While peripheral venipuncture of elderly patients assisted by NIR devices is still an understudied area, the studies found indicated results favorable to its clinical application. However, such results should be carefully analyzed, since potential bias and lack of larger study samples may prevent the generalization of the results.

Keywords: Peripheral venipuncture · Near-Infrared Light · Elderly

1 Background

Population ageing is a phenomenon affecting most countries around the world [1]. By 2050, 79% of the population will be 60 years of age or over, amounting to nearly 1.6 billion people [2]. It is estimated that almost half of 65–74 year-olds have five or more chronic health conditions, and this may reach 70% once individuals are aged

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over 85 years [3]. This exponential growth is expected to place a substantial demand on healthcare systems worldwide due to the intensive use of healthcare services, specifically acute settings [4].

In acute clinical settings, the peripheral venipuncture for vein catheterization or blood draw is the most often performed invasive procedure, and there is evidence that up to 96.7% of patients need to have a peripheral intravenous catheter inserted [5–7]. In this sense, peripheral venipuncture has become an indispensable resource in acute care for the collection of blood samples as well as for the intravenous administration of medications, solutions, blood components, parenteral nutrition and diagnostic purposes [8].

Traditionally, health professionals detect and select a new venous access using the landmark technique [9]. This technique involves applying a tourniquet at a proximal location to the insertion site, promoting venous distention, followed by the palpation and observation of the limb [9, 10].

However, this technique may not be suitable for the elderly population, since they often display a number of factors that increase difficulty, such as: disease processes that result in structural vessel changes (e.g., diabetes, hypertension); history of recurrent venipuncture and/or extensive courses of infusion therapy; variations in skin such as excessive hair and scars; and advanced age [9, 11].

Guidelines state that puncture should be attempted only twice per professional up to a maximum of four attempts [9]. However, against this recommendation, there is evidence that the total number of puncture attempts amounts to 49 times, at an average of 6.5 times per patient [5].

In this regard, as a practice standard, international guidelines recommend the use of Near-infrared (NIR) light technology to aid health professionals in locating viable superficial peripheral venous sites and decreasing procedure time for short peripheral catheter insertion [9].

Infrared technologies allow illuminating the vein with NIR light, which is absorbed by blood and reflected by contiguous tissue. This technology can improve peripheral venous catheterization first-attempt success rates, reduce the number of associated complications, prevent health professionals' frustration and improve the patient's overall experience [12–14].

After extensive review of the literature performed in the JBI Database of Systematic Reviews and Implementation Reports, the Cochrane Database of Systematic Reviews, and in the International Prospective Register of Systematic Reviews (PROSPERO), no studies were found that synthesize the use of Near-Infrared Light Technology in the peripheral intravenous catheterization of elderly patients, neither identifying health professionals' perceptions regarding its usability and acceptance.

Therefore, a scoping review was conducted, guided by the methodology proposed by the Joanna Briggs Institute for Scoping Reviews [15, 16]. This review intends to answer the following questions: *What studies have been conducted focusing on the detection and/or selection of elderly patients' peripheral veins using NIR Technology? What are health professionals' perceptions regarding NIR Technology usability and acceptance?*

2 Review Method

Given its intent on mapping the existing evidence behind a research area and identify gaps in the existing evidence the Joanna Briggs Institute methodology [15, 16] and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses for Scoping Reviews Extension for Scoping Reviews (PRISMA-ScR) checklist [17] were used.

Using the **Participants, Concept, and Context (PCC) strategy**, this scoping review included studies that focused on: (a) as participants, elderly patients (age 65 years or older), in need of vein detection/selection for peripheral intravenous catheterization or blood draw; (b) as the concept, studies focusing the use of NIR technology; (c) all clinical and geographic settings were included as the context.

The search strategy included published and unpublished studies and was composed of three steps: (i) restricted search in MEDLINE (via PubMed) and SciELO to identify articles on this topic, followed by the analysis of text words in titles and abstracts and index terms used to describe these articles; (ii) a second search using all keywords and index terms identified in the included databases; (iii) the reference list of all articles and reports found in the search were analyzed to identify supplementary studies.

Boolean logic was used with search terms, including: infrared*; NIR*; Accuvein; "Active Vascular Imaging Navigation"; near-infrared*; infra-red*; VeinViewer*; "Spectroscopy, Near-Infrared"; light*; Catheter; Cannula; "vascular access devices"; "peripheral access"; "peripheral intravenous catheterization"; "peripheral venous catheterization"; "peripheral intravenous access"; "venous access"; elder*; old*; age*. The search strategy was adapted to each of the included databases due to their differences in terms of vocabulary. Studies written in English, Spanish, French, and Portuguese were considered for inclusion in this review, regard-less of the year of publication. The final database search was conducted on June 8th, 2019.

Regarding the search strategy and study identification, the following online databases were searched: JBI Database of Systematic Reviews and Implementation Reports, MEDLINE (via PubMed), SciELO, and Cochrane Central Register of Controlled Trials. The search for unpublished studies was performed by searching the Scientific Open Access Repository of Portugal (RCAAP) and OpenGrey.

In order to assort study relevance, two independent reviewers (PC and LS) confronted the information provided in the title and abstract with the inclusion criteria delineated. Every time the reviewers had doubts about the relevance of a study, the study was included for full-text analysis. Two reviewers (PC and LS) independently revised the full-text version of the articles to comprehend if the inclusion criteria were met. Divergences between the reviewers were decided through dialogue with a third reviewer (RB). An identical approach was employed to the studies identified after the analysis of the reference lists.

Data extraction was conducted by two independent reviewers (PC and LS) using an instrument previously created by the authors. The instrument was designed to recover data consistent with this review's question and objectives. When necessary, the authors of primary studies were e-mailed in order to obtain further information or clarify data.

3 Presentation and Interpretation of Results

The search identified 755 potentially relevant studies. Of these, 52 were excluded for being duplicates. The remaining 703 articles were screened by title and abstract. Of these, 12 articles were included for full-text analysis by two independent reviewers. Overall, 9 studies were excluded, mainly due to the type of intervention (use of thermography-based devices) not matching the inclusion criteria. Therefore, two studies were included for data extraction and synthesis (Fig. 1).

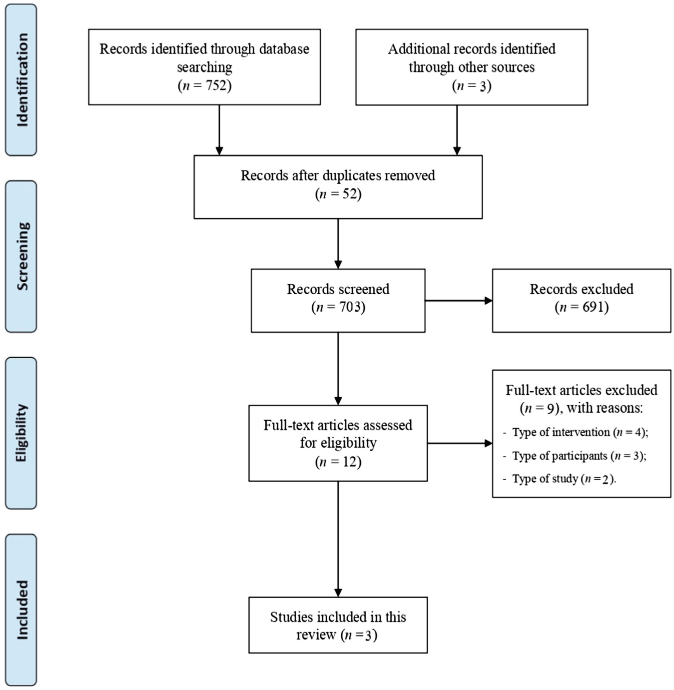

Fig. 1. Flowchart describing the search progression.

Of the three included studies, one was conducted in a large urban medical centre in the United States of America [18], while the other was undertaken in four Haemophilia Treatment Centres (HTCs) affiliated with university hospitals in France [19]. The third study was conducted in an intensive care unit in Italy [20]. The included study was published between 2013 [18] and 2016 [20], which may reflect that the use of Near-Infrared Light devices with elderly patients is a relative current practice and research focus. Study design and considerations regarding patient inclusion criteria for both studies can be found in Table 1.

NIR Device Characteristics and Health Professionals' Training

Chiao and colleagues [18] used the **VueTek Veinsite™ system** (Grey, ME, USA). According to the authors, this device includes: a portable NIR emitter; video acquisition;

Table 1. Study design and outlined patient inclusion criteria.

Study	Study design	Inclusion criteria	Patients enrolled	Other methodological considerations
Chiao et al. [18]	Randomized prospective study	Males and females of all ages, irrespective of race or ethnicity, without emergency surgery or pregnancy	384 patients, of which 42 were ages 65 years or above	Each subject underwent two observations: one using the Conventional method (CM) and the other with the Infrared vein finding (VF) device
Guillon et al. [19]	Prospective multicentre study with a randomization in a 1:1 target ratio	Patients of all ages undergoing at least one peripheral venipuncture every 6 months for infusion therapy or blood sampling	450 patients, of which 28 were ages 65 years or above	Consecutive patients fulfilling the eligibility criteria were enrolled
Fumagalli et al. [20]	Randomized pilot study	No exclusion criteria were defined	103 elderly patients	None disclosed

display device; rechargeable battery; and an optional VGA cable for separate monitor display (Fig. 2). The VueTek Veinsite^{TM} allows for simultaneous vein selection with normal eyesight and operates autonomously of ambient light conditions. NIR radiation emissions range from 700 to 900 nm, with a tissue absorption coefficient between 0.02 and 0.3 cm^{-1}. Moreover, Chiao and colleagues [18] highlighted that after converting the raw image to greyscale, the Veinsite displays it on the headset's LCD screen, giving health professionals a near real time experience and video of the elderly patient's peripheral vascular system.

In their study, the authors claim that each **health professionals was trained in the proper use of the device** at a training session before examining their first subject [18]. Before examining any patients, the observers were shown the device (e.g. power button, viewing lens, and head strap adjustment knobs). After adjusting the head strap, health professions were able to examine two volunteers' upper extremity veins in order to become familiar with Veinsite^{TM} use. The research team recorded comfort and ergonomic scores, time of use (from mounting the device to its full study operation), and any other reported feedback [18].

Fig. 2. The VeinsiteTM headset diagram (left) and View of upper extremity veins (center and right) (Source: [18], p. 967).

Guillon and colleagues [19] employed the **AccuVein - Vein Viewing System** (AccuVein Inc., Huntington, New York, USA). The authors described this device as a lightweight battery-operated vein illumination device that can be hand held by the health professional or mounted to a chair/wheeled stand for hands-free use (Fig. 3). The AccuVein does not require pre-use calibration or any software/hardware adjustments. In their study, Guillon and colleagues [19] **did not report any formal training period for health professionals**.

Fig. 3. The AccuVein system (Source: San Gorgonio Memorial Hospital. AccuVein is Changing Lives At SGMH [Internet]. 2019 [cited 2019 Jul 8]. Available from: https://sgmh.org/accuvein-changing-lives/)

In the study by Fumagalli and colleagues [20], the authors used **EasyVein** (InSono, Calenzano, Florence, Italy). This NIR electronic-optical device displays the reflect wavelength on a 7 inches LCD screen. According to the authors, the system offers an 'augmented reality' image, in which veins, which intensely absorb NIR because of unsaturated hemoglobin, appear as dark vessels and are superimposed on the real optical picture [20]. Although it has not been reported in what form professional training in the use of EasyVein was operationalized, **three trained nurses actively took part in the study.**

Impact of NIR Use During Vein Location and Selection with Elderly Patients

In their study, Chiao and colleagues [18] enrolled 42 elderly patients, of which one was considered to have difficult veins (2.4%). Nevertheless, the authors also included in their study a broad range of study participants in respect to age (e.g. infants, children/adolescents, young adults and middle-aged individuals). When using the conventional method, health professionals located an overall average of 5.8 veins (95% CI 5.4–6.2). Using the conventional method, the number of hand and forearm veins identified for attempted cannulation in the elderly participants was of 6.8 veins (95% CI 5.8–7.9). After conducting a regression model, the authors [18] highlighted that a **positive correlation between overall age and visible vein count** was found ($r = 0.27$, $p < 0.0001$). Overall, health professionals that use NIR technology identified an average of 9.1 (95% CI 8.6–9.5) possible cannulation sites [18]. In respect to the elderly group of patients, the use of a NIR device assisted health professionals in locating a number of veins 10 veins (95% CI 8.8–11.2).

With somewhat different results, Guillon and colleagues [19] included 28 elderly patients, of which 15 (53.6%) were considered to have a difficult venous access. Nevertheless, similarly to Chiao and colleagues' study [18], the authors also included participants from other demographic groups, ranging in age from 1.8 months to 90.6 years. Overall, difficulty in locating veins was encountered in a significantly smaller percentage of the patients with a difficult venous access ($p = 0.002$) when the NIR device was used (76.0%). However, no specific data regarding its effectiveness in elderly patients is reported [19]. According to Guillon and colleagues [19] the percentage of patients posing difficulty in vein localization was significantly lower when the NIR device was used and pain was also significantly less commonly reported.

In their study, Fumagalli and colleagues [20] enrolled 103 patients with a mean age of 74 ± 12 years, and of which 59.2% were men. Patients were randomly subdivided in the standard venipuncture technique ($n = 56$) and in the NIR technology ($n = 47$) groups. The main causes of hospitalization were acute coronary syndromes, clinically relevant heart failure worsening and supraventricular arrhythmias. Arms and forearms veins were chosen in 65.0 and in 35.0% of cases, respectively. Overall, the time needed for venipuncture (standard: 7.0 ± 3.9 vs. NIR: 8.0 ± 5.8 min, $p = 0.173$) and the number of consecutive attempts (standard: 1.3 ± 0.6 vs. NIR: 1.2 ± 0.6, $p = 0.361$) did not differ between groups. However, NIR was associated with a significantly lower incidence of hematoma (statistical power: 84.0%, $\alpha = 0.05$). Moreover, while the proportion of patients with pain was similar in the two groups before and after the procedure, elderly patients in the NIR group reported lower anxiety ($p = 0.038$) and depression scores ($p = 0.037$).

Health Professionals Reported Usability and Acceptance-Related Outcomes
Chiao and colleagues [18] reported that the NIR device was worn for an average of five minutes before comfort and ergonomic ratings at their training session. The time required to secure the NIR device onto the health professional's head, before conducting observations, averaged 7.8 s (95% CI 7.2–8.4). Of the 14 health professionals that used the NIR device in the pre- and post-study assessments, none expressed concerns regarding its use. However, in the studies by Guillon and colleagues [19] and Fumagalli and colleagues [20], health professionals' perceptions regarding NIR device usability and/or acceptance were not reported.

Overall, **the found literature on elderly patients' vein detection and selection assisted by NIR technology is scarce**. According to Lamperti and Pittiruti [21], the lack of evidence within this thematic scope may be due to three main reasons: training, cost-effectiveness, and technical concerns about vein visualization.

For the authors, it is not clear how health professionals should be trained in the use of NIR technology, which is consistent with our review findings, since only two studies briefly address professional training prior to NIR technology use [18, 20]. Moreover, Chiao and colleagues [18] reported only one training session before NIR technology use, which may raise questions about the professionals' acceptance. While the authors reported that the involved health professionals did not report any concerns pre and post-NIR use [18], this may be due to the this may be due to the fact that practitioners feel inhibited given the controlled environment and/or have not had sufficient opportunities to exploit technology in a real clinical context. The development and implementation of new technologies in complex clinical settings should address operator characteristics and skill set, as well as organizational variables. This reality is also reported with other types of vein localization technologies most commonly used in clinical practice, such as ultrasound, where professional proficiency is the main obstacle to the use of these technologies [22].

Secondly, NIR technology cost-effectiveness may raise a challenge in a scenario where a significant number of health institutions are facing recurrent budget restrictions. According to Lamperti and Pittiruti [21], the value of introducing NIR devices may be difficult to be acknowledged by hospital managers, if not supported by a proper economical and clinical rationale. However, only one of found studies reported outcomes traditionally used to calculate peripheral intravenous catheterization (e.g., procedure time cost-effectiveness and number of consecutive puncture attempts), although the results did not different significantly when comparing the groups using NIR technology and traditional technique [20]. Although two studies reported an overall improvement in the number of peripheral veins detected using NIR technology [18, 19], only one study disclosed specific data for elderly patients [18]. Moreover, vein detection does not always equal successful venipuncture, which undermines any formal conclusions in respect of NIR cost-effectiveness.

4 Conclusion

The recurrence of hospitalization among elderly patients is often synonym with long periods of multiple infusion therapies and successive blood draws, which are often performed through a peripheral intravenous access. However, elderly patients constitute a risk group for vein depletion due to structural skin and vessel changes as a result of the aging process and the increasing incidence of chronic diseases such as diabetes or hypertension. Therefore, there is an evident need to preserve the peripheral vein patrimony of the elderly patients and avoiding the risks associated with a potentially unnecessary central vein access.

The use of NIR technology can constitute a significant aid in the detection and selection of an optimal peripheral vein, allowing for a safer and more efficient catheterization or blood draw. Moreover, NIR technology can potentially reduce peripheral venipuncture-related negative outcomes (e.g. hematoma development), while reducing elderly patients' anxiety throughout the procedure. However, the lack of evidence of its use in elderly patients is still evident, despite NIR technology being widely popular in pediatric settings. Moreover, while other vessel detecting technologies used with elderly patients, such as the ultrasound, are extensively explore in terms of operator proficiency and training needs, the results of this review show that there is still a huge gap in this domain for NIR technology. Finally, health professionals' perceptions of NIR technology use in elderly patients are still underexplored, especially when focusing on key issues of technology use such as usability, acceptance and intention to use.

Therefore, further studies should be developed within this thematic scope, focusing not only on NIR technology effectiveness in elderly patients requiring peripheral venipuncture, but also in health professionals' acceptance of its implementation in clinical practice.

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Internet of Things (IoT)

Allowing IoT Devices Collaboration to Help Elderly in Their Daily Lives

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Abstract. Elderly people have the stereotype of being bad to technology, but they are one of the groups that can benefit the most from recent technological advances. The Internet of Things (IoT) is one of the new technologies that aims to facilitate people's lives, automating tasks or allowing them to be carried out more easily. IoT smart devices provide an increasing number of ways for elderly people to stay active, independent and secure. In addition, the collaboration among smart devices increases the possibilities that the IoT offers, achieving that it can be more exploited. Unfortunately, this collaboration is not easy considering the different types of devices that exist in the market and the absence of communication standards. To mitigate this problem, solutions based on semantic web have shown promise, facilitating interoperability among different devices through the representation and the relationship of their information. In this paper, we propose a system that improves the interoperability among smart devices in the application domains of healthcare and smarthome by using semantic web and ontologies. This solution allows a proactive collaboration among smart devices that elderly people have around them regardless of the technology used, in order to increase their quality of life through more effective and efficient monitoring, and promoting actions associated with their needs.

Keywords: Internet of Things · Elderly · Healthcare · Smarthome · Semantic web · Ontology

1 Introduction

The importance of the Internet of Things (IoT) is growing as more and more Internet-connected devices are developed. According to recent estimates [1], we will have around 30 billion smart devices connected to the Internet in the next few years. One of the general purposes of these devices is to make people's lives easier by simplifying tasks or helping them get things done. IoT is being applied in many areas: smarthome, automotive, smart cities, healthcare, etc. [2]. Specifically, in the healthcare application domain, the IoT paradigm allows us for more personalised, preventive and collaborative care, in which patients monitor and manage their own health, and responsibility for healthcare is shared

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between patients and medical staff [3]. These solutions are particularly interesting in homes where elderly can take advantage of these devices for activity monitoring, alarm detection, home security, integrated care, exercise promotion or prevention of social isolation.

The performance of certain tasks requires smart devices to collaborate with each other. These tasks can be detecting the level of air quality taking into account the times a person uses an inhaler or recommending certain foods depending on the glucose level, where devices from different domains are involved. This collaboration is easy when the devices belong to the same application domain and manufacturer, but unfortunately, it becomes more difficult when these are different. In addition, to achieve proactive collaboration between devices, it is necessary that the devices are correctly configured, which requires a minimum of knowledge and time. This is why it is necessary to increase the level of interoperability between smart devices to promote more proactive collaboration with minimal user interaction. Nowadays, there are works that allow a higher level of interoperability to be achieved, but in most cases, they require the intervention of the users, which implies having basic technical knowledge.

This work proposes a solution based on semantic web techniques and ontologies to achieve the collaboration of smart devices in the domains of smarthome and healthcare. Semantic web-based techniques have shown great promise in solving these issues. The main objective of the semantic web is to improve the Internet by extending interoperability between computer systems that use intelligent agents and applications that seek information without human intervention [4]. The semantic web is a widely used resource to achieve semantic interoperability between services and devices. Therefore, the proposed solution includes a system based on the semantic web and ontologies that allows devices belonging to the domains of smarthome and healthcare to interact with each other to facilitate elderly tasks as well as monitoring health conditions or keep caregivers reported. This proposal aims to make elderly people gain in healthcare security through the proactive collaboration of IoT devices.

The rest of this paper is structured as follows. After this introduction, Sect. 2 describes the motivations. Then, Sect. 3 details our proposal to deal with the interoperability among IoT devices. Next, in Sect. 4, some related works are detailed. Finally, in Sect. 5, some final conclusions are drawn.

2 Motivations

Currently, the IoT provides us with many different types of devices that are distributed in application domains. However, the interaction among devices belonging to different domains is not always possible [5]. This makes devices interoperability difficult, which means that everyday tasks can not be solved in the most optimal way. This, in the area of healthcare becomes more critical if we consider that smart devices can monitor a person's state of health, the heart rate, the blood sugar level or keep health staff reported. In addition, if devices in the healthcare area could communicate with those in other domains, such as those in the smart home, more complex tasks could be performed that would provide elderly with more everyday facilities and increase their quality of life.

To show the consequences of the lack of collaboration among IoT devices we propose a scenario where an elderly person has several smart devices that facilitate some tasks, but where collaboration among devices would be required.

George is a 76-years-old man living in Guadalupe, Cáceres. As George is an elderly person, his family has installed in his home some smart devices to monitor his health. Among these devices are a blood pressure monitor, a glucose meter that allows him to have his diabetes under control, and his pantry is controlled through a camera capable of identifying the food he consumes. As a complement to these devices, George wears an activity smartband that controls his daily activity and monitors his heart rate. He also has other smart devices at home that make his day-to-day life easier, such as a smart fridge that controls the food and beverage he has, a multimedia player where he can search and listen to his favourite music, and a virtual assistant that allows him to set up reminders and send alerts.

These devices make it easy for George to do many of the things he does every day. However, the lack of collaboration among smart devices does not allow that certain actions could be performed, which would be beneficial to George's life. For example, if the glucose meter detects unstable levels of his blood glucose levels, it could notify the refrigerator to recommend a certain type of food or drink water in order to regulate his glucose level, or he could be recommended the right foods from his pantry to maintain a balanced diet and alert if a certain food is running out. In addition, George's family should be informed in these situations. If the virtual assistant were able to recognize these situations, it could report George's health status to his family. The same goes for the media player, which could recommend a more relaxing type of music if his smart band detects a higher-than-normal heart rate.

This scenario (Fig. 1) shows the interoperability problems that can arise when devices from different domains or manufacturers cannot communicate or collaborate with each other in elderly daily lives. Currently, there are works focused on solving problems similar to those detected, and although in some cases can increase the level of interoperability between IoT devices for concrete domains, the user intervention is still required. From our point of view, this interaction should be as minimal as possible when it comes to health care for the elderly. So that, the following section shows the proposed solution that, by using semantic web techniques, achieves that devices from the domains of smarthome and healthcare can collaborate regardless of the manufacturer with minimum human intervention.

3 Proposal

This proposal considers to achieve interoperability between devices and to adapt their services to the needs of elderly. This is achieved through semantic web techniques and ontologies. In this section, the required information that allows elderly to link to the smart devices is specified. Then, a study about the current ontologies is conducted for the smarthome and healthcare domains, with the aim of finding similarities that allow devices belonging to these domains to be related. Following this study, an ontology of its own is proposed which, based on the study carried out, is capable of relating devices from different domains.

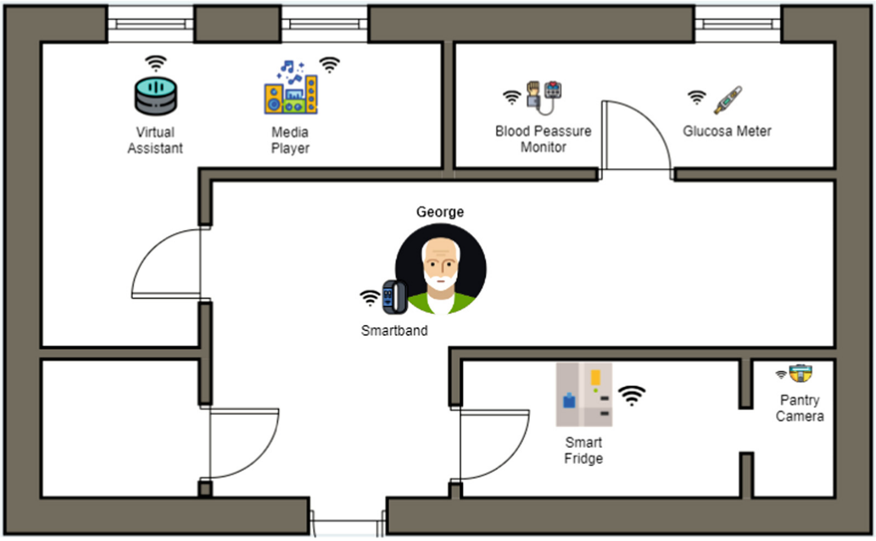

Fig. 1. George's home with different smart devices

3.1 Required Information

To achieve that elder's tasks are easier by the collaboration among smart devices, we must link elder's needs to the services that the devices offer. We define as *needs* the preferences that people have and that need to be covered in order to carry out a certain task, such as, for example, selecting a certain type of food. These needs can be manually specified by the person, or be detected by another device. For example, selecting a specific type of food when a blood sugar level that needs to be stabilized is detected. These needs will be covered by the *services* that the smart devices possess within the scenario. For example, the fridge may recommend specific food available to the person.

Therefore, the minimum information we need to know to perform this process are, on the one hand, the needs of elderly, and, on the other hand, the services of smart devices that are available. Also, additional information is needed to help perform the linking process correctly as specific data of the devices (id, location, service parameters, etc.). This information is represented by ontologies. Below is a study on some of the ontologies considered that could represent the information required in our process.

3.2 Ontology Study

An ontology is described as a formal and explicit specification of a shared conceptualization [6] and it is used to represent knowledge within a domain as a set of interrelated concepts [7]. Considering that one of the best practices of the semantic web is to reuse ontologies [8], a study about existing ontologies within the IoT has been performed in order to evaluate whether they can be used to represent the required information to relate IoT devices belonging to smarthome and healthcare domains with elderly. To perform this study we revised one of the largest repositories of ontologies: **Linked Open**

Vocabularies for Internet of Things (LOV4IoT) [9]. This repository contains a wide variety of ontologies in many application domains such as industry, agriculture, robotics, food, climate, energy efficiency, among others, as well as smarthome and healthcare. The considered ontologies belonging to the smarthome and healthcare are appreciated in Table 1. This study considers all the main classes and types of data they possess, with the aim of determining whether, through their use, the information necessary to match devices and people can be represented.

Table 1. Considered ontologies

Ontology	Domain	Description
HealthIoT [10]	Healthcare and wearables	Semantic representation of both medical connected objects and their data
HOTMES [11]	Healthcare and smarthome	To provide personalized care to remote patients with a wide range of chronic conditions
AALUMO [12]	Healthcare and smarthome	This ontology includes specific classes that characterizes users of Ambient Assisting Living (AAL) services, to cover as wide as possible elderly conditions and environments
FIESTA-IoT [13]	Generic IoT	A combination of existing IoT ontologies into a single one with minor updates to overcome the most common issues associated to the mainstream ontologies
SAREF4EE [14]	Smarthome	The Smart Appliances REFerence (SAREF) ontology is a shared model of consensus that facilitates the matching of existing assets (standards/protocols/datamodels/etc.) in the smart appliances domain

Related to the features of these ontologies, the performed study can be summarized as follows:

HealthIoT: it contains several classes and relationships, some of them extended from other ontologies such as SSN (Semantic Sensor Network) or SAN (Semantic Actuator Network), and others dedicated to the measurement of time or specific intervals for patients. This ontology stands out above all for the declaration of the necessary classes as *ssn:Device*, which allows specifying actuators, *san:Actuator*, and even to group them in categories (*HIoT:Categories*).

Although with this ontology we could represent some information required, such as devices (*ssn:Device*) or services (*HIoT:Capability*) there is other information that would not be possible to represent, especially at the level of data types, such as MAC addresses, endpoints or specific values for services.

HOTMES: with this ontology, we can represent numerous information related to patients (*PatientProfile*), which allows us to store a large amount of data about them. In addition, it allows to assign tasks (*PlanningTask)* or to monitor them (*MonitoringTask)* by means of rules to determine the state of the patient. For clinical monitoring, this ontology is combined with another ontology (HOTMES Clinical) that allows obtaining information from the environment (*EnvironentalInformation*) or representing other control information such as the amount of food the patient eats or if the patient consumes cigarettes. Unfortunately, we cannot apply it to our use case due to the lack of classes to represent information such as services and needs, as well as the relationship between them.

AALUMO: based on the ontology GUMO (General User Model Ontology), this ontology is quite interesting for our work because it allows us to divide people into three dimensions (EmotionalStates, Characteristics and Personality) depending on the information that needs to be used. Within these dimensions, we find specific classes to represent services (*Ability*) and basic human needs (*Personality*), which are very close to what our work needs to represent. Although the information that allows us to represent people's data is quite complete, the part that prevents us from representing our required information is that related to the devices and their associated data.

FIESTA-IoT: this ontology is one of the most complete to improve the interoperability of IoT devices. That is why it takes advantage of important concepts of SSN, IoT-Lite, M3-lite taxonomy, among others, to cover most of the possible needs. Thanks to its great composition, FIESTA-IoT can represent virtual entities (*iot-lite:VirtualEntity*), resources and IoT services (*Service*), which largely solves our needs. However, although the information referring to devices can be represented, the part corresponding to people, as well as their needs would remain unfulfilled, which prevents us from using this ontology.

SAREF4EE: it is based on SAREF, extending 115 classes, 31 object properties and 51 data types. This ontology is quite complete when it comes to representing smart devices and their metadata (*s4ee:Device*). Although this ontology focuses on the representation of multiple types of smart devices with multitude of data types, the part of the representation of people and their relationship with needs is not possible to perform in the way our work requires. Even so, this ontology is interesting to establish basic configurations of devices or to determine when a certain action is carried out, processes that are very close to our needs.

The development of ontologies is usually done to solve a specific problem. It is for this reason that although the ontologies considered have classes and types of data that could solve our problem, they do not achieve it completely, and do not allow us to represent the required information in the way we intend to do it. For this reason, we propose our own ontology to solve the detected problem.

3.3 Ontology Specification

The proposed ontology is defined as *Ont4E* (Ontology for Elderly) (Fig. 2). The aim of this ontology is to represent the information of smart devices belonging to different application domains and manufacturers as well the information about elderly to achieve a semantic relationship.

Given the fact that both people and devices have services and needs, we use a single class *(Entity)* to represent both concepts, that we treat them equally. In addition, this class allows us to represent the entity's personal information so that it can be correctly

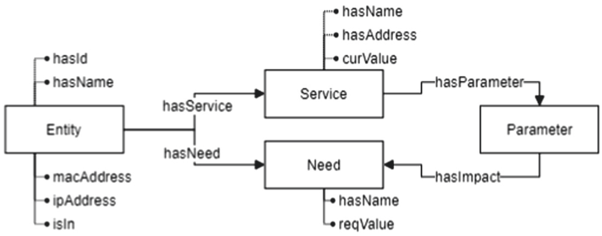

Fig. 2. Proposed ontology to help elderly by using IoT smart devices *-Ont4E-*

identified, and for the moment is not necessary to make a separation. Besides, this ontology is able to represent the services *(Service)* the entities have, as well as the needs *(Need)* that will be solved by the available services. We must bear in mind that the impact of services on needs will not always be the same and will depend on different parameters. For this reason, a class *(Parameter)* has been introduced that receives the necessary parameters to make the invocation and to adapt the service according to the characteristics of the need that it is going to solve. The following section shows the processing that is done through this ontology to communicate devices with each other.

3.4 Ontology Processing

The processing of the ontology goes through several phases (Fig. 3).

1. The smart devices and their services and needs, as well as people with their needs, must be included within the ontology. This is a required step and is currently being developed, but because this phase is outside the scope of the proposed topics and to simplify the process, we assume that this information has already been included in the ontology and is available to be processed.
2. The list of people and devices (entities) is made through the SPARQL query language. SPARQL allows us to search within the ontology and to relate information [15]. In this way, we can identify how devices can collaborate depending on elderly needs.
3. When a search is made to solve a specific need and a device is discovered, its services are invoked. In this way, a device is able to cover an elder's need and allow collaboration with other devices.

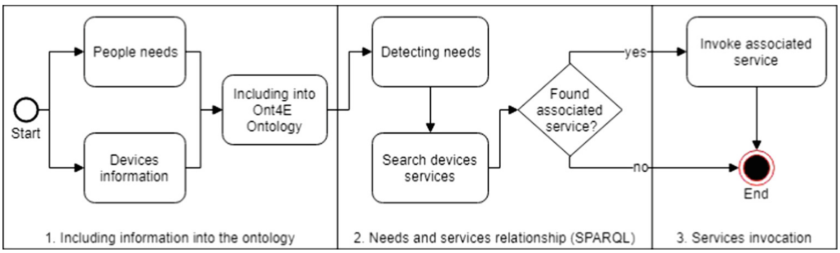

Fig. 3. Ontology processing flow

This process is conducted by a device capable of manipulating the ontology. This device can be from a Raspberry Pi to a dedicated equipment for that purpose. Besides, this process is performed automatically when a person or device is detected on the stage, minimizing the interaction of people with the devices.

3.5 Use-Case Demonstration

Moving on to the previous scenario where George has several devices from the application domains of smarthome and healthcare, the use of the proposed ontology and query languages allows these devices to be able to collaborate. Table 2 shows the devices as well as their services.

Table 2. Use-case smart devices

Device	Application domain	Services
Blood pressure monitor	Healthcare	srv checkBloodPressure
Glucose meter	Healthcare	srv checkGlucoseLevel
Smartband	Healthcare	srv checkHeartRate
Camera pantry	Smarthome	srv checkFoodsAndBeverage
Smart Fridge	Smarthome	srv checkFoodsAndBeverage srv recGlucoseFood srv recBeverage
Media player	Smarthome	srv setMusic srv findArtist
Virtual assistant	Smarthome	srv reminder srv alert srv familyNotification

As stated above, the ontology contains all information about devices and people. Thus, when George's glucose meter detects inadequate levels, it can report this information to the smart fridge or the pantry to suggest George certain types of food to correct these levels. This is done by developing SPARQL queries on the ontology. These queries are performed dynamically according to the needs and services detected in the scenario. An example of a SPARQL query to recommend food when an unstable glucose level is detected can be appreciated in Table 3. In this way, the detected need due to the glucose level (*ne glucose*) is communicated to the devices that are able to cut down it (*srv recommendFood)*, in this case, the smart fridge. In the same way, his blood pressure monitor could perform a similar operation, or the virtual assistant could alert his family to a potentially dangerous situation for George. For example, if the smartband detects a high health rate for a long period of time, a family member can be notified by the virtual assistant to check whether George has a problem. All this is achieved by invoking the services of smart devices to adapt them to George's needs and in a transparent way for him.

Table 3. SPARQL query for "glucose" solution

Query: services with "glucose" relation

```
SELECT * WHERE
{
?Need a :Need .
?Need :isImpactOf ?service .
?Need rdfs:comment ?comment .
FILTER (CONTAINS(lcase(str(?Need)),
    lcase("glucose"))) .
?Entity a :Entity .
?Entity :hasService ?service .
}
```

Result

Need	ne_glucose
Service	srv_recFood
comment	Recommend food and beverage
Entity	Smart Fridge

The treatment of the information coming from smart devices through the proposed ontology is capable of solving George's needs, improving his quality of life and keeping his relatives informed of his health status. Therefore, through the information stored in the ontology, when one of the devices detects a specific event or a need of George, it is sent to the Raspberry to perform the search associated with the need and discover which devices can solve it.

4 Related Work

In a society where there is an increasingly ageing population, the collaboration of smart devices from the IoT is a problem that concerns to the scientific community. In this section we highlight some works such as [16], where Azimi et al. study the systems enabled for IoT that address the monitoring of elderly to classify existing approaches from a new perspective and to introduce a hierarchical model for monitoring focused on elderly; or [17], where a research is conducted to develop a theoretical system empirically to determine the central factors that can affect the acceptance of smarthome services by elderly users for medical care.

In addition, the use of semantic web techniques and ontologies is becoming increasing to achieve collaboration among smart devices. Jabbar et al. [18] propose a semantic interoperability model based on IoT (IoT-SIM) to provide semantic interoperability among heterogeneous devices from IoT in the healthcare domain application. In this way, healthcare workers communicate with their patients through heterogeneous devices to control their current health status. In addition, Gomez et al. [19] develop an ontology-based architecture capable of monitoring routine health recommendations and training for patients with chronic diseases, with the aim of providing information on the health status of patients and providing real-time information. Moreover, the smarthome application domain is also quite important within the semantic web, and is quite related to the healthcare domain. Some works in this line demonstrate the importance of this domain, such as [20], where the authors propose an IoT architecture that allows them for personalized medical care, as well as continuous monitoring of physical parameters and processing of medical data, form the basis of a more intelligent, connected and personalized medical care. In addition, [21] addresses the use of IoT in the healthcare system, the challenges of IoT in the healthcare system and reviews the most interesting solutions in this field.

Additionally, we can also find specific frameworks that try to solve these collaboration issues. Among them are [22], where Maarala et al. process the information coming from the IoT devices through the last generation semantic technologies. To this end, they have developed a semantic reasoning system that works in a realistic IoT environment. In addition, Gyrard et al. address in [23] the issue of the semantic relationship of devices. Besides, in [24] Kiljander et al. develop a framework based on two main aspects: the information and capabilities of the devices are represented with the semantic web; and that the global IoT is divided into numerous intelligent spaces managed by a semantic intermediary.

Thanks to these works we can appreciate that the collaboration between IoT devices is a problem that worries the scientific community. Although these works solve some of the detected aspects, unfortunately, they do not solve all of them. The interoperability between smart devices is increased and it is achieved that these devices are increasingly able to communicate in a more optimal way. However, the interaction with them is still too manual, having to make manual settings to achieve the desired behavior. Therefore, this interoperability depends in many cases still on people making a correct configuration, and as long as it is possible to do it, because it is not always possible.

5 Conclusions

Due to the accelerated ageing of the population, healthcare-focused on monitoring has become of great interest. Thanks to the smart devices of the Internet of Things, these aspects can be solved to a large extent. However, the collaboration among these devices is still difficult in many situations, preventing elderly from getting the maximum benefits from them.

This paper addresses the problem of collaboration among IoT devices from the perspective of elderly care, combining the application domains of smarthome and healthcare. Besides, this collaboration must be achieved in a most transparent way for the user, thus simplify their day-to-day life. The use of the semantic web and ontologies allows us a more efficient treatment of the information coming from the IoT devices to establish semantic relationship between them, and allowing collaboration to solve elderly daily tasks.

This work is a further step towards achieving the IoT devices collaboration but there is still work to be done. In future work we will focus on decision making when using the services of IoT devices, as well as the extension of the ontology to allow the representation of devices from other domains and even more defined information of IoT devices and the people who use them.

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Voice Assistant to Remind Pharmacologic Treatment in Elders

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Abstract. Nowadays, the European population is dealing with a serious ageing increment. It is estimated that almost half the population will be over 65 in the next decades, involving society into a vital challenge. This context is specially impacting on the healthcare industry which is facing a significant increase in service and medicine petitions. Elders daily cope with multiple medicine doses, a complex scenario due to the difficult management of drugs and affected by other factors such as solitude or neglect. In this paper a solution is introduced: a voice assistant that reminds the daily pharmacologic dosage using an autonomous system that operates without internet connection.

Keywords: Elder healthcare · Medicine disposal · Ambient assisted living · Voice assistant

1 Introduction

The ageing of European population is an existing fact. Only in Spain, the current percentage of people who is over 65 involve a 20% of the total population, becoming more than 50% in the next decades [1]. Rural areas are the most affected by these circumstances where more than 30% of the population are already senior and aspects like solitude get intensified [2]. The increment of third age individuals implies several challenges to society, specially for the healthcare industry. During the last years, health services and medicine requirements have experienced a severe increase [3]. Almost 50% of health resources expenditure have been intended to third age people eliciting a 30% of all medicine doses and a 75% of chronic treatments.

Elders have the defiance of managing medicine takes, meeting a conflicting scenario due to difficult administration of medication. Around a 15% of elderly population are polimedicated patients [4]. It means that there is a big percentage of third age people who takes five or more medicines for a period of six months or more. This problematic context is specially favoured by the absence of assistance and the age-related cognitive issues. Statistically, this background has an strong impact in society: around 5% of emergencies related to elderly are due to bad medicine management and almost a half of chronic patients at third age does not

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follow properly prescriptions. This set of conducive circumstances are favourable to the use of technology.

Recent technological advances have been specially influenced by new interaction ways. Voice assistants have been one of the most disruptive tendencies at human-computer interaction [5] and has teared down many constraining barriers. Taking advantage of this new paradigm, elders can easily engage with devices which could help them in day-to-day situations.

Taking this into account, voice assistants can be a very suitable technology to remind the elders their daily medicine doses. However, there are some important restrictions derived from the own context that limit possible options. In this paper a possible solution is explained as well the main factors that have been taken into account in the implementation of the project: a voice assistant that helps elders at rural areas reminding the daily medicine takes and clinical appointments. In the following chapters, the platform performance is expose as well as the future possibilities.

2 Overview

The idea of this research project involves a set of challenges that implicate environmental and human factors. There are some important restrictions derived from the own context that limit possible options at development: (1) voice assistant at rural areas and (2) appropriate speech with elders.

1. **Voice assistant at rural areas.** Population in rural areas is generally the most aged [2]. This fact induces that the main targets are those elders who live at rural areas where, widely, homes do not count with an Internet connection. This limitation discards the use of the most popular voice assistant devices such as Alexa from Amazon or Google Home since they require a constant Cloud connection [5].
2. **Appropriate speech with elders.** Since the target users are elders, it is necessary to take into account this fact at speech composition, specially when it references medicines and doses. Usually, third age people do not identify medications through the name or trademark. Physical descriptions or even personal specifications [6] such as position inside a storage rack, are more common. This way, the voice assistant has to allow high customizable options.

On the basis of these two main limitations, the project has been implemented over Snips [7], an open source voice assistant which operates autonomously without Internet connection. Thus, the device has been adapted and integrated into a platform that helps elderly to remind medicine doses and takes. Through this system, medical personnel are able to configure the voice assistant and add prescriptions and appointments (Fig. 1).

The platform follows a simple working scheme that tries to diminish configuration processes and user intervention. *The data synchronisation is the most relevant process. It is based on three main steps: (1) Elderly information* *configuration, (2) Snips synchronisation and (3) Snips operation. This procedure has to be done every time a change is made in the prescriptions or appointments (step 1).*

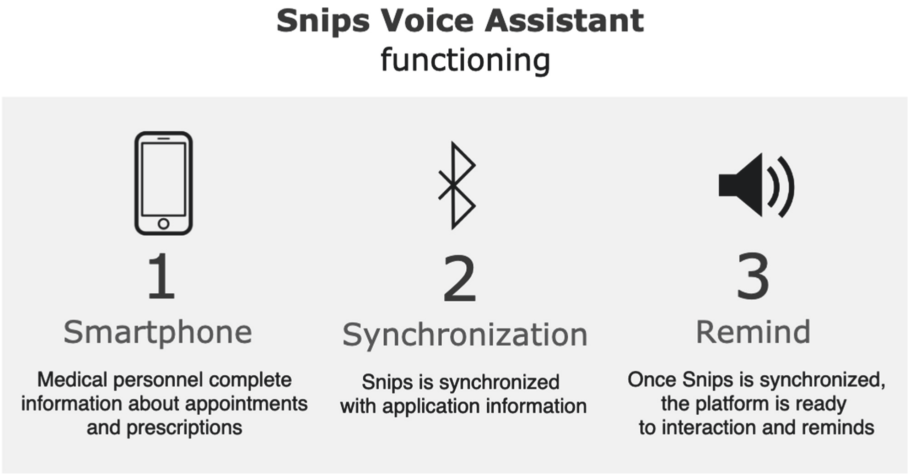

Fig. 1. System overview.

(1) Elderly information configuration. The first step is to specify the elderly information in the smartphone application. Since prescriptions and appointments are clinical data, the medical personnel are in charge of completing this information. Initially, personal data is provided in order to create a new patient profile, once this task is completed, prescriptions and medical appointment can be made. These specs implicate several details:

Prescription. Prescriptions are one key piece in the application and in the full system. This concept associates the elderly with the medication prescribed by the doctor. This way, a medicine can be specified as well as the doses. Since drugs can be consumed at several takes, days of the week and hours are selected, stating the set of reminders that will be lately announced. It is quite important to take into account that the project targets are older adults, therefore, the way medicines are identified has to be taken into consideration. It is usual third age people identify medication following a physical description or even a more personal denomination. This way, the application provides the option of specifying a custom overview to solve this matter.

Appointment. Clinical appointments are really common on elders routine. The variety of motives, places, dates and hours at appointments can turn out to be confusing to elders. In order to solve this, the application integrates a personal user calendar that allow appointments specification. Thus, it includes the involved medical specialist, the place where the meeting will be and the full date.

Once the full information is provided, the application is ready to synchronise with the Snips device.

(2) Snips synchronisation. In contrast to most popular voice assistants, Snips platform is designed to operate in an autonomous way. This means that internet connection is optional, being capable of performing interactions without any Cloud processing. On this basis, an Snips Skill has been develop in order to program schedule reminders using the information from the application. Once all data has been provided in the app, the synchronisation is simply made by Bluetooth, selecting the Snips device as destination. The full step is invisible to user and does not demand any effort. Once this quick step is made, the device is ready to announce the elder's appointments and medical prescriptions.

(3) Snips operation. As a result of the previous tasks, Snips is able to work autonomously and remind elderly about the appointments and medicine takes. This way, the device will announce the medicine that should be taken followed by the custom description at the corresponding daytime. Also, within few days before, medical appointments will be reminded.

The system functioning is really easy and involve just three simple steps. Each component of the platform works independently and they are implemented involving several technologies. In the next chapter, technical architecture details are drawn.

3 Architecture

The platform has been developed into several components that conform the full system. Each element evolves a concrete function to the architecture and can be clearly differentiated through the defined working steps: (1) Smartphone application used to fulfil elderly information and (2) the skill developed over Snips platform.

(1) Smartphone Application. As an starting point, the platform needs information input and requires a way of synchronising Snips devices with that information. Taking into account that one of the premises is the absence of Internet connection at Snips devices, the most suitable idea is using an smartphone application. Thus, data can be easily kept and managed while the physical independence of the phone allows carrying this information into voice assistants installed at elders home.

The smartphone application has been developed using Kotlin. This programming language has motivated the agile development of the platform and has allowed the multiple management of the resources at phone. Through a tab-based navigation model, a fluid browsing has been reached, enabling an easy use and interaction of patient, appointment and prescription information (Fig. 3). Once the application keeps all valid information, synchronisation process is made via Bluetooth (Fig. 2).

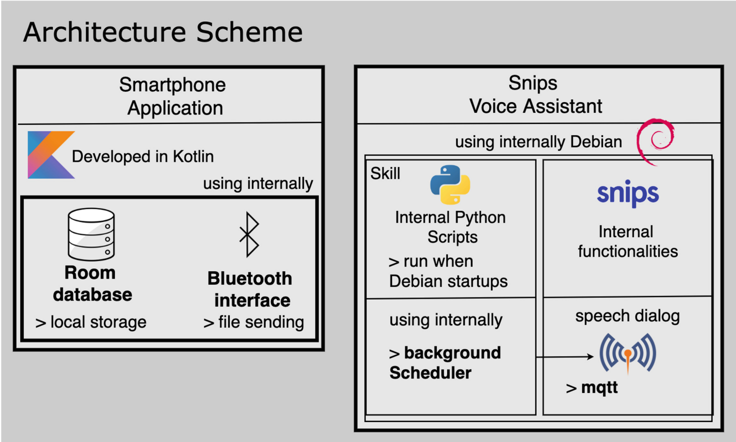

Fig. 2. Voice assistant architecture.

2) Snips skill. Snips device is a voice assistant which main feature is the autonomous working and the independence from Internet connection. This platform integrates a NLP (Natural Language Processor) component that allows the programmer identifying key words and sentences in order to perform tasks. *When the key words are recognised, the instructions to execute are specified using Python language. Internally, Background Scheduler library is used to program reminds. Then, Snips internal functionalities are invoked in order to allow the device to speak.*

Another relevant factor is the capability of integrating functions that commercial platforms disable such as proactivity or device internal settings modification.

Once the full patient information is completed in the smartphone application, Snips can be synchronised. In order to perform this communication, the system follows a quick dialog process: firstly, the application creates a JSON format file (Fig. 4) with the full information of the patient, then, this archive is sent by Bluetooth to Snips and, at last, the device reads this data and programs reminders. Next, this process is explained detailed.

1. **File generation.** When the sync option is selected in the application, it generates a file with the full information of the patient, including appointments and medicine prescriptions. The content is specified in JSON format, enabling an easy interpretation of data.
2. **Bluetooth sending.** Once the application generates the file, it is sent via Bluetooth to Snips.

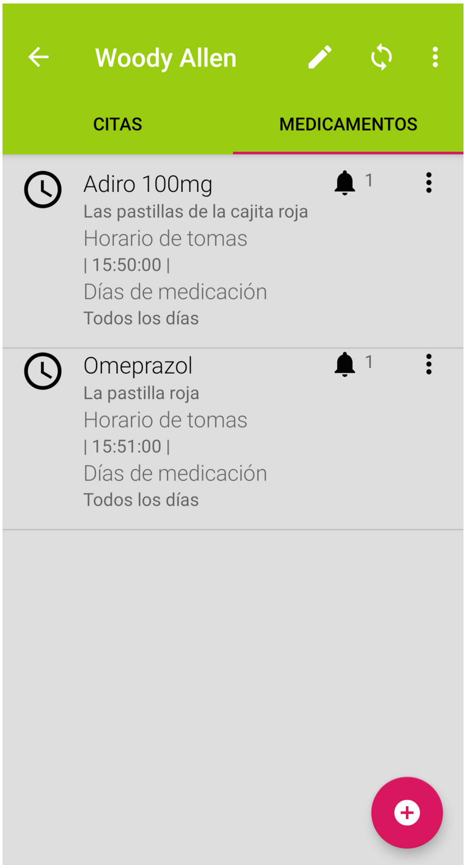

Fig. 3. Application screenshot.

3. **Snips processing.** When Snips receives the file, it identifies the content and new appointments and prescriptions. This way, once information is interpreted, the device launches the reminders and speeches coordinators. As a result of this last step, Snips will remind elderly the medicine doses and takes while announces clinical appointments.

As a result of the development process, Snips is able to recognise the detailed information about prescriptions and appointments. When the corresponding taking hour is reached, the device will announce the medicine name joined the custom description. Furthermore, clinical appointments are notified few days before they take place. All this functions conform the current working of the platform, opening a work line full of possibilities and options to the voice assistant and assuming a very significant improve in elders' life.

Fig. 4. Json file format.

4 Related Work

Technology is a discipline closely linked with health. The possibilities and advances at digital healthcare are quite relevant and they are becoming a very significant branch in research. Elders are the target users of many projects and the literature offers many ideas to improve their day-to-day activities. In this Section, several projects related to medicine prescriptions reminders are collected, exploring the working and studying the possible impact. This way, related articles are classified into two main clusters: (1) medicine takes reminders and (2) elderly healthcare assistants. This two working groups explore the two main lines of this project.

(1) Medicine takes reminders. Several projects and patents about medicine takes reminders can be found in the literature. The main objective is helping elderly or dementia patients at daily drugs ingestion. Thus, some of the most relevant works are: Medicine Reminder and Monitoring System for Secure Health Using IoT [8], Feasibility study of a robotic medication assistant for the elderly [9] and Multimodal and adaptable medication assistant for the elderly: A prototype for interaction and usability in smartphones [10].

Medicine Reminder and Monitoring System for Secure Health Using IoT [8] specifies the working and architecture pattern that medicine reminders implement. In order to identify the functioning core of these ideas, the article assembles

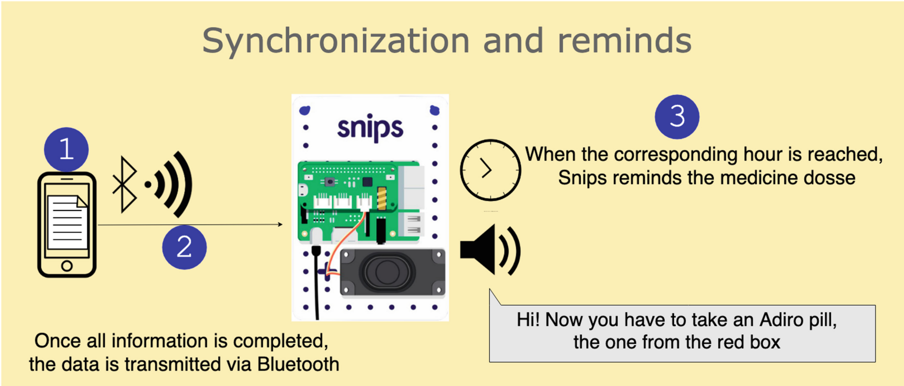

Fig. 5. Synchronization process.

several projects and previous work, drawing a performance schema and analysing the useful use of IoT devices (Fig. 5).

Feasibility study of a robotic medication assistant for the elderly [9] brings the mixed concept of robotic assistant and medication reminders. This way, using a robot equipped with a touchscreen, the device reminds the elderly the drugs that should take, checking if the doses has been taken.

Multimodal and adaptable medication assistant for the elderly: A prototype for interaction and usability in smartphones [10] proposes a solution based on mobile devices that reminds elderly the daily medication. One of the main strengths of the platform is the capability of adaptation to the context, adjusting information output to the user's situation: distance from user's face and screen is calculated thus, icons and fonts are scaled while ambient noise is checked in order to establish a right notifications volume level in each case.

(2) Elderly healthcare assistants. The developed skill in Snips platform opens up a full future work line where options like deep speech responses and proactive care of the elderly can be finely integrated. This way, elderly assistants can be a very powerful tool in order to provide wellness to the user. Literature offers several relevant ideas that match with this premise: iCare: A Mobile Health Monitoring System for the Elderly [11], Pearl: A Mobile Robotic Assistant for the Elderly [12] and Tele-medicine system based on a personal robotic assistant [13].

iCare: A Mobile Health Monitoring System for the Elderly [11] is a healthcare platform based on smartphone and wearable that monitors elderly vitals. Moreover, the system can identify possible emergencies and provides multiple information about the user, allowing relatives, friends and health personnel know about the progression. Furthermore, iCare also includes functions about reminders and medical guidance.

Pearl: A Mobile Robotic Assistant for the Elderly [12] is a platform based on a robot that helps elders at day-to-day tasks. The device works as a personal assistant with two main functions: reminding elderly about tasks like taking medicines or drinking; and guiding people through environments. The robot is based on a well-defined action scheme which includes the possible programmed actions like informing, moving or reminding.

Tele-medicine system based on a personal robotic assistant [13] introduces an elderly tele-assistance system implemented on a robot assistant. In this manner, the system is able to communicate and interact with the elderly on a natural and intuitive way. One of the main functions of the project is remote telemedicine which is mainly based on a video-conference system that allows medical personnel to keep a visual and telematic diagnosis.

All this works are perfect examples of the encouraging work line this project follows. The possibilities new advances provide to the research bring the opportunity of improving notably the elder's life through technology.

5 Conclusions and Future Works

Many older adults daily face with multiple medicine doses. The difficult of managing several medicine brands with various doses and different takes becomes a hard situation for ageing people. Technology can be a suitable option to improve this daily routine, specially voice assistant devices. The purpose this paper describes has the main objective of reminding elderly of the daily medicine takes and the clinical appointments. This way, a voice assistant is a matching solution to the polymedical problem at third age, working successfully at helping in medicine management. *Nevertheless, not all voice assistant platforms adapt to the context of the problem. Popular devices such as Alexa or Google Home require a constant Cloud connection. Therefore, deployment is not possible in areas where there is not Internet connection. Moreover, these voice assistants provide a very restricted development environment. Thus, the Skills operations are limited and functions like proactivity are not possible. On the other hand, Snips Platform is a voice assistant that operates without Internet connection. The working of the device allows the developer to operate with internal options of the voice assistant. This way, it is the best option to the purpose.* The custom capability of the platform assures that user understands the device indications, improving elderly-machine interaction. Since Snips Platform is used to define the assistant, deployments are immediate in every context. The Internet independence enables the use of the device in rural and isolated areas, assuming one of the most disruptive concepts of the project.

The voice assistant has been tested in several lab contexts. During these tests, researchers and students have been using the platform in order to detect possible functional errors. It is quite relevant to guarantee a successful working in the prototype before next versions since it is planned to involve real users in next tests. Moreover, results have been favourable. The voice assistant device has successfully stored and reminded all prescriptions and appointments. Thus, next versions will be tested with final users in a real context.

The implementation of the prototype adjusts elder's need and allow interaction based on natural language and without any learning curve. However, this is the first step in a very relevant work line thanks to the possibilities of autonomous connection and programming faculties. There are pendent interesting tasks that will notably increase platform possibilities like a deep speech implementation or proactive care of the elderly. Next, some of this ideas will be detailed.

A deep speech implementation will be specially useful at user-device interaction. The potential of these functions translates the usage into a better experience that improves medicine management, allowing consults about prescriptions details. *Therefore, the elderly will be able to interact with the voice assistant, asking about the next medicine takes or precising details about future appointments. It will be a substantial feature since it provides an easy interaction between the user and the system. This communication will play a key role in future developments since it can be extended in order to provide fluid speeches with the elderly. This way, the conception of the voice assistant will change into a companion device.*

Proactive care is also a keystone on the future work line. The opportunity of using context information and elderly health reports brings the option of proactive care. This way, the system asks the user about his wellness and medicine effects, giving advices about prescriptions, health and physical care. *It is also a key part at healthcare. The voice assistant device will be able to ask the elderly about issues related to medication. Moreover, a deep study of prescription symptoms can be developed. Since the elderly will answer about doses effects, the voice assistant device will store the reply. When the next synchronisation process is made, the device will provide the information to the medical personnel. This feedback can be essential to successfully adjust the dosage.*

System interconnection is a technical challenge that improves system effectiveness. The possibility of connecting the assistant into several wearables and devices assure medicine notifications will be received. Appliances like vibrating bands and smartphones are examples of devices that would notably increment the platform presence.

This paper brings an idea that notably improves elder's day-to-day. The project is a solid approach to solve polymedical derived problems and provides an easy reference to drugs management and recognition. Future works are evidences of the disrupting ideas the system brings.

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Technology for Anthropological Research. Feedelio: An Application for Food and Nutrition Studies

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Abstract. Food has a social and cultural sense that surpasses dietary rationality and visions focused exclusively on caloric values. Anthropology has developed an entire field of study focused on analyzing all that underlies the forms of eating and food in different cultures and societies. This space has not escaped, in recent years, the use of technology to facilitate the work of anthropological fieldwork. The aim of this text is to set the context and lines of development in which we have designed an application in order to provide fundamental support when making ethnographies of food. It is an application for smartphone developed on the Android platform and optimized to work in versions equal or superior to API 22, with a compatibility with 80.2% of Android devices. It compiles different tools, such as the recording of interviews or the collection of surveys 24 h Menu Recall, which try to facilitate the collection and organization of materials in the field. The application can be adapted to different scenarios and research contexts.

Keywords: Elderly · Food · Nutrition · Anthropology · Sociology · Technology

1 Introduction

The relationship between dietary practices and habits and quality of life and well-being is already generally accepted scientific evidence [1]. This is particularly important in the case of the ageing population, where their particular vulnerability in relation to dietary habits has been highlighted. This has usually been approached from nutrition-dominated approaches, with a purely biological point of view. owever, on the other side of these biological approaches, the social sciences have endeavoured to underline that food is not, and never has been, a simple set of foods chosen on the basis of a strictly nutritional or dietary rationality, since both, food and the way in which we feed ourselves, have their own social and cultural significance [2]. This was affirmed by Mary Douglas [3], one of the main references in Anthropology of Food, who went so far as to state that,

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properly analysed, food was one of the best tools for expressing social symbolism. Lévi-Strauss also commented on this idea, stating that the food of a society is a language in which its own structure is unconsciously translated [4]. López García [5], in this same sense, points out that we eat what we eat not because we really know the nutritional utilities of what we eat, but because we value, in addition to these, other social and symbolic utilities. All of them are sufficient reasons to understand that food and its lack must be treated from a biological approach, but that it is also essential to do it from a cultural prism.

On this basis, Audrey Richards [6,7] was pioneered such anthropological approaches to feeding from her work with the Bembas and Bantu in Rhodesia (now Zambia and Zimbabwe). From these earliest ethnographies that approached the field of food from an anthropological perspective, the subject of food has become the focus of a significant number of works. This development has been added to the theoretical reflection carried out by a good number of anthropologists, thus constructing a space for a culturalist perspective on concepts related to the ways in which human beings express themselves through food, and which go much further than the nutritionist visions of caloric values than are usually expressed in food studies.

However, over time, the reality of the possibilities of using research tools has changed rapidly, also in research carried out by anthropologists. With the birth of smartphones the possibility has arisen to carry digital tools capable of assisting in ethnography. Some of these new possibilities have come in the form of applications for smarth-phones that are revolutionizing the ways of conducting research on various issues, no longer think alike when selecting subjects for a study or produce data, store and analyze them. As it could not be otherwise, these "new ways of doing" have also reached the ethnographies that aim at food and nutrition. The application presented in this text aims to bring together in a single tool all those areas of research in which the anthropology of food is fixed.

2 Objectives

The purpose of this text is to present the app "Feedelio" , oriented for the development of field work in research in anthropology of food and nutrition. The development of this application is part of the project "International Institute for Research and Innovation on Ageing (4IE)" . The aim of this project is to develop technologies to improve the quality of life of older people in rural environments. To this end, one of the actions focuses on research into food universe and the representations and ideologies around it have older people and also how it can relate to their quality of life and health. Within this framework, we have developed this application to help improve data collection and organization in the field. In addition to a classic way of researching a topic as widely used as food and nutrition, we have tried to add the possibilities offered by new technologies. This does not prevent it from being used in other contexts and situations where ethnographic fieldwork is carried out.

3 The Anthropology of Food and the Field

Research on food habits and consumption has traditionally been carried out using different methodologies that propose a multiplicity of tools extracted from quantitative and qualitative methodologies. Thus, in the studies on food and nutrition we find from purely ethnographic proposals with the use of techniques closer to fieldwork in anthropology, to questionnaires such as the "24 h Recall Menu" or "72 h Recall Menu" or self-administered questionnaires closer to research seeking to know the intake of nutrients or certain data on anthropometric measures.

Within the framework of the innovation and research project 4IE we propose to carry out a diagnosis of the nutritional state of the population through the methodological tools that Anthropology offers us, such as the participant observation and the in-depth interview, with the purpose of knowing the practices and the narratives around the feeding of the population object of study. The field work and the different survey relationships aim to collect testimonies and descriptions of food practices, collection processes or representations of the population about the notions of "healthy food" .

In recent years, technology has transformed the ways in which fieldwork is carried out in research. From anthropology, different elements have traditionally been used to help in the collection of data, from the first field notebooks to the arrival of the first audio and video recordings of the cultures studied, such as the photographic recordings that have enriched a multitude of ethnographies. In recent years, we can see how the development of information and communication technologies has fully reached ethnography. The space of technology has even become an interesting context for research, and studies have been developed both for the purpose of study and as a field in which to develop one's own virtual reality [8]. In our case, the application we have developed serves only as a tool for field work, but we try to bring a plus to the research carried out.

4 Feedelio, an Application for Fieldwork

The objectives and needs of "Feedelio" (in a little word game that honors Fidelio, Beethoven's famous opera), place the concept of mobile application as the most appropriate platform, thus discarding alternatives such as web or desktop programs. Bearing this in mind, Android is the most optimal option for its development, as it has significant advantages over other operating systems, especially in the ease of implementation.

Android classifies version compatibility through a numbering called API, which groups operating system versions[1]. In the case of Feedelio, the greatest possible compatibility is sought while taking advantage of the device's most advanced resources. Therefore, the application has been optimized for API 22, Android 5.1, reaching compatibility with 80.2% of devices that have Android.

[1] https://developer.android.com/studio/releases/sdk-tools.

In order to achieve greater ease of use and simplicity in the operation of the application, something we consider essential to work in the fieldwork when we are with people, we have opted for a navigation pattern based on tabs. In this way, it is possible to represent the necessary information in an adequate way, reducing windows at the same time and achieving a fluid navigation.

Android programming is especially characterized by the possibility of using external libraries. These are independent components that are used to carry out specific tasks, especially speeding up the implementation tasks. Feedelio makes use of several libraries for specific functions such as the dynamic loading of images, the management of permissions or the storage of information.

The addition options fall only on a floating button (lower right corner) that remains visible. The root element would be the ***Research***, from which you would access the set of ***Observations*** and the ***Informants*** that would be part of the ethnography. Each informant is interviewed obtaining the information in four different sets: 24 Recall Menu; 72 Recall Menu; anthropometric data or audio or video interview recording.

The first option we find is the tab ***Observations***. This tab is in charge of collecting everything that has traditionally been considered as "field notes" . In it, we can take a photograph of a specific element and write down text linked to this photograph, along with the place and the date and time it was taken. This helps us to organize chronologically all our field notes, adding the possibility of being able to collect graphic testimony of our observation. In these observations we can also have space for, for example, making a Household Food Inventory supported by images, grouping the information in different spaces from the movement we make it. In our case, we are trying to photograph the refrigerators of our informants to take note of everything they have (or lack).

The other main tab, ***Informants***, aims to collect all information linked to one or more field informants. The intention of this tab is that all kinds of notes can be collected during the interview that we develop. One of the future objectives is to develop an instant voice transcription tool, in order to be able to transcribe the text at the same time as we develop the interview, something that would avoid the work of several hours of transcription. The intention is to be able to combine it through another application with these functions. The options that this tab raises at the moment are:

- ***24/72 Menu Recall***: These are survey relationships in which the informant is asked about his or her diet during the previous 1 or 3 days. It allows you to save all the answers in .xlxs format so that they can be exported for later analysis. This format facilitates the collection of all the information. The intention is to add in the future a library from which all possible foods can be registered.
- ***Interview recording***: It's about the recording of the interview. It includes the option of, by clicking on an initial screen, reading and accepting the informed consent of the interview. Apart from recording voice, we intend in the next development to add video recording. Perhaps this is the option that can make the information more "heavy" to be saved.

– ***Antropometrics data***: In this option, the aim would be to collect different weight and height controls or other selected markers, such as fat percentage or abdominal perimeter. The intention is that these data complement the different survey relationships or that they can be used as small indicators.

One of the main attractions of the app is the free navigation of data. In our research context (and we assume that in many of the contexts in which a large part of the food anthropologists carry out their fieldwork) there is a serious difficulty in being able to reliably access 3G Internet networks. Currently the resources are stored in the device, but we are working on an information dump that allows us to have a database in real time, in which the moment you locate a stable network, you can upload all the data obtained.

In the future, with the technical developments that we are currently carrying out, the app will allow us to geolocalize all the actions that we carry out in ethnography. This will allow us to generate a map of actions, which will mean a technical improvement and an increase in the possibility of data analysis and visual support for the presentation of them.

5 Conclusions

Studies on food and nutrition require the approaches that social scientists are able to provide. Without them, any such study would be incomplete because, as has been said, food is not just a collection of calories, minerals and vitamins. The current technological development allows us to think the field work on food and nutrition from new approaches. Thanks to the new tools, the possibilities in the focus of our research, the collection of data in the field, the analysis of the data and even the way we present our final results present a range of options that had never before been had. We must attend to all of them in such a way that we do not lose the essence of what field work has traditionally meant in anthropology studies, but that we take advantage of all the facilities and strengths that these new technologies offer us. In this sense Feedelio is a magnificent example that shows us the way towards which the work of anthropologists is directed.

In conclusion, we would like to point out the important possibilities of adaptation to different contexts and ethnographic realities that the appendix Feedelio contemplates. In a discipline so complex and that attends such diverse realities as Anthropology, we have to bear in mind that any technological development has to be adapted and adaptable to all kinds of realities. We hope that this small contribution can enrich not only the research we are developing, but many others in the field of anthropology of food and even, from other scientific disciplines, will be carried out in the coming years. Our intention is to be able to open this application to all the public from the moment in which the tests that we are realizing offer us the sufficient stability and reliability to take to field the work of field.

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Providing Support to IoT Devices Deployed in Disconnected Rural Environment

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Abstract. The increase in the end and near-to-the-end devices capabilities has led to the development of paradigms such as the Internet of Things, Fog Computing and Edge Computing. These devices require an internet connection for sending the sensed or processed data, and for getting specific requests. Many of these devices are intended to make people's live easier and they can also be used to better monitor people's health. One of the problems of these devices is that they require internet connection and in most rural areas there is a poor internet infrastructure, making their use almost unfeasible. This paper presents a tool for generating applications with a mobile-centric architectural style that takes advantage of the capabilities of the end devices for processing and storing the sensed data. This style allows devices to process the information requests asynchronously, reducing the Internet requirements and allowing the use of these technologies in areas where the Internet connection is poor and intermittent.

Keywords: Internet of Things · Server-centric · Health · Mobile-centric

1 Introduction

End and near-to-the-end devices capabilities have increased enormously. During the last years, computational and storage capabilities have been multiplied with the aim of obtaining more information from the environment and performing increasingly complex operations. This increase has favored the development of paradigms such as the Internet of Things (IoT) [1], where they have a greater integration in the Internet.

IoT and end devices are designed to be connected to the Internet all the time. Usually, they are integrated into the Internet following a server-centric

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architecture [2], in which the final devices act as simple clients obtaining information through their sensors and interfaces, and sending it to the back-end. Currently, with the capabilities that many devices have, other architectures, such as mobile-centric, p2p, and so on, can be followed with the aim of limiting the use of Internet [3], being useful in many cases.

For instance, in rural environments, it is common to find areas with poor and limited access to 3G/4G communication networks [4]. These connections are often of poor quality and intermittent. Therefore, the use of server-centric architectural designs can provide a bad user experience. If we have a set of IoT devices collecting information and sending it back to the server or cloud, it is more than likely that in this environment some of the information will be lost generating a bad user experience and a undesirable behaviour that can jeopardize the success of almost any application.

To cover these shortcomings, the use of mobile-centric architectural designs have been proposed by some researchers [5]. These designs focus on making use of the devices' capabilities for computing and storing the gathered information. The stored information is provided by the device itself to any other entity to be consumed in an asynchronous manner, limiting the need for constant Internet connection. Nevertheless, the lack of tools assisting developers in the application of these designs, hinders and limits the use of these architectural styles [6].

In this paper, we present a tool that helps developers to implement APIs following a mobile-centric architectural design. This tool is focused on Android devices, since currently they usually are the devices with enough computing capabilities for computing, storing and providing the sensed information. To assist in the development of these APIs, this tool requires an OpenAPI specification [7] of the designed application, and it generates the scaffolding of the application and the whole communication interface. In this way, the effort to develop this type of architectures is reduced.

This type of design is very useful in rural environments that have an intermittent connection since the gathered data is no longer sent to cloud environment, reducing the loss of information.

The rest of the paper is structured as follows. Section 2 describes the motivations for this work and describes briefly two tools used in this work. Section 3 explains the tool for generating mobile-centric applications. Section 4 shows several related works. Finally, Sect. 5 details the conclusions.

2 Motivation

Elderly people are increasingly accessing new technologies, and specially smartphone and IoT devices, to live independently and be in contact with their relatives [8]. With the massive deployment of IoT devices and the mHealth paradigm [9], they also are starting to use their smartphones to monitor and control their health status [10]. Usually, they have different IoT devices, such as tensiometers, oximeters, smartbands, or the smartphone itself, to gather information about their health like heart rate, oxygen levels, etc. Once this information is gathered, it is sent to the smartphone that acts as a gateway with the cloud environment, where it is processed and stored.

This designs leads to some advantages, since the information is stored in the cloud and can be remotely evaluated by relatives and healthcare professionals. Nevertheless, it also has some drawbacks. For instance, one important problem is raised in rural areas, where the Internet coverage is poor and intermittent. In these situations, these IoT devices and the smartphone cannot send the gathered data to a server or cloud, being lost in some situations. This may also lead to some health alarms to be raised because, for instance, the heart rate value has not being received by the cloud during a couple of days, generating unnecessary worries to relatives and healthcare professionals.

To better show this problem, we are going to describe a scenario. This scenario will be used as running example in the rest of the paper to show the benefits of this work.

Pedro is 74 years old and lives in Casares de las Hurdes in the province of Cáceres. His sons purchased him a device for monitoring different health dimensions (heart rate, blood pressure, oximeter, ...) and a smartphone with an application to receive data from the device and to get the GPS position of the smartphone. When the application receives the data, it connects to a server and sends all the sensed data so that it can be reviewed by some healthcare professionals. Casares de las Hurdes is a village with poor accessibility and communications networks, therefore, the coverage is quite bad being null or intermittent in many locations. Pedro's sons indicated him some places in his home where there is some coverage, but they are not the usual place where he stays. So, Pedro usually forgets to move to another location to take the measurements and sometime they are lost when they unsuccessfully sent to the server. Figure 1 shows a scheme of the current architecture.

There are different architectural styles and designs to try to solve this problem, in this paper we will use a mobile-centric architecture. This architecture is focused on taking advantage of mobile devices' capabilities in order to compute, store and provide services or functionalities that are invoked or consumed by a third entity, that is, as if we had our own server in the smartphone itself. In this architecture, the interactions with the mobile devices could be asynchronous and its connection to the Internet could be limited. Therefore, if the application described above is updated with this style, the values captured by the IoT devices are processed and stored on the smartphone and the request to obtain the data are sent and processed directly by it.

The problem that exists with these alternative architectures is that there are not tools supporting them and facilitating their development [6]. Most of the current development tools are focused on providing support to the server-centric architectural style, since it is the most used one. For example, through an OpenAPI specification [7], developers can generate part of the source code of both the back-end and the client of the application. However, these same tools are not yet available for these alternative architectures. This is a great disadvantage for developers using such designs, since it entails an extra effort for its development.

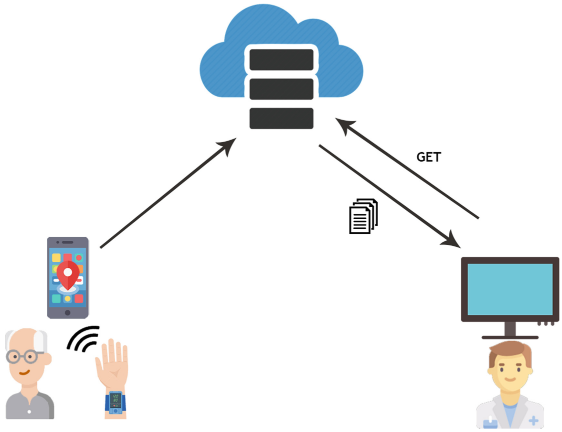

Fig. 1. Server-centric architecture.

To facilitate the development of these designs, in Sect. 3, we shall present a tool that assist developers in the implementation of applications following a mobile-centric architecture. This development tool is focused on using OpenAPI for specifying the app's behaviour and Firebase Cloud Messagging (FCM) [11] for supporting for communication and interactions with it.

2.1 OpenAPI

Currently, there are many tools that facilitate the specification and deployment of applications. One of them is OpenAPI, which was created to standardize the description of RESTful APIs [12]. With it one can specify APIs using its standard, and through code generators such as OpenAPI Generator [13], get the skeleton of the application from both the server and the client. However, these facilities are not available for other architectural styles, such as mobile-centric. The current capabilities of mobile devices allow them to also be mobile cloud environment having different APIs deployed on them processing and storing data and serving the information to third entities. This is especially useful in rural environment that have an intermittent connection.

2.2 Firebase

One of the major problems of mobile-centric applications, especially those deployed in closed or not completely open operating systems, is the communication between consumers and the providers, as it is limited by privacy and security policies. To solve this problem, services offered by Google, Firebase Cloud Messaging (FCM) [11], can been used to interact with the devices through Push notifications.

There are other similar messaging protocols such as MQTT [14] or RabbitMQ [15]. These can also be used is this design. In fact, MQTT is already included, but it has not been specified because the focus of this paper is in the general workflow. The advantage of FCM is that its integration is easier in Android-based applications.

FCM can send messages through the Firebase Admin SDK or through HTTP or XMPP protocols. These messages can be received through push notifications to iOS, Android or Web (JavaScript) devices. This system allows one to send a message directly to a single device or a set of them through '*topics*'. FCM has the property of storing messages in a queue for a while until the device has Internet connection. It is an asynchronous communication method, therefore, it can be used in places with an intermittent internet connection.

3 Generation of Mobile-Centric Applications

In this section, the process to generate mobile-centric applications and APIs for Android devices is explained. As can be seen in Fig. 2, in the first step *"API Definition"* the API features are defined, this task will be done through the OAI (OpenAPI) Specification following the same notation as if it were to be developed and deployed on a cloud environment. The API specification will describe the different resources and endpoints that it will have available to be invoked.

In the second step *"Generate base code"* generates the skeleton code of the API. Currently, there are no tools to facilitate this task for this type of architecture as discussed above. In order to offer this functionality, the OpenAPI Source Code Generator has been extended so that the skeleton of services or functionalities can also be generated to be deployed on Android-based mobile devices. Thus, these services can be consumed by third entities as if they were deployed in an cloud environment. To that end, the source code to simulate the communication logic of an APIRest is also generated, reducing the effort required by developers. This communication logic has being simulated using Firebase Cloud Messaging, Thus, first, any third party can invoke the offered services and, second, the services can also be consumed asynchronously, providing support to the consumption of this information in environment with an intermittent Internet connection.

Therefore, having the application generated in the second step, in the third step *"Deployment"*, developers only have to finalize the implementation of each feature and configure the Firebase Cloud Messaging services to be able to deploy it.

Finally in the fourth step *"Requests"* with the application deployed, we invoke the resources defined through any service invocation tool.

Following the described scenario, with this new proposal, as can be seen in Fig. 3, all the data collected from both the devices and the smartphone itself will be stored on the smartphone. To access this data, relatives and healthcare professionals will only have to invoke the necessary smartphone's services through a client application to obtain the sensed information. The services invocation is done asynchronously, so if Pedro does not have Internet coverage when the request is made, the request (asynchronous) will be sent and it will be stored in

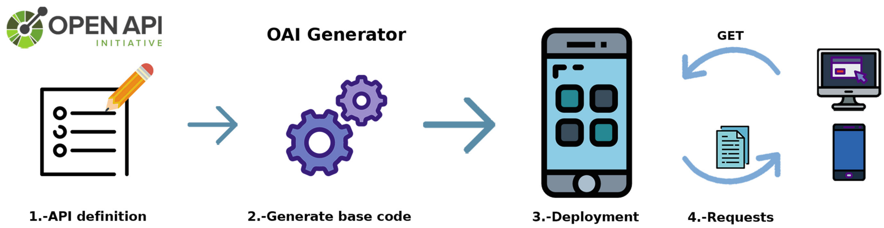

Fig. 2. Steps to generate mobile-centric application.

the Firebase's queue waiting for Pedro to have connection. Once he has Internet connection, it will reach Pedro's phone and the requested data will be sent to the doctor's app.

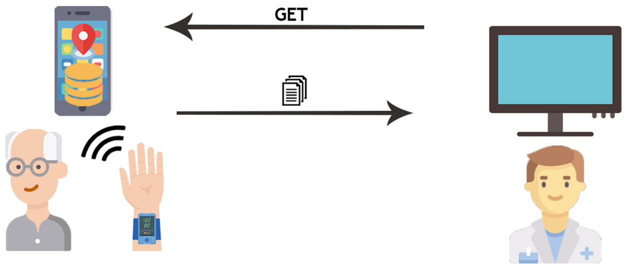

Fig. 3. Mobile-centric architecture.

Below an extract of the OpenAPI specification for the *Health Monitoring* application of the described scenario can be seen. As discussed earlier, this specification uses the same notation that could be used to implement it in a cloud environment. Obviously, the main difference is that the services have to be designed to offer and provide the specific information stored in a mobile device.

With the specification shown above, the OpenAPI Source Code Generator performs the conversion and generates a project with the API's skeleton. The generation of the source code is done as follows: the title of the specification "*Health Monitorization*" is used as the identifier and name of the application; each tag, in this case only *Health*, groups all the endpoints it contains (in this case only *getHealthConstans*); then, each tag is transformed into a resource or Android service (Class) that exposes those endpoints; finally, for each endpoint a specific method is created for developers to implement the concrete behaviour.

Thus the HealthResource class that is shown in listing 3, groups all the endpoints belonging to the *Health* tag. This class is formed by a first method called "*executeMethod*", which contains a switch to redirect the request to each specific endpoint. In this case, the OAI generator only generated one endpoint *getHealthConstans* (as was defined in the specification). This is the only method that have to be implemented by the developer, in addition to the Firebase configuration. Finally, the generated API also contains an auxiliary method to return the request results.

```yaml
openapi: 3.0.1
info:
    title: Health Monitorization
    description: This application monitors the health constants
    of users to keep track of their health.
    version: '1.0'
    termsOfService: 'https://healtmonitorization.spilab.es/terms'
    contact:
    name: Health Monitorization
    url: 'https://spilab.es'
    email: info@spilab.es
paths:
  /health:
    get:
      tags:
        - Health
      summary: Gets a health constants.
      description: Get several health constants from a patient.
      operationId: getHealthConstants
      parameters:
        - name: patientID
          in: query
          required: true
          schema:
            type: number
            format: double
      responses:
        '200':
          description: Successful response
          content:
            application/json:
              schema:
                $ref: '#/components/schemas/HealthConstants'
        '404':
          $ref: '#/components/responses/404NotFound'
```

Listing 1.1. Code generated by new version of OpenAPI Generator.

```java
public class HealthResource {
    ...
    public void executeMethod(HealthResponse response){
        healthResponse=response;
      switch (response.getMethod()){
         case "getHealthConstants":
          getHealthConstants(response.getParams().getuserID());
         break;
      }
    }
```

```
    public HealthConstants getHealthConstants (Double userID){
        //TODO
        return null;
    }
    ...
}
```

Firebase Cloud Messaging (FCM) cannot be directly used to implement the same communication logic as an APIRest, the communication between consumers and providers have to be asynchronous. For environment with an intermittent connection, an asynchronous communication is an advantage. FCM saves the requests in a queue for a while, so if the from which we want to get information do not have Internet connection, there will be no problem, requests will reach devices once they have it. In addition, the integration with this communication method is generated automatically by the tool when the mobile application is generated. An implementation for synchronous communication could also be generated, but it is out of focus of the paper.

Having the application deployed, it is possible to invoke the services using any REST client. The following listing shows the structure to invoke the service from which one can obtain the vital signs of a patient using the defined API. The structure general of the request is the same for every application, the *Url* and the type of *Method* don't change. In the *Header*, it is necessary to put the Authorization Key that Firebase provides in the project configuration details. Finally, the structure of the *Body* is also the same for every application, obviously, it has to be adapted to its corresponding methods, parameters, etc.

- Url: https://fcm.googleapis.com/fcm/send
- Method: POST
- Headers:
  - Content-Type: application/json
  - Authorization: key=<Key obtained from Firebase configuration>
- Body:

```
{
"to": "tokenId or topic",
    "data":{
        "resource": "Health", --Endpoint
        "method": "getHealthConstants", --Method (operationId) of Endpoint
        "sender": "158.49.112.1/result", --Address to send reply
        "params":{ --Parameters of the method
            "patientID": 2458372
        }
    }
}
```

The tools presented in this paper, facilitate the development of applications following a mobile-centric style, promoting their use and also covering problems, such as those presented in disconnected environments.

4 Related Work

There are few commercial tools that support other architectural styles, such as mobile-centric, peer-to-peer or other fog-based styles. However, at the research level, more and more proposals are presented fostering the use of the available specification and resources to generate the source code and facilitate the development process of any application following these alternative styles.

As we have seen, the popular OAI specification is very useful for defining applications, including generating new styles by creating or expanding its code generators. In [16], the authors propose WoTDL2API. WoTDL2API is a tool to generate a RESTful API with a web interface from an OAI specification. The generated API has the goal of generating and deploying a web-based RESTful interface obtained from the WoTDL descriptions to provide interoperability between different IoT devices that communicate with different communication protocols (Zigbee, Bluetooth, RFID, ...).

However, this solution doesn't cover our connection problem in rural environment. Although it is possible to deploy the API on a local network not relying on 3G / 4G connections, it requires Internet coverage to receive request from third entities that are not connected to the same local network.

On the other hand, in [17] they propose a system to download generalized applications with strict delay requirements as stateless functions on edge nodes with available computing capabilities. The execution of functions passes through edge nodes with sending capabilities, which are ideally located as close as possible to end users and is highly scalable. They have shown that this distributed architecture works better than a centralized approach but still does not cover the problem regarding the bad or intermittent connection that occurs in most rural areas.

With these works, we see that tools are needed to support the deployment of applications in environments with intermittent connectivity and following a mobile-centric style.

5 Conclusions

The increase of the computing capabilities of end and neart-to-the-end devices opens the possibility to the application of architectural styles that until now could only be used in very specific scenarios. Thanks to these emerging architectural styles, one can solve some problems that exist today. This paper exposes the lack of tools helping in the development of these alternative architectures.

In this paper, we have presented a tool that automates the creation of the skeleton of an application following a mobile-centric style, thus promoting its use and advantages such as, for example, in disconnected rural environment.

Currently we work, first, on analyzing the impact of using these tools and if they would increase the application of these alternative architectural styles. In addition, we are also working on providing support to other emerging architectures such as Fog Computing.

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Remembranza Pills: Using Alexa to Remind the Daily Medicine Doses to Elderly

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Abstract. European countries are facing a population widespread ageing. The percentage of third age inhabitants is becoming higher, specially in rural areas, where older adults demand special services in order to improve their life, notably when they live alone. This way, some tasks like medicine management can be a very hard day-to-day challenge. In this paper, Remembranza Pills is introduced. This is a platform that supports elderly at daily medicine takes using Alexa. The system reminds users the medicines and pills that have to be taken in each moment of the day using a web platform to manage the prescriptions. In this manner, medical staff and relatives can keep control over consumed doses.

Keywords: Elder healthcare · Medicine disposal · Human computer interaction · Amazon echo · Alexa Skill

1 Introduction

Nowadays, European population is becoming elderly. Countries are experiencing a widespread ageing of population, involving the society into the challenge of providing appropriate services and support. Around 20% of the European population is over 65 years old what means that 1/5 of the inhabitants are elderly [1]. This reality gets intensified at rural areas, where more than 30% of the population is over 65 [2]. The elderly people needs are highly specific and demand measures that allow them to develop a successful day-to-day. One of the main tasks that elderly have to face is medicine takes.

In this project, a technological solution is provided with Remembranza Pills. The platform allows elderly to keep a control over medicine takes with an Alexa Skill. This way, when users ask for what medicine should be taken, Remembranza Pills will answer with the medicines that correspond to that time. Furthermore, the system enables medical staff and relatives to keep control over the taken pills.

The rest of this paper is organised as follows. Firstly, Sect. 2 describes the overview of the platform, explaining the full functioning and the role of each

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system component. Secondly, Sect. 3 specifies details about the implementation decisions, explaining the internal performance of the different elements. Then, Sect. 4 reviews related works about Voice Assistants and Elderly, including several project related to eHealth and medicines management. Finally, Sect. 5 draws some conclusions about the paper and exposes future outlines and research lines.

2 Overview

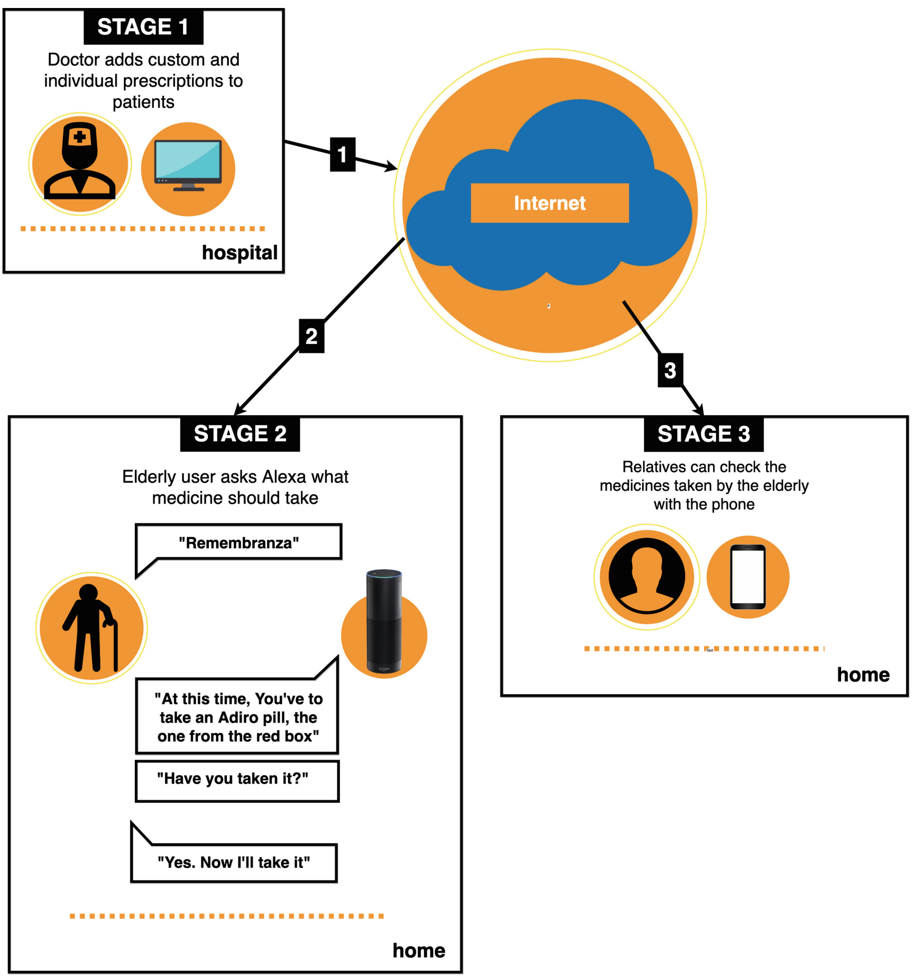

Fig. 1. Overview of Remembranza

Remembranza Pills is a platform that involves multiple services and functions. The main idea is providing elderly with a support at medicine takes, explaining which pills correspond to each moment. Furthermore, Remembranza also checks, through a question, whether the elderly has already taken them. The elements involved in the schema are mainly two: a web platform that allows interaction with the medicines of the patient and an Alexa Skill that communicates with the elderly user. Also, an Android app is provided in order to let relatives know about the takes information. These components keep synchronised with internet connection.

On the one hand, the web platform is the main interaction point. It is a profile-based system that allows medical staff to manage the medicine doses of each patient while relatives can check out the progress. This way, Remembranza provides an online tool for doctors that keeps all medicine takes of each patient while supplies details about the times the elderly asks which pill should take and whether it has already been taken. It is important to take into account that most of elderly are not able to recognise or distinguish the pills and medicine names thus, in order to solve this challenge, the platform includes an individual and personal description that the doctor can specify for each patient. The web platform is a substantial component that brings relevant easily read information.

On the other hand, Alexa Skill is the key to complete the functioning of Remembranza. Using the information provided through the web platform, the elderly can check which medicines should take. Depending on the time of day the user asks, the skill will answer with the appropriate pills before asking if the user has taken the medicines. After this process, the skill updates the web platform information depending on the user's answer.

Taken the overview into account, the operation of the platform involves three main stages: (1) doctor specifies prescription, (2) Alexa reminds elderly the medicine that should take and (3) relatives check the historical doses information.

In order to allow medical staff to define individual and personal prescriptions, the web platform includes the patient set assigned to the doctor and defines the pertinent operations. These options involve the prescription definition with a time range, medicine identification, dose specification and a brief description that allows elderly to identify the medicine with a familiar representation, e.g "the red pill" or "the one from the blue box".

Once the system keeps the prescriptions specification, the elderly is able to ask Alexa Skill what medicines should take at anytime of the day. This way, saying the hotword "Remembranza", the device will answer with the corresponding medicine dose at that moment and it will ask whether the user is going to take it. In the case the elderly accepts, a new medicine take will be added to the system.

As these stages are completed, the platform stores all relevant information about the daily dose takes. Thus, relatives can check from the Android app if the elderly has been taking the medicines and monitor the progresses.

3 Architecture

This section introduces and describes the elements that compose Remembranza implementation. Concretely, the implemented components are the following: (1) the web platform used by the medical staff for the management of medicines and takes, (2) the Alexa Skill to interact with the elderly patient to help him remember to take medicine, (3) an Android app that enables relatives to review statistics about the use of the skill and finally, (4) a server that centralises all the information of the components, working transparently to the user.

(1) Web Platform is designed to provide medical staff with a friendly interface, for this reason MVVM [3] architectural pattern is used. It is essential to provide the user with an easy-to-use interface so the CRUD(Create, Read, Update and Delete) operations are able on prescriptions management. Concretely, the platform is developed using the Angular framework [4]. Also, the platform sends requests to the server through the Application Programming Interface (API) in order to manipulate the data hosted in it. When the data is hosted into server, Alexa skill can request each medicine prescribed by the doctor (Fig. 2).

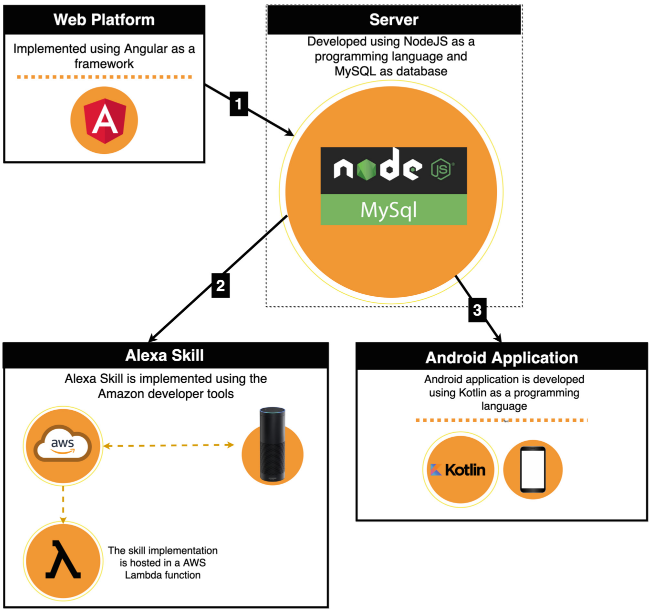

Fig. 2. Platform architecture.

(2) Alexa Skill is developed using the Amazon developer tools. The Skill is invoked with "Remembranza". In order to recognise the needs of the elderly, intents to interact with individuals are defined. These intents are triggered when

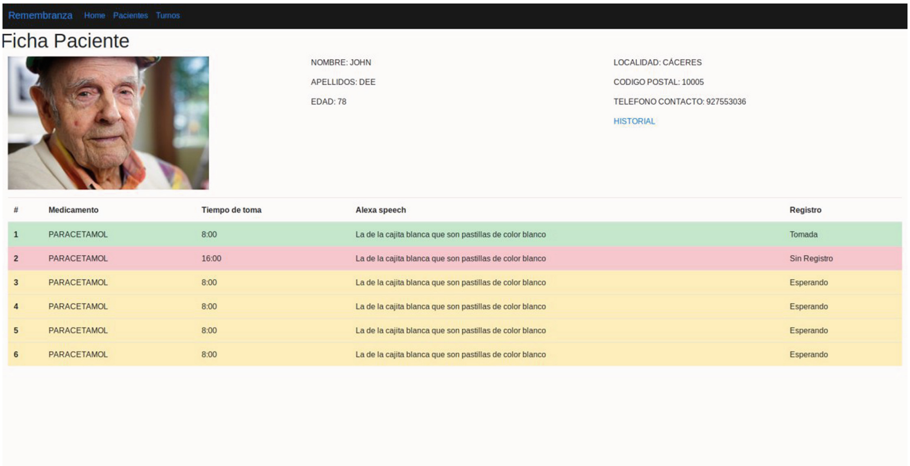

Fig. 3. Elder profile page in web platform.

the elderly makes an specific request to Alexa. Also, all the skill information is represented through a JSON (JavaScript Object Notation) format (Fig. 3).

On the other hand, the skill implementation is hosted in a AWS Lambda function. AWS Lambda is the Function-as-a-Service (FaaS) platform of AWS which is able to run code without server. AWS charges for service when the use limits are exceeded. The AWS Lambda connects with the server to receive and announce the medicine prescription that the elderly has to take at the time of the request. Concretely, the AWS Lambda is developed using NodeJS as programming language.

(3) Android Application represents all the information about the prescriptions of the elderly patient. In order to allow relatives to check elderly evolution, the application connects with the server to show the use statistic of Alexa skill. Relatives can consult reports with daily, weekly, monthly and annual filters. Reports contain information related with the elder interaction with the skill.

(4) Remote Server centralises all the information about the elderly patients and their medicine. The server allows clients to interact with stored resources through an API. Concretely, the server stores the data using a MySQL database. Also, the server provides an interface that enables stored management information in database. This interface is developed using NodeJS as programming language. The components previously defined perform requests over the API. This process is completely transparent to the user.

4 Related Works

The eHealth field is fulfilled by ideas that integrate technology in many daily tasks of elderly lives. Next, several related works are introduced and classified into different topics: (1) Medicines remind, (2) Elderly assistant communication and (3) non-function properties management.

(1) Medicines remind is the topic that involves projects and devices that remind elderly the daily medicine takes. The most relevant works in this group are: Feasibility study of a robotic medication assistant for the elderly [5], Multimodal and adaptable medication assistant for the elderly: A prototype for interaction and usability in smartphones [6] and "It's time for your life": How should we remind patients to take medicines using short text messages? [7].

Feasibility study of a robotic medication assistant for the elderly [5] shows a solution to medicine management in elderly population. Through a touch screen installed in a robot, the system is able to remind elderly the pills and medicines that should take, following a dialog schema that checks whether the user has already taken them.

Multimodal and adaptable medication assistant for the elderly: A prototype for interaction and usability in smartphones [6] is a solution that uses smartphone technology to remind elderly the medication takes. The system provides the user with several information about the medicine including a custom response in case of forgetting medication. It also considers context situation in order to adapt output. This way, the application uses the camera of the device to detect the distance between the user and the screen and enlarge proportionally screen content. Furthermore, ambient noise is taken into account in order to establish notifications and speech volume.

"It's time for your life": How should we remind patients to take medicines using short text messages? [7] is another approach to medicine reminder, in this case oriented to HIV-positive patient. This research exposes a system based on SMS that uses a simple and concise speech that guarantees confidentiality and privacy.

These purposes define different solutions to remind medicine prescriptions. However, each one specifies alternative approaches. Remembranza Pills purposes an interaction model essentially based on voice. This way, users do not have to deal with further operations than talking.

(2) Elderly assistant communication is the second main topic found at literature. Voice assistants are a disruptive technology that has to face the challenge of being able to communicate with every possible user. Elderly requires some special points at conversation like concise speech and a successful management of times. Next, most relevant articles in this topic are shown: Design and development of Medication Assistant: older adults centred design to go beyond simple medication reminders [8] and Design and Evaluation of a Mobile User Interface for Older Adults: Navigation, Interaction and Visual Design Recommendations [9].

On one hand, Design and development of Medication Assistant: older adults centred design to go beyond simple medication reminders [8] shows the importance and relevance of technological solutions at medication reminders while analyses the iterative process of developing the platform following an elderly-centred philosophy.

On the other hand, Design and Evaluation of a Mobile User Interface for Older Adults: Navigation, Interaction and Visual Design Recommendations [9] explores design recommendations at smartphone applications development. This way, good practices and patterns are highlighted in order to adapt successfully interfaces to elderly.

(3) Non-functional properties is one of the most relevant technical point at development. In this case, the system has the challenge of keeping and processing sensible data about the health of elderly thus, the use of external tools and ultimate advances at performance are quite relevant. Next, RoQME Integrated Technical Project is explained as well as the important role it has played at Remembranza Pills.

The RoQME Integrated Technical Project [10,11] has developed a model-driven tool-chain aimed at easing the modelling (at design-time) and the estimation (at runtime) of system-level non-function properties such as safety, performance, resource consumption, etc. Although RoQME is circumscribed to the robotics domain and it builds on domain-specific models, software and tools (in particular, on the SmartMDSD tool-chain), the RoQME team is working on a platform- and domain-independent implementation that will enable monitoring non-functional aspects such as user acceptance, trust and engagement, which could be applied for dynamically adapting the behaviour of the system or for learning how to better interact with the users.

5 Conclusions and Future Works

Nowadays, population is facing a widespread ageing. The increase in population's average age involves society into the challenge of promoting elderly healthcare measures. Many older adults require assistance in the daily routines, specially at drugs management. Polymedicated older people deal with multiple medicine brands with different take hours and several doses. Therefore, it is a difficult context to handle for elderly population, particularly if factors such as solitude or cognitive problems exist. This way, technology is a matching option at helping older people in the management of medicines.

Multiple technological solutions exist in order to support older adults at medicine management. Nevertheless, some solutions imply an effort to users which can be hard to handle by elderly people. Moreover, voice assistants has been a disruptive solution that has drastically changed interaction with devices. This way, this paper purposes a platform based on Alexa voice assistant that enables elderly to know about the medicine prescriptions just using the voice.

Remembranza Pills is composed by three main endpoints: the web platform where medical personnel specify prescriptions data, Alexa Skill which is used by the elderly and the smartphone application that provides the family with monitoring about the taken medicines. These three components conform a solution that helps older adults to remind daily medicine takes.

The Alexa Skill answers the elderly telling him the medication that has to be taken at each time. Therefore, the device speaks in an easy to understand natural language that allows the user to identify straightforwardly the medicine, e.g "At this time, you have to take a Paracetamol pill, the one from the blue box".

The full platform has been tested in a laboratory context. Researchers and students where involve at several user tests that analysed the usability and response quality of the system. It is quite relevant to assure a successful working before next versions which will be tested with final users in a real context. As a result from the test period, Remembranza Pills keeps an effective working and a successful performance. Nevertheless, several problems where detected. The Internet connection dependency is a critical aspect that can become problematic. Taking into account Alexa needs a constant Cloud connection, the skill will not be operative if there is not Internet connection. As a response to this question, 4IE Project is working at an assistant that helps older adults to remind medications takes using Snips Platform [12]. This voice assistant works autonomously without Internet connection. Thus, this solution can be specially suitable for isolated rural areas where the lack of Internet infrastructure precludes the use of popular voice assistants such as Alexa or Google Home. On the other hand, user tests also showed the need of using additional technologies in order to enable takes notification and proactive speech. Moreover, future works opens these new functionalities.

The future work line in Remembranza Pills platform is encouraging. The new possibilities to improve the working are numerous and involve the system into a better performance. In this manner, there are two main lines which will improve Remembranza functioning: (1) Proactive reminders and (2) Interconnection with other technological devices.

(1) Proactive reminders are one of the main lacks in Remembranza Pills. Due to Alexa development environment, proactive speech is not supported in Alexa Skills. Moreover, it is not possible to interact with the older adult in order to remind proactively the medicine takes. However, as next versions of Alexa development environment are released, this option will be added.

(2) Interconnection with Other Technological Devices. Test process showed that it is relevant to take into account that sometimes the elderly will not be in touch with the Alexa device. This way, additional technologies can be considered in order to remind the elderly about the drugs takes. Smartphones and smartbands can be two main options to notify these events. Moreover, the addition of these elements in Remembranza Pills scheme will improve substantially the performance and will notably reduce possible risks.

Remembranza Pills brings an useful idea that reconcile technology with elders. Voice assistants has teared down the barriers and learning curves through the use of voice and natural language. The disruption of this idea is a great possibility to provide technology of new applications that improve individuals live. This platform is a small step in a strong future work line we expect to build.

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Solutions for Active Aging, Social Integration and Self-care

Theoretical Contributions from Orem to Self-care in Rehabilitation Nursing

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Abstract. Self-care allows one to maintain the health and well-being of the person and may be compromised. Approaches to Orem's theory and rehabilitation specialist nurse competencies allow the development of intervention plans to minimize the person's dependence on self-care. **Objective:** To identify Orem's theoretical contributions to self-care and their relevance to Rehabilitation Nurse practice. **Methods:** Integrative literature review through search engines (EBSCO, RCAAP and Google Scholar), using the descriptors self-care, nursing, and Orem, assisting us from the Boolean operator "AND". **Results:** Nine articles were selected, the results of which we grouped into two studies of a theoretical nature and three groups according to Orem's theory (fully compensatory systems, partially compensatory systems and educational support systems). **Conclusions:** Praying to privilege your approach to self-care, can differentiate their performance, with visible gains in the health of the person.

Keywords: Self-care · Nursing · Orem · Rehabilitation

1 Introduction

Today's society faces one of the biggest problems of the 21st century, aging. Although resulting from an increase in average life expectancy as a result of economic development and, consequently, improved social and health conditions, the aging of the population also represents higher levels of dependence and need for care. Living longer and being older also means a decline in personal and social networks and a greater willingness to develop chronic diseases, as well as the emergence of physical, emotional and cognitive limitations, leading to higher levels of dependence on the performance of activities of daily living (ADL's). Dependence thus arises as a condition for people who, for reasons linked to the lack or loss of physical, mental or intellectual capacity, for a more or less prolonged period of time, need help from another person or equipment to perform certain self-care activities [1]. Although the elderly are those who are more willing to

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dependence, given the functional decline to which they are subjected, it can appear in other age groups, such as degenerative diseases, accidents or others.

When the person is unable to self-care, there is a need for another person to perform such care for themselves, highlighting here the family a key role, as well as the nurse. Self-care is a human regulatory function that people deliberately perform for themselves or that someone else performs for them in order to preserve life, health, development and well-being; It is also assumed as a personal matter that begins with rituals, habits, time periods, and modes of learning in childhood through families and cultures [2]. Here comes Dorothea Orem's Theory of Self-Care, which indicates that the purpose of nursing practice is to assist patients in their self-care needs and to enable them to return to self-care, that is, that the person is able to perform it for themselves only. Nurse interventions may be fully compensatory, partially compensatory or educationally supportive, depending on the needs identified [2].

Nursing theories play an important role in practice, as they provide support and structure on a given subject in order to guide interventions systematically. Moreover, it is only through them that it is possible to document scientific knowledge, leading to professional autonomy, and guiding care, teaching and research within the profession [2]. Orem's theory provides a basis for understanding the conditions and limitations in people's action. Through this, it is possible to determine the need for nursing care, aimed at ensuring the satisfaction of self-care or the promotion of autonomy for it, i.e. be able to self-care.

The nurse presents themselves as one of the best placed health professionals to ensure the person's self-care ability. To this end, some authors argue that an assessment of the degrees of dependence on the activities of each self-care domain should be made, allowing for individualized care planning, implementation of realistic interventions tailored to their needs, and achievable goals in each situation [1].

With the evolution of knowledge in nursing and the profession itself, training and specialized care emerged in various contexts, also emerging the category of Specialist Nurse. Following this idea, and taking into account the theme of self-care and empowering the person, the Specific Skills Profile of the Rehabilitation Nursing Specialist Nurse (EEER) [3] tells us that:

> "Its intervention aims to promote early diagnosis and preventive rehabilitation nursing actions to ensure the maintenance of clients' functional capacities, prevent complications and prevent disabilities, as well as provide therapeutic interventions aimed at improving residual functions, maintaining or recovering independence in life activities, and minimize the impact of installed disabilities (whether due to illness or accident) such as neurological, respiratory, cardiac, orthopaedic and other disabilities" (pp. 8658).

In view of the above, Rehabilitation Nursing is a comprehensive specialty that provides care throughout the life cycle, in various contexts, whether in the community, hospital or clinics, among others, seeking to maintain, maximize or restore the functional capabilities of the person. Healthy or ill, in an acute, chronic or palliative situation, and minimize their impact on their vital functions. Rehabilitation Nurses thus play a key role in preventing complications, adapting to change and promoting a person's ability to perform self-care or address deficits and, where possible, to achieve functional independence.

2 Objective

To identify Orem's theoretical contributions to self-care and their relevance to Rehabilitation Nurse practice.

3 Research Questions

What are Orem's theoretical contributions, and their applicability in practice, to Nursing Self-Care? And what is its relevance to the Rehabilitation Specialist Nurse?

4 Methodology

This article consists of an integrative literature review, which allows the research, critical evaluation and synthesis of available evidence on a particular theme, where the final product is the state of knowledge, the implementation of effective care interventions and cost savings [4].

After the selected theme, the starting questions were elaborated, considering the criteria FINER (Feasibility, Interesting, Novel, Ethical, Relevant), in order to develop a good research question, that is, feasible, interesting, original, respect the principles ethical and relevant to nursing practice [5].

The scientific databases and search engines used in the search were EBSCO and RCAAP, complementing with Google Scholar. The research descriptors were limited to the variables that resulted from the research questions, using the words: Nursing, Self-Care, Orem and Rehabilitation, assisting us from the Boolean operator "E" (AND) in the combination of various searches (English at EBSCO and Portuguese at RCAAP and Google Scholar).

The following inclusion criteria were also established:

– Articles with nursing interventions in the face of self-care;
– Articles that address Orem's Self-Care Theory;
– Articles with full-test access;
– Articles written in Portuguese, English or Spanish;
– Articles with date of publication between 2014 and 2019.

Articles that did not meet these conditions were excluded, as well as those repeated in the different databases.

Thus, the selection of studies was performed primarily according to the inclusion/exclusion criteria. Subsequently, a brief reading (title, summary, methodology, results, conclusion) and observation/analysis of the articles found were made, excluding

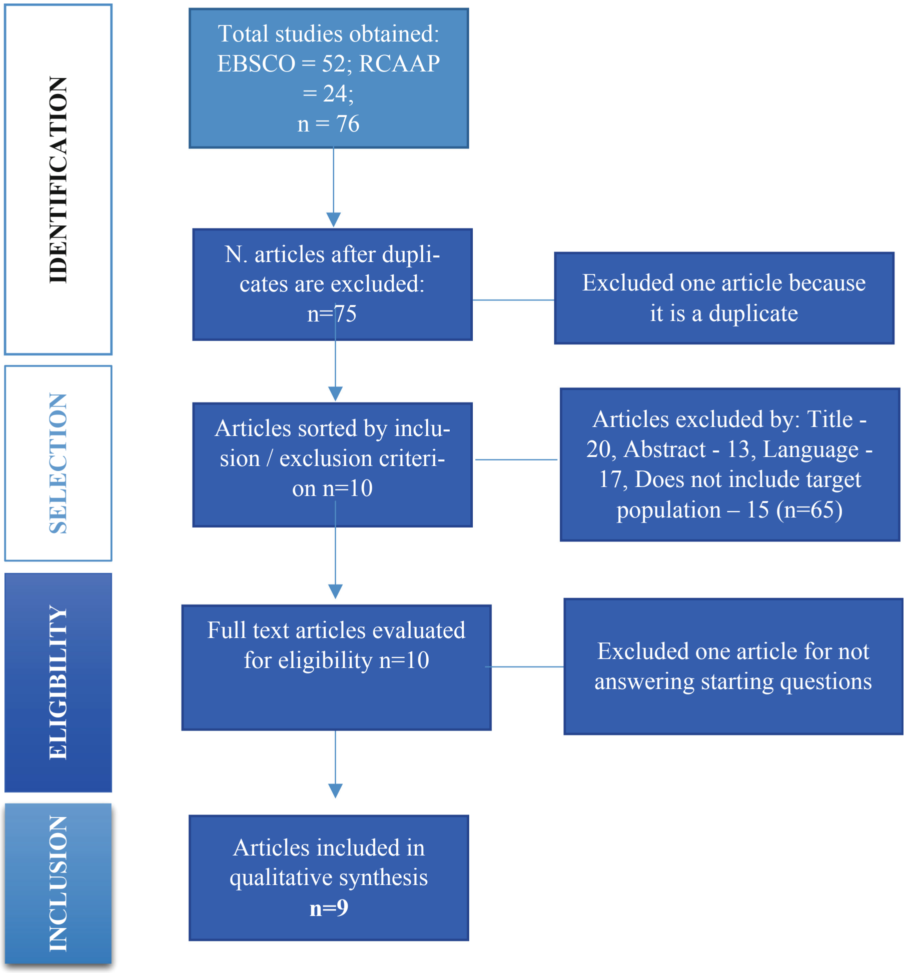

Fig. 1. Flow diagram describing the systematic review process

articles that did not answer the starting questions, as well as those that were duplicated, totalling nine articles included in the study (Fig. 1).

After the articles were selected, they were evaluated according to the level of evidence, in order to assess their eligibility and ensure the quality of the results and conclusions. The nine selected articles were classified according to Melnyk and Fineout-Overholt [6], which suggests seven levels of scientific evidence (Table 1).

5 Presentation and Discussion of Results

For discussion of the results found, it is understood the importance of differentiating them in relation to their theoretical and practical nature, and the latter focus on studies with fully compensatory systems, partially compensatory systems and educational support systems.

Table 1. Characteristics of selected articles

Study identification and authors	Method	Level of evidence
A - "The dependent person in self-care: implications of Nursing" Ribeiro, Pinto and Regadas [1]	Quantitative, exploratory and descriptive study	**Level 6**
B - "Self-Care: Orem's theoretical contribution to the Nursing discipline and profession" Queirós, Vidinha and Filho [7]	Qualitative study	**Level 6**
C - "Nursing care for ostomy patients based on Dorothea Orem's theory" Couto, Vargas, Silva and Castro [8]	Descriptive, observational clinical study	**Level 6**
D - "Nurse's Intervention in the Promotion of Self-Care in People with COPD: A Systematic Literature Review" Nabais and Sá [9]	Systematic literature review	**Level 5**
E - "The Theory Self-care Deficit: Dorothea Elizabeth Orem" Hernández, Pacheco and Larreynaga [10]	Systematic literature review	**Level 5**
F - "Care Proposal for readjusted worker based on Orem's Theory" Cacciari, Farias, Guariente, Haddad and Martins [11]	Qualitative, descriptive and exploratory study	**Level 6**
G - "Self-care of family caregivers of dependent adults or elderly after hospital discharge". Costa and Castro [12]	Qualitative study	**Level 6**
H - "Effect of Orem-based self-care education program on disease-related problems in patients with multiple sclerosis: A clinical trial" Dahmardeh, Kianian and Vagharseyyedin [13]	Randomized clinical trial	**Level 2**
I - "Construction of the Self-Care Competence Assessment Form in the Person with Ventilated Ostomy" Queirós, Santos, Brito and Pinto [14]	Methodological research study with construction of expert assessment and judgment tool	**Level 7**

5.1 Theoretical Studies

One should look at the approach of the seven articles [10] of theoretical nature, which face Orem from a perspective of reflection on the importance of his theory for nursing. The different systems explored by the theory are objectively explained by the authors, contributing to the reflection of self-care and the results found. This reflection becomes crucial for the EEER which aims to be able to work together with the person to promote or recover their missing self-care. In either article, the authors recognize this theory as useful in clinical practice and teaching. Likewise, management and promotion of structures are highlighted, allowing the development of other more accurate and testable concepts. It is therefore a fundamental theory for nurses to provide quality care in situations of illness and prevention by modifying health risk behaviours.

5.2 Practical Studies with Fully Compensatory Systems

There are a high percentage of people dependent on self-care to shower, get dressed and undress, get dressed, eat, walk, take medication and use the toilet. Also in self-care rising, turning, transferring and using the wheelchair has a clear dependence, but less than 50%. Regarding self-care taking a bath, 77.4% of participants had a dependence on body washing and 81.1% on drying it; in self-care, 81.7% are dependent on nail care and 66.4% are dependent on cleaning the perineum; in self-care use of the toilet, 62.1% are dependent on performing intimate hygiene after urinating or evacuating and 58.6% on adjusting clothes after intimate hygiene. Given the importance of hygiene care for the maintenance of skin functions and comfort of the person, these percentages reveal an urgent need for approach by different professionals. Likewise, in self-care dressing and undressing, putting on socks and shoes show high percentages, conditioning the person's daily life (77.4% and 76.6%, respectively). In self-care, 82.6% of people are dependent on preparing food for their intake and 63.5% on opening containers.

Dependence on food is worrying because it limits the person ingesting the necessary nutrients. These dependency numbers show that some people do not make a food selection and choose to purchase plastic food that is hyper caloric and harmful to health [1].

Although the average age of the dependent person in self-care is 67.57 years, it was found that the highest percentage of dependence is in people aged 80 or over. Thus, diet is paramount for the maintenance of health and prevention of disease or uncontrolled situations, due to the excessive intake of sugars and decreased fluid intake, making this self-care an essential focus of work for the EEER. As a result, the 92.1% dependence on providing the medication and the 89.1% dependence on preparing it become even more alarming and urgent action by health professionals. Regarding mobilization, 62.1% is dependent on safely moving to and from the wheelchair and 64.9% on manoeuvring the chair against curves, access ramps and other obstacles at different speeds; in self-care walking, the longest distances have the highest value (61.3%) and the moderate distances (48.1%). Considering that the majority of self-care dependents were 80 years old or older, it is understandable that the longest distances had the highest values. In self-care rising and turning there is a lower percentage of dependence (37.8% and 29.9%, respectively), whereas in self-care moving from chair/armchair to bed is 44% dependent and the transfer of the bed to the chair/armchair of 42.8%. These results [1] are unsettling, as they lead the person to immobility and, inherently, to their consequences, which are most accentuated in the age group mentioned above.

Therefore, it is understood that the high percentage of people dependent on ADLs, identified by these authors, requires an EEER approach based on partially and fully compensatory systems, because on the one hand the nurse compensates the inability of the person to perform self-care or, on the other hand, the person can perform some self-care actions, requiring the nurse to just regularize and promote the situation. Given that this approach was taken by the general care nurse, it is understood that, in the light of the EEER's work, the work developed allows the establishment of more differentiated strategies, as already mentioned when referring to the skills of the specialist nurse [3]. Given the rehabilitation goals mentioned by the OE [3], it is up to the rehabilitation nurse to work with the person in order to "maximize their functional potential and independence", achieving this by "providing therapeutic interventions aimed at improving residual functions, maintaining or regain independence in life activities, and minimize the impact of installed disabilities." The development of strategies suggested in the article could contribute to a real health gain for families with dependents.

Considering, furthermore, that with the arrival of the twentieth century, the devaluation of the role of the elderly became more pronounced in relation to unproductivity, fragility and dependence, i.e., age was "a defining criterion of social status" [15]. Currently, addressing the self-care of the elderly, given the real difficulties, is one of the necessary concerns for the future. Empowering the elderly in their self-care will enable them to participate more in the community and improve their health continuum, providing health gains, which is a privileged intervention area for EEER.

Identifying the need to ensure continuity of care, based on Orem's model and focused on the systems it develops, some authors [14] have built an instrument to assess self-care competence in the person with ventilator ostomy. With intervention to the patient with ostomy ventilation, in a fully compensatory system, the development of the nurse's decision support tool can be developed.

5.3 Practical Studies with Partially Compensatory Systems

In the study by Nabais and Sá [9], with the objective of "Systematizing nursing interventions that promote self-care in people with COPD, in the light of Orem's Self-Care Theory", they found that the most relevant symptom was dyspnoea and that, guides the person to immobility, harming not only the chronic disease, but conditioning the self-care. In this focus, the EEER directing its intervention allows the person to gain independence from the dyspnoea situation.

Another study [12] highlights the importance of intervention to minimize difficulties and stimulate the potential of caregivers with self-care deficits. Still in the partially compensatory system approach, Dahmardeh, Kianian and Vagharseyyedin [13], contributed to the reduction of complications of multiple sclerosis patients, due to the program of practical training exercises and prolonged follow-up to evaluate the self-care evolution.

The construction of the self-care assessment tool developed by Queirós and collaborators [14] also took into account the self-care in which the person only needed assistance in performing it. It is therefore important, as it covered more than one compensatory system.

5.4 Practical Studies with Educational Support Systems

In the study by Couto et al. [8], they found that the monitoring of the ostomy patient by nurses contributed to greater independence in self-care regarding hygiene and replacement of the ostomy device. The approach based on the educational support system, taking into account the problem (sadness over ostomy and fear), thus allowed the patient to readapt to the change in her life, promoting her health and contributing to the improvement of the quality of life.

In another difficulty, the multidisciplinary approach is essential in relation to the person with dyspnoea, with the EEER being of central importance in its intervention [9]. The family plays an important role in adherence and health education is of utmost importance to ensure health gains. By maintaining follow-up, with family involvement, the EEER can make a difference regarding dyspnoea control skills and family educational involvement as essential support for intervention effectiveness [9].

Cacciari and collaborators [11] also show how an intervention based on the educational support system has allowed a worker with limitation to restructure herself. The nursing intervention after the diagnosis of the situation enabled a promotion and recovery of the workers' autonomy, which translated into a more effective performance of tasks, without prejudice to it. In the self-care approach based on the educational support system, it was evident in some studies [12] that nurses are the best positioned professionals to identify problems and help develop strategies to solve them, which is possible with the accompaniment of the person and reassessment of needs. Another study [13] made it possible to improve the quality of life of patients with multiple sclerosis as a consequence of the development of education programs focusing on their needs.

The use of the self-care assessment tool built by Queirós and collaborators [14] was very important, as it allowed synthesizing and systematizing all the relevant information for the self-care competence assessment, ensuring the standardization of care, the criteria of competence assessment and, consequently, gaining in quality of the care provided, thanks to the continuity of the same.

Orem's theory is fundamental to nursing practice. Unequivocally, everyone develops intervention or understanding of facts in light of the importance of empowering the person in self-care. EEER through a differentiated and specialized intervention can demonstrate health gains.

6 Conclusion

Nursing over the last decades, beyond the construction of a unique and exclusive identity, divided into branches of specialty, has also developed and organized methodologies, based on theories and models of care, with the purpose of its application in clinical practice. It is a science based on the incessant search for answers to the needs of the human being, wrapped in all its multiple characteristics of being biological, social and moral. Therefore, it is also emphasized the need for nurses to rely on theoretical references to support their practice and thus contemplate the different dimensions of nursing care [16].

With this study, the importance of the model and concept transmitted by Orem is reinforced to enable patients to meet their needs and promote self-care. The EEER has a preponderant role, given its competences, which allow it to assist in the recovery, autonomy and functional capacity, assuming as functions the promotion of quality of life, maximization of functionality, self-care and prevention of complications, avoiding disabilities or minimizing them [17].

Studies show that Orem's theory distinguishes intervention needs according to the patient's degree of dependence on self-care, presenting itself as a guiding guide for nurses. Thus, it is possible to establish functional and educational intervention plans, and to set goals together with the patient, providing them with skills and tools to cope with disability. Faced with the self-care deficit, the nurse provides care to minimize the effects of this deficit, empowering the person and promoting support and education strategies, aiming at self-control of their condition [9]. This is perpetuated through fully compensatory, partially compensatory and educational support interventions. In these, the nurse can completely replace the patient in his activities, or be able to take him to a level where only assist in some aspects until his independence, where only his guidance is needed. However, it appears that although the patient can achieve a certain degree of autonomy, the nurse should be aware of possible regressions in degrees of dependence. These aspects reinforce the importance of teaching in changing behaviour, not only in terms of autonomy, but also in terms of self-determination, ensuring accompaniment and orientation, and enabling adaptation to their new reality, in order to maintain their self-care and self-care and their independence.

Some authors state that to ensure the effectiveness of these concepts it is necessary that the nurse is familiar with the social and cultural environment in which the patient is inserted. In addition, physical and cognitive ability and family support are also relevant aspects in the evolution of their recovery. Another important factor is the relationship established between nurse and patient, which favours the knowledge of the person and their expectations for the future, and which may influence the motivation for their social reintegration. The attitude adopted by nurses directly interferes with what the person will learn in the care process, hence the need for this professional to seek strategies that will facilitate, guide and seek solutions to problems [16].

It is concluded that in rehabilitation nursing the teaching of techniques is not enough, it is necessary to implement much broader strategies, namely in educational support, fostering the involvement of the person both in their well-being and in their health-disease state. The importance of rehabilitation in the community is emphasized, thus establishing a connection with the patient's social environment, where the patient feels integrated and safe, facilitating their openness to learning. This may be the future, and where this specialty can act effectively and efficiently, avoiding hospital recurrences, with regression of the clinical situation increased by the risk of hospital infection and other complications.

Nursing research is essential and scientifically affirms the importance of the rehabilitation of people with disabilities or decreased functionality and family in today's society. The effects of new knowledge implemented by the EEER, both at hospital and community level, contribute to earlier recoveries, shorter hospitalizations, with fewer associated complications, resulting in significant results that show health gains.

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Physical Activity for Elderly People After an Acute Myocardial Infarction

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Abstract. Acute Myocardial Infarction (AMI) emerges, within cardiovascular diseases, as the leading cause of death and disability in Portugal and in the world with higher prevalence in the elderly population, thus emerging as a central axis in intervention strategies of health professionals. Population aging is accompanied by progressive changes that, in addition to increasing susceptibility to the development of cardiovascular diseases (CVDs), also have an impact on functional capacity, autonomy and independence versus dependence. It is essential that interventions with significant gains in nursing are developed that actively seek to intervene with an elderly individual after an AMI. The aim of this study was to identify health gains resulting from the intervention of nursing care in the practice of physical activity in the elderly person after an AMI. To this end, a systematic literature review was carried out using articles on the subject under analysis, published retrospectively until 2014. The results show gains from the practice of physical activity that are framed with the descriptive statements of the regulation of nursing care quality standards. Thus, physical exercise emerges as a form of treatment that should be implemented with multiple benefits in terms of decreasing morbidity and mortality rates, controlling cardiovascular risk factors, promoting healthy lifestyles, increasing functional capacity, improved prognosis and decreased limitations.

Keywords: Nursing care · Elderly individual · Acute Myocardial Infarction · Cardiac rehabilitation · Rehabilitation

1 Introduction

This study is framed in the *Interreg España-Portugal* project of the International Institute for Aging Research and Innovation.

Population aging has been a hotly debated topic in recent times as a result of the sharp decline in birth rate and of the increase in life expectancy. It is seen as a challenge for health services and professionals aiming at aging with health, autonomy and independence [1].

In 2015, CVDs were the leading cause of death worldwide, and their high incidence is due to changes in the cardiovascular system that accompany the aging process. This is a real problem and a major cause of morbidity and mortality worldwide [2].

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AMI is the leading cause of morbidity and mortality worldwide. Its main etiology is the rupture of an atherosclerotic plaque with thrombus formation and subsequent partial or total obstruction of the coronary arteries, resulting in a final phase in cardiac muscle necrosis. Current research aims to identify strategies to prevent cardiovascular diseases and/or to improve their treatment. Thus, it is intended to intervene with contributions that promote an improvement in quality of life, regarding the increase of functional capacity, relief and/or decrease of signs and symptoms resulting from the disease and allow that the person with the cardiac pathology regains its autonomy in performing daily life activities [3].

Quality of life assumes a central position in care, valuing the promotion of functional capacity, autonomy, participation in care and self-satisfaction. It is associated with the possibility of the elderly fitting into social contexts, thus elaborating new meanings for aging [4]. The perception of an acute disease situation is individual, depending on the nature of the disease, its causes, the consequences and whether it can be treated and, in the vast majority, an AMI is commonly seen as a sudden and dramatic event that involves initial collapse and sudden death or permanent debilitation. An AMI should be interpreted as an event that was already under development before its manifestation, whose antecedents come from one's lifestyle. In this sense, it is essential that the person with a cardiac pathology perceives the triggering factor(s) of the disease, adopting strategies to control their health [3].

Regular physical activity is assumed to be an exercise corresponding to one of the components of primary and secondary prevention of cardiovascular disease and has a set of direct benefits at the cardiac and coronary vessels level. These benefits have an influence on the improvement of the endothelial function, autonomic tone, coagulation, inflammatory markers and promote the development of collateral coronary vessels [5].

2 Objective

To identify health gains resulting from nursing care interventions in the practice of physical activity in the elderly after an AMI.

3 Research Question

The research question was formulated using the PI[C]OD methodology: population (P), type of intervention (I), comparisons (C), outcome (O) and type of study - design (D). In order to answer to the previously outlined objective that served as the guiding thread for this integrative literature review, the following guiding question was elaborated: "What are the health gains (Outcomes) resulting from nursing care interventions on physical activity (Intervention) of the elderly after an Acute Myocardial Infarction (Population)?"

4 Methodology

Following the formulation of the research question, data was collected on the subject under study during April 2019 in the MEDLINE Complete and CINAHL Complete databases through the EBSCOhost platform. The descriptors used in the research were as follows: "Nursing interventions", "Nursing care", "Nursing", "Enfermagem", "Aged", "Elder", "Idoso", "Acute myocardial infarction", "Acute cardiac syndrome", "Doença isquémica", "Reabilitação cardíaca", "Reabilitação". The descriptors were searched on the EBSCOhost platform in the following order: [(Nursing interventions) or (Nursing care) or (Nursing) or (Enfermagem)] AND [(Aged) or (Elder) or (Idoso)] AND [(Acute myocardial infarction) or (Acute cardiac syndrome) or (Doença isquémica)] or (Enfarte Agudo do Miocárdio)] AND [(Reabilitação cardíaca) or (Reabilitação)]. Inclusion criteria were articles with quantitative and/or qualitative methodologies, published in full (*full-text*), in Portuguese or English, in the area of nursing and which allowed answering the above-mentioned guiding question, inserted in the CINAHL Complete and MEDLINE complete databases, with available references and publication date between January 2014 and March 2019. Exclusion criteria were articles unrelated to the theme under study, with ambiguous methodology, with publication dates prior to 2014 and repeated in both databases. The selection of studies involved title evaluation and abstract analysis to verify if the articles met the inclusion and exclusion criteria. When these were not enlightening, the article was read in full in order to minimize the loss of important studies. We identified 48 articles in the CINAHL Complete and MEDLINE Complete databases through the EBSCOhost platform. The evaluation of the articles proceeded in two phases: in the first phase 9 articles were selected after reading the titles, and in the second phase after reading the abstracts, the potential of 7 articles was justified. Of these, 5 articles were selected resulting from the methodological quality analysis, after a full reading of the article. The critical analysis regarding the methodological quality of the articles focused on the assessment of the evidence levels of each article. The contributions of Melnyk and FIneout-Overholt [6] were used to identify the different types of knowledge production that are implicit in the studies. They consider the following levels of evidence:

- Level I – Systematic reviews (meta-analyses, guidelines for clinical practice based on systematic reviews);
- Level II – Experimental studies;
- Level III – Quasi-experimental studies;
- Level IV – Non-experimental studies;
- Level V – Program evaluation reports/literature reviews;
- Level VI – Opinions of authorities/consensus panels.

5 Results and Discussion

In order to answer the PICOD question previously described, we proceeded to read the various articles, aiming at the analysis of their content. The results obtained are summarized in Table 1.

Table 1. Results of bibliographic search

Authors/Method/Level of evidence	Objectives	Results
Herring, Dallosso, Chatterjee, Bodicoat, Schreder, Khunti, Yates, Seidu, Hudson and Davies [7] Method: Systematic review of literature Level of evidence: I	To implement a structured, acceptable and effective educational program, with support for text messages, to increase total daily physical activity, specifically walking, and to reduce cardiovascular events in individuals, between 12 and 48 months after the diagnosis of AMI To evaluate the effectiveness of structured teaching to improve cardiovascular risk factors such as smoking, blood pressure, lipid profile, obesity, physical activity, and intensity of physical activity To assess the acceptability, acceptance, and feasibility of the program implementation in a population at high future risk of another CVD event in primary care	It is evident that lifestyle health education and risk factor management are required after a myocardial AMI event in order to minimize the likelihood of recurrence. The "PACES – Physical Activity After Cardiac Events" educational program combined with follow-up text messages support is used to complement care after cardiac events. It is noted in the study that the dominant profile of people undergoing cardiac rehabilitation in the United Kingdom is male, married and retired, and the reason for not enrolling in this program is still unclear, which makes it difficult to establish interventions that aim to overcome this situation. PACES sought to cover the widest possible population. It is revealed that interventions based on structured and sustained programs have shown success in preventing long term comorbidities following cardiac events. Management of coronary disease as well as prevention of secondary events is of utmost importance and this is described in national guidelines. Currently, rehabilitation plans following cardiac events are established between the patient and the health services with a view to fulfilling structured physical activity, body mass index control and smoking. It is also noted that timely physical rehabilitation optimizes the outcomes of the person with cardiac pathology
Anjo, Santos, Rodrigues, Brochado, Sousa, Barreira, Viamonte, Fernandes, Reis, Gomes and Torres [8] Method: Retrospective study with randomly selected participants divided into two groups (cardiac pre-rehabilitation group and cardiac post-rehabilitation group) Level of evidence: IV Participants: 386 patients in the cardiac pre-rehabilitation group and 858 in the post-cardiac rehabilitation group Inclusion criteria include patients who attended at least 80% of cardiac rehabilitation program sessions following acute coronary syndrome or PTCA between January 2008 and December 2019	To describe the prevalence of women in a cardiac rehabilitation program To rate this group's response to the cardiac rehabilitation program implemented	Of all those enrolled in the cardiac rehabilitation program, only 24% of them were female patients When compared to men, women are older, have more cardiovascular risk factors and probably more severe ischemic heart disease Thus, with the present study it was found that they undoubtedly benefited from the cardiac rehabilitation program, demonstrating a significant improvement in the control of cardiovascular risk factors and of most of the ischemic heart disease prognostic markers studied

(*continued*)

Table 1. (*continued*)

Authors/Method/Level of evidence	Objectives	Results
Lopes, Delgado, Mendes, Preto and Novo [9] Method: *Quasi-experimental* quantitative study, with non-randomly selected participants divided into two groups (experimental group and a comparison group) Level of evidence: III Participants: 13 participants who were hospitalized between October and December 2016 and who were not part of phase II of the Cardiac Rehabilitation program	To assess the impact of a home exercise program on the functional capacity of the person with ischemic heart disease To evaluate participants' adherence to the home exercise program	At the end of the study there was a verified improvement in the functional capacity of its participants, and this improvement in functional capacity translates into a better ability of the person to perform daily life activities, increased aerobic capacity and muscle strength The result obtained in patient compliance was also positive, and the average of sessions of physical exercise performed was higher than the minimum stipulated, which potentiated its effects It is concluded that the application of the home exercise program may be a positive response to address the underutilization of the cardiac rehabilitation program at the hospital, since all people with a cardiac pathology benefit from some degree of physical activity and should be framed and encouraged to adopt healthy lifestyles
Grossman [10] Method: Experimental study with randomly selected participants divided into two groups (experimental group and control group) Level of evidence: II Participants: 104 people diagnosed with AMI, with PTCA with one or more stents placed	To determine the most effective intervention to improve recruitment for cardiac rehabilitation of patients after an AMI who have one or more coronary stents placed	The results corroborate that the most effective way to increase enrollment of patients with cardiac pathology in cardiac rehabilitation is by scheduling an outpatient interview before discharge, at the bedside The study also revealed that bedside nursing care is essential to establish a continuous relationship with patients from the hospital to the outpatient setting, resulting in positive outcomes for patients with a cardiac pathology, thus reducing the mortality rate associated with AMI
Uysal and Ozcan [11] Method: Experimental study with randomly selected participants divided into two groups (experiment group and control group) Level of evidence: II Participants: 90 patients, 45 in the intervention group and 45 in the control group Inclusion criteria are patients with an AMI for the first time between April and November 2008	To determine the effects of individual education and counseling given to patients with an AMI, including its effect on treatment adherence	Individualized education increased functional capacity by providing patients with advice on how to maintain their weight and improve treatment adherence through physical activity Individualized education programs are effective tools for improving patients' functional status and quality of life after an AMI

(*continued*)

Table 1. (*continued*)

Authors/Method/Level of evidence	Objectives	Results
Neves and Oliveira [4] Method: Integrative literature review Level of evidence: V	To identify if cardiac rehabilitation is effective and if it can be started immediately after an AMI To identify the type and intensity of cardiac rehabilitation; To understand the indication and contraindication of cardiac rehabilitation for the prescription of exercises in the hospital phase	The results obtained with the present study reveal that cardiac rehabilitation is an essential non-pharmacological intervention for patients after an AMI. In-hospital Cardiac Rehabilitation is beneficial and should be started as early as possible and therefore it is linked to faster recovery
Harbman [12] Method: Prospective cohort study Level of evidence: IV Participants: 66 patients diagnosed with AMI in a hospital environment divided into two groups: 33 individuals diagnosed with AMI receiving nursing interventions for secondary prevention, and 33 individuals diagnosed with AMI that were not the target of nursing interventions in the secondary prevention scope The inclusion criteria defined were confirmed diagnosis of AMI with presence of troponins, chest pain lasting more than 30 min and electrocardiographic changes compatible with an AMI The exclusion criteria we defined were patients with an AMI with myocardial revascularization surgery on admission or transferred from other hospitals for coronary procedures	To evaluate the effects of nursing interventions on secondary prevention in patients with a diagnosis of AMI	The results of this study show the multiple benefits of secondary prevention nursing interventions in patients with an AMI as they can significantly improve various components compared to usual treatment such as smoking cessation, normalization of blood pressure, increased participation in cardiac rehabilitation, physical activity five days a week, glycated hemoglobin value below 7, normalization triglyceride values, statin use following treatment. It is concluded in this study that nursing interventions in the context of secondary prevention in patients with myocardium AMI significantly translate into benefits in terms of decreased morbidity and mortality rates, reduced risk factors as well as improved diabetes levels and exercise performance and improved treatment goals achieved by patients

In the discussion of the results obtained through the analysis of the articles selected in the integrative literature review, Nursing interventions were analyzed, based on the descriptive statements of the Nursing Care Quality Standards Regulation [13] that sought to translate the sensitive health gains from nursing care interventions on physical activity of the elderly after an AMI (Table 2).

Functional Capacity

The practice of physical activity presents itself as an intervention that significantly reduces the susceptibility of recurrence of cardiovascular diseases, impacting on the reduction of associated morbidity and mortality rates, improving the quality of life and enhancing the functional capacity of people with a cardiac pathology. At the functional

Table 2. Health gains resulting from nursing care interventions in the physical activity of the elderly after an Acute Myocardial Infarction

Category	Indicators
Functional capacity	– Improvement of one's ability to perform daily life activities [9] – Increased aerobic capacity [9] – Increased muscle strength [9] – Improvement in quality of life [11] – Improved functional capacity with increased oxygen uptake which translates into greater ability to withstand prolonged exertion due to improved cardiovascular performance [4, 9]
Health promotion	– Fostering the adoption and maintenance of healthy behaviors [9] – Maintenance of structured physical activity with control of modifiable risk factors [7, 8, 12]
Mortality rate	– Reduction of mortality and morbidity rates associated with an AMI [10, 12]
Prevention of complications	– Promotion of the delay in the advancement of atherosclerosis, being the main cause of coronary blood flow obstruction [9] – Reduction of cardiovascular risk [9] – Increased ischemic threshold [9] – Minimization of recurrence probability of AMI [7] – Prevention of long-term comorbidities [7] – Reduction of heart rate and blood pressure, with improvement of lipid and glycemic profile, preventing the development of coronary artery disease [4]

capacity level, aerobic exercise optimizes peripheral oxygen distribution and utilization resulting in an increase in submaximal effort for myocardial ischemia to occur [9]. In the study by Lopes et. al. [9], with a target population of 13 participants who met the inclusion criteria and who underwent a 3-month home aerobic exercise program, adherence was approximately 92%. This percentage coincides with the general literature which shows excellent adherence of patients to home cardiac rehabilitation programs. It was found in this study [9] that, regarding the gait test and comparing the average distance covered at discharge and 3 months after discharge, there is an increase with statistical significance, with an increase in this distance covered, thus showing an improvement of the functional capacity of the sample. Physical activity is proven to be the best way to slow the progression of the nature of heart disease, as well as to increase functional capacity in terms of increased aerobic capacity and muscle strength of people with heart disease, allowing them to perform their daily life activities independently and effectively for a longer period of time and with less dependence [9].

Health education programs, individualized and tailor-made for patients after an AMI, have an impact on increased functional capacity by providing patients with the knowledge to take control of cardiovascular risk factors and adherence to treatment through physical activity. These programs, still carried out in the context of hospitalization, are effective tools to improve the functional capacity and quality of life of users, promoting responsibility in their health/disease process, reducing the length of stay and the possibility of readmission due to cardiovascular disease [11].

Several studies have shown the benefits of early integration into the cardiac rehabilitation programs, preferably within the first 24 h after an AMI, both in terms of recovery and prevention of disease recurrence and/or cardiac deterioration. Thus, aerobic exercise has impacts at various levels, positively influencing a person's functional capacity after an AMI, such as: (i) improved functional capacity with increased oxygen uptake which translates into a greater ability to withstand prolonged exertion with better cardiovascular performance; (ii) structural and hemodynamic adaptations in the cardiovascular system, promoting adjustments in the autonomic nervous system through cardiac adaptation with adjustments in systolic and diastolic function and volumes; (iii) positive changes in cavity diameter and ventricular mass; (iv) reduced heart rate and blood pressure, with control of risk factors. In addition, resistance exercises, present in the Cardiac Rehabilitation protocols, show significant improvement in terms of physical performance, strength, endurance, balance and coordination. Thus, there is evidence that programs combining aerobic and resistance exercises have greater benefits for people with a cardiac pathology when compared to one modality alone [4].

Health Promotion

Ischemic disease, in addition to presenting a major cause of mortality, is also an important cause of disability and decreased functional capacity, the latter being regarded as the ability of the person to effectively and autonomously perform daily life activities. Thus, the treatment of this condition arises from the combination of pharmacological therapy and revascularization procedures with the control of cardiovascular risk factors and the adoption of healthy behaviors and health promoters. The transition to a healthy lifestyle through the adoption of healthy behaviors is facilitated by cardiac rehabilitation programs aimed at promoting cardiovascular risk reduction by fostering the adoption and maintenance of healthy lifestyles. In the study by Angel et al. [8] a target population of 858 people with a cardiac pathology who attended a cardiac rehabilitation program based on physical activity was considered to study its impact on the control of cardiovascular risk factors. It was concluded that, in a universe of 858 people with cardiac pathology, all benefited from the cardiac rehabilitation program with a significant improvement in cardiovascular risk factors and most prognostic markers.

There is an association regarding health education interventions and risk factor management, minimizing the possibility of future cardiac events [7]. Thus, considering physical activity as a health-promoting behavior, it is associated with reduced risk of developing a CVD, as it induces a positive response in the control of cardiovascular risk factors [7]. The implementation of secondary prevention strategies by nursing professionals and targeting people with a cardiac pathology reveals significant improvements in controlling cardiovascular risk factors as well as achieving lower triglyceride levels, glycated hemoglobin $<7\%$, smoking cessation and blood pressure $<130/80$ mmHg. Thus, safe and effective secondary prevention interventions are well received by patients and act as a positive strategy for controlling risk factors in people with heart disease [7].

Mortality Rate

The implementation of secondary prevention strategies, particularly regarding cardiac rehabilitation programs in people after an AMI, is strongly related to the control and reduction of cardiovascular risk factors with a positive contribution to reducing the rate of mortality [10, 12].

Prevention of Complications

Ischemic disease is one of the main causes of disability and decreased functional capacity of individuals who suffer from it. Cardiac Rehabilitation is an essential tool in the treatment of patients with cardiac pathology, consisting of a structured program of physical exercise accompanied by awareness and teaching work on the CVD, as well as management of the therapeutic regimen. Cardiac Rehabilitation aims at the recovery and prevention of new relapses in patients with cardiac pathology, promoting the reduction of cardiovascular risk, delaying the advance in atherosclerosis, increasing the ischemic threshold and promoting the adoption and maintenance of healthy behaviors [9]. There are multiple reasons why there is no referral of patients with cardiac pathology to a Cardiac Rehabilitation Program, the most common being the distance from the patient to the hospital, the associated costs, the incompatibility of schedules between the Cardiac Rehabilitation Program and the patient's working life and insufficient human and material resources to provide Cardiac Rehabilitation Programs. Thus, in order to respond to the problem, there are home cardiac rehabilitation programs in which the patient complies with a remote rehabilitation program at home, with remote monitoring by health professionals. According to the same study [9], out of a population of 13 patients (11 men and 2 women) there was 92% adherence, and this high percentage is related to a higher probability of maintaining an active long term lifestyle, reinforcing the importance of betting on home cardiac rehabilitation programs for patients who are not referred to hospital inpatient cardiac rehabilitation programs. At the end of the study it was found that the application of this type of program presents itself as a response to the underutilization of hospital cardiac rehabilitation programs since all patients, regardless of their cardiovascular risk or comorbidities and dependence, benefit from some degree of physical activity and should be encouraged to adopt healthy lifestyles to prevent complications from the disease [9].

The practice of physical activity in patients after coronary events is associated with a decreased risk of cardiovascular disease, thus inducing a positive response to decreased cardiovascular risk factors, as well as minimizing the likelihood of recurrence of AMI [7]. A structured health education program is an appropriate method to provide the person with a cardiac pathology with self-management of their therapeutic regimen, positively affecting the future risk of cardiovascular events and comorbidities. Recognizing that there is often inadequate follow-up within 12 months of a cardiac event driven by the high cost of direct contact with health professionals and time-consuming strategies, advancing technology with an acceptable, effective, structured educational program with support for text messages, can increase adherence to therapy, promote healthy eating as well as exercise by demonstrating success in preventing long-term comorbidities following cardiovascular events [7].

There are several studies that demonstrate the benefits of cardiac rehabilitation after an AMI in relation to the recovery process, prevention of new diseases or deterioration of heart function. The phases of this program are divided into phase I (hospital), phase II (outpatient) and phase III (maintenance exercises). Regarding the prevention of complications, the exercises performed present a reduction in heart rate and blood pressure and control of risk factors such as improvement of lipid and glycemic profile, thus preventing the recurrence of the disease [4].

6 Conclusion

The practice of physical activity in the person after an AMI leads to gains associated with functional capacity, health promotion, decreased mortality rate and prevention of complications. Scientific evidence shows that the nursing interventions outlined earlier in health education and cardiac rehabilitation programs provide people with a cardiac pathology control of cardiovascular risk factors, as well as increased aerobic capacity, strength muscle and fitness to perform daily life activities, translating these gains into an increase in their functional capacity. On the contrary, there are several studies that report that non-adherence to health-promoting behaviors, such as physical exercise, have consequences not only in terms of increased cardiovascular risk factors with increased hospitalization rates, mortality and morbidity, but they are also associated with decreased quality of life and increased physical dependence.

Professional intervention strategies for physical activity in people after an AMI, on the one hand, positively affect the control of cardiovascular risk factors and allow the person to maintain their functional capacity but, on the other hand, these strategies also allow the acquisition of knowledge and tools so that these people can get involved in their recovery process.

CVDs have a high rate of comorbidities and complications, and physical exercise plays a major role in preventing them. It is essential that physical activity be started as early as possible, in phase I or at the hospital, reducing on the one hand the length of stay and on the other hand the complications resulting from immobility. Scientific evidence demonstrates the importance of a person's physical activity after an AMI at three main levels: recovery, prevention of disease recurrence, and maintenance of cardiac function. It is therefore essential that people after an AMI be integrated into a Cardiac Rehabilitation Program if they meet the inclusion criteria, enabling appropriate monitoring by health professionals and close monitoring with multiple benefits.

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Flourishing and Satisfaction with Life in Older People Practicing Yoga

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Abstract. We live in a time when the increase in life expectancy is reality. In many cases, life expectancy can exceed 100 years. Therefore, there is a real concern that the elderly have the right to enjoy well-being and quality of life. The present study is part of the field of psychogerontology and positive psychology, whose main objective is to understand well-being (happiness) and increase the amount of human flourishing (positive emotions, engagement, positive relationships, meaning and achievement, as determinants for achieving happiness). It would be ideal if the elderly could find happiness and full bloom in their lives. This is an exploratory, cross-sectional study of quantitative and qualitative methodology, focused on four dimensions: flourishing, satisfaction with life, perception of flourishing and implications of the practice of yoga for the welfare of the elderly. We count on the participation of twelve elderly, regular yoga practitioners, divided into two groups, from Spain and Portugal.

Evidence has shown that yoga practitioners are people who are characterized by a high level of flourishing and satisfaction with life, however, exhibit some fragility in optimistic disposition. Based on the results obtained, an intervention project "Senior Flourishing & Yoga" was designed, whose main objective is to improve the well-being, the successful ageing and the health skills of the elderly population through yoga.

Keywords: Older persons practicing yoga · Successful aging · Health aging · Human flourishing · Satisfaction with life

1 Introduction

The increased life expectancy coupled with a significant decrease in fertility rates are some of the causes of rapid global demographic aging. Therefore, comprehensive public action on aging is urgently needed [1]. This requires important changes, not only in what we do, but in the way we think about aging and the way we promote healthy aging. In the field of Social and Community Gerontology, and in the current demographic situation in Europe with the aging of its population, it is necessary to develop public policies that allow the full enjoyment of the elders of their personal and social rights. According to Fonseca, the possibility of a successful aging is valuing the psychological and social aspects [2]. Regarding the psychological aspects of aging, this study fits into the approach of positive psychology whose aim is to raise the level of the human condition through

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the concept of subjective well-being, happiness, and human flourishing, as goals to be achieved so that our relationship with the world is a symbiosis of success. The concept of human flourishing allows us to analyze what leads us to cultivate talents, establish solid and lasting relationships with others, feel pleasure and contribute significantly to the world. That is, what allows us to grow as people [3].

Studies show that regular meditators are happier and more satisfied than average people. These results have important repercussions on health, since positive emotions are associated with a longer and healthier life. Anxiety, depression, and irritability decrease with regular meditation sessions. Memory improves, reactions become faster, and mental and physical vigor increases. Regular meditators have better and more fulfilling relationships [4]. It is of general knowledge, the benefits that a yoga practice brings to the level of the physical body and at the level of the mind. Through techniques of physical postures, breathing, relaxation and meditation, one can acquire a greater awareness of oneself and others. Within the philosophy of Yoga, the state of Santosha or contentment means being happy with what you have, enjoying life in the present moment, without wanting anything else. The state of contentment or Santosha means to maintain a permanent state of satisfaction and realization in life [5].

Given that we can consider that yoga can bring benefits in terms of health and well-being, we wanted in this study to know how this activity can be an asset for older people. Thus the problem of the study is limited to the knowledge of flourishing and satisfaction with life in regular yoga practitioners, with practice time of more than 1 year, from the age of 60 onwards, in Spain and Portugal. In this regard, and to answer the question, "What is the flourishing and satisfaction with the lives of older people, practitioners of yoga and how does this practice contribute to their well-being?" A research was designed by three parts: theoretical framework; empirical study; and a proposal for an Intervention Project called "Senior Flourishing & Yoga" which has as main objective: to promote the flourishing and well-being in older people, considering yoga practice, and the techniques of full meditation, based on the principles of Mindfulness.

2 Successful Ageing

The psychogerontology or psychology of aging can be defined as the science that studies the aging process as part of human development, the behavior and the mental processes of the elders, starting from a psychosocial perspective. The application of this knowledge enables the promotion of the welfare of older people [6]. For the World Health Organization [7], Psychogerontology is a meeting point for mental health processes; defining the term "mental health" as a state of well-being in which the individual is conscious of his own abilities, can face the normal tensions of life, in which he can work productively is able to contribute to his community.

The relationship between the person and his/her environment (family, community and social context) is an important object of study for Psychogerontology. The elderly individual can optimize his/her lifelong skills, even in old age. That, moreover, can compensate for the physical, psychological and emotional conditions that diminish, or even deteriorate, with the passing of age, through precise interventions. The intervention in physical areas through regular, cognitive and emotional physical exercises are effective in improving the overall functioning of the elderly person. If aging is a process, influenced both by the outside (social, cultural, environmental), as through the interior (subjectivity of the individual, or meaning that gives its own aging process), this leads us to the following question: “How can we help people to experience quality and happiness in the aging process?”. This is the challenge of psychogerontology.

Aging is a process whose quality is directly related to the way a person satisfies their needs throughout their life cycle, which leads us to the concept of quality of life. The quality of life is the interaction between life, satisfaction and the objective conditions of life. The latter encompass health, family care, work, recreational activities, state responses and satisfaction of social relationship needs [8, 9].

The concept of successful ageing leads us to the concept of healthy ageing. The World Health Organization [7] presented the public health framework for healthy aging and identifies a common goal for all stakeholders to optimize functional capacity. The report explores how this can be achieved in five heavily interconnected domains of functional capacity, essential to allow older adults to accomplish the tasks they value. The capacities considered are: (1) Meet your basic needs; (2) Learn, grow and make decisions; (3) Jogging; (4) Build and maintain relationships; and (5) Contribute. Together, these capacities allow older adults to grow safely in a suitable place for them, in order to continue to develop personally, contribute to their communities and maintain their autonomy and health.

3 Satisfaction with Life in Ageing

Life satisfaction was identified as part of subjective well-being [10], in which the person’s quality of life is assessed globally according to their own criteria or standards. The authors consider it important to ask about the overall assessment that each subject makes of his/her life, instead of merely questioning the satisfaction in specific areas [11]. To do this, they developed the life satisfaction scale that allows this assessment according to a comparison of the circumstances of the self, with the standard that it judges appropriate [12]. The two components of subjective well-being are: (1) “The cognitive component”: is the main component of subjective well-being, consisting of the perception of satisfaction with life or how much a person enjoys the life it takes; and (2) “The affective component”: affection reflects our reaction to almost any life experience. It includes positive affection: emotions with a nice subjective content (joy, interest in things, etc.) and negative affection: emotions and mental states with an unpleasant subjective content (anger, sadness, anxiety, worry, guilt, shame, envy, Jealousy) and expresses negative reactions from people to their lives, other people or circumstances. In the context of the determinants of subjective well-being, the authors highlight four dimensions [13]: Demographic, Personality, Psychosocial and Contextual.

The studies have shown that, for older people, the family constitutes the main source of emotional support, safety, care and affection, as well as the natural resource of care. In particular, they point out that the “positive relations and support networks influence the maintenance of a positive self-image and high self-esteem, central aspects of subjective well-being” [14]. The investigation evidences that the psychosocial variables of the elderly who seem to predict better the satisfaction with life are: health, functional skills, social contacts and the level of activity of the person [15]. In relation to the determinants of happiness, although health is important at all ages, it is especially relevant for the elderly, because it constitutes a problem and a source of concern at this stage of life [16].

4 The Practice of Yoga as Promoter of Human Flourishing in Ageing

The term flourishing was used to talk about feeling totally alive, being creative and resilient or able to overcome adversity [17]. In Seligman's theory of "Authentic Happiness" [18]. we highlight the key elements that contributed to happiness: positive emotions, involvement and meaning. Subsequently, the author found that these elements do not express everything that people seek to feel good. Thus, it was considered that there was a change in the object of study of positive psychology, happiness for well-being, and that it would be evaluated through flourishing [3]. The development of Seligman's theory of Well-being [3] gave rise to the PERMA model, in which the factors for personal growth are: (P) positive emotions; (E) engagement, involvement, commitment; (R) positive relationships; (M) meaning; (A) achievement, realization. Feeling that we can achieve the goals that can increase our well-being, is the realization perception. The flourishing depends on the presence of these five elements in the life of the individual. That is, it results from a pleasant life, with meaning, with experiences of flow that presupposes a complete delivery to what it accomplishes, with feelings of accomplishment and success, and the presence of positive relationships with others [19, 20]. We must therefore minimize our suffering, on the one hand, and increase our growth, on the other, with attention to these factors. In addition, we must have at least three of these six additional features: self-esteem (to have a positive attitude towards oneself), optimism, resilience (ability to overcome adversity), vitality, self-determination and positive relationships [3]. In this perspective, flourishing as part of welfare is fundamentally the result of an optimal psychological functioning, which implies a self-acceptance, one of the central criteria of well-being. The evidences show that not all individuals have the right competencies to achieve well-being or then have difficulties in acquiring them or showing them, in this follow-up arises the need to prepare people to flourish in life [21].

The word yoga means "unity" and derives from the Sanskrit word "yuj" which means "unite". This unity is the union of individual consciousness with universal consciousness. On a more practical level, yoga means a method to balance and harmonize the body, mind and emotions. This balance is achieved through the practices of asanas, pranayamas, mudras, bands, shatkarmas and meditation. Yoga is the science of correct life and as such is designed to be incorporated into daily life. It works in all aspects of the person: physical, vital, emotional, psychic and spiritual [22]. Yoga is, therefore, a practice accessible to all, and that allows the individual to live as a whole, harmoniously. Yoga proposes the coexistence of the human being with the best of oneself, allowing the practitioner a physical, emotional and mental well-being, which maintains it in his state of health and natural happiness [23]. The regular practice of yoga can be an important aspect to maintain a healthy ageing, as it allows the body and mind to regain balance, combat stress, keep the body flexible and in good physical condition, allows to experience subtle changes in Approach to life. In addition to the benefits already mentioned and as the practice, the individual gains a different consciousness and perspective of himself and others [22].

5 Methods

This is an exploratory study of quantitative and qualitative methodology. The present study is part of the following research question, "What is the flourishing and satisfaction with the life of older people, practitioners of yoga, and how does this practice contribute to their well-being?". This research presents as general objective to know the degree of human flourishing in a group of older people, practitioners of yoga (Portuguese and Spanish). And as specific objectives: (1) To know the aspects of human flourishing in older people, practitioners of yoga; (2) To identify the level of satisfaction with life in a group of older, practicing yoga; (3) To identify the disposition of positive interpersonal relationships a group of older, practitioners of Yoga, (4) To identify the positive mood/emotions in a group of older people practicing yoga; (5) To know the implications of the practice of yoga in older people; and (6) To promote welfare in older people, through identified needs.

5.1 Participants

This investigation was carried out from the data collected in a convenience sample formed by older people practicing yoga, from Spain and Portugal, not institutionalized and inserted in their communities. The selection criterion for the inclusion of the participants was to have a regular practice and committed to yoga of at least one year. This is a sample consisting of twelve participants: ten women (83.3%) and two men (16.7%). The age range was between 63 and 81 years, with a mean age of ($M = 71.9$) and Standard deviation ($SD = 5.2$). In terms of academic qualifications, 50% ($n = 6$) had higher education; 8.3% ($n = 1$) had secondary education; 25% ($n = 3$) had a third cycle of basic education; 16.7% ($n = 2$) First or second basic education cycle. The sample consisted of ten participants of Spanish nationality and two of Portuguese nationality.

5.2 Material

Data collection was carried out through the use of an interview survey and through the application of two psychological assessment instruments, the flourishing scale [24], and satisfaction with life [11]. In order to collect proximity information with the participants concerned, it was considered the realization of a semi-directed interview, built to this investigation. For this purpose, an interview script consisting of five parts was performed, evidencing the respective dimensions: (1) characterization of the participant; (2) flourishing perception; (3) satisfaction with life; (4) practice of yoga and; (5) reflections and suggestions on the theme. The Flourishing Scale [24] was used, validated for the Portuguese population [25]. That in the two samples studied [25] revealed internal consistency values of (0.83) and (0.78). For the Spanish population, the Spanish version [26] was used with internal consistency values of (0.89) in the two samples studied. The flourishing evaluation was carried out through the Portuguese and Spanish version of the Flourishing Scale (FS) [24].

5.3 Procedure

Data collection was carried out between January and April 2019, in the municipality of Beja (Portugal) and in the cities of Madrid, Alcalá de Henáres and Tres Cantos (Spain). The subjects were informed about the investigation, the objectives of the study and the assurance of data confidentiality and anonymity. The instruments were applied individually, with voluntary participation.

The descriptive statistics analysis of the data obtained (means, minimum and maximum, standard deviation, percentage) was performed through the program IBM SPSS Statistics 20. Content analysis was used for the qualitative analysis of the open questions performed in the interview.

6 Results

In the Flourishing Scale, a score between 43 and 55 points was observed, with an average of (M = 48.67) and Standard deviation (SD = 3.96). Of the values obtained, (16.7%) were in the third quartile, and (83.3%) maximum values for the scale. We can conclude that the majority of the group is in a high degree of growth or psychological development. In the life satisfaction scale, values comprised between 25 and 35 points were observed, with a mean of (M = 29.08) and Standard deviation (SD = 3.78). Of the values obtained (33.3%) were in the third quartile, and (66.6%) maximum values for the scale.

Regarding the dimension of “Flourishing Perception” and the Sub-dimension “Positive interpersonal relationships”, the participants reported that “Yes, have positive interpersonal relations” (75%), “more or less have positive interpersonal relationships” (16.7%) and “do not have good positive interpersonal relations” (8.3%). Regarding the Sub-dimension “Positive emotions” participants reported that “Yes, have positive emotions” (66.7%), “more or less have positive emotions” (16.7%).

Related to the sub-dimension “Purpose of life” the participants reported being connected in the first place to “family and children” (33.3%) and then, to “social life, friends” (8.3%), to have “peace, harmony, happiness” (25%), “health” (16.7%), “positive attitude towards life” (25%) and “yoga support” to find the purpose of life (8.3%). As for the sub-dimension “Positivism” before life, the participants reported “Yes, I am positive” (75%) and “I’m not positive” (8.3%). As for the sub-dimension “Optimism” before life, the participants reported “Yes, to be optimistic” (66.7%), “More and less optimistic” (8.3%) “I am not optimistic” (8.3%).

Regarding the “Perception of Satisfaction with Life” dimension, the participants reported “Being satisfied” (83.3%) and “More or less satisfied” (16.3%). As for the main “Contributions to satisfaction with life” they refer to: “Family and children” (33.3%), “Achieving life goals” (16.7%), “Friends” (8.3%), “Assertiveness” (16.7%), “Genetics and Culture” (16, 7%), and “Self-perception of satisfaction with life” (16.7%).

The participants refer to the relationship of “Yoga with wellbeing” (100%). As for “Yoga and satisfaction with life” they stated that “Yes. It relates yoga with satisfaction with life”, (58.3%), and “More or less. It relates yoga with satisfaction with life”(25%). There were also relationships between “Yoga and positive emotions “(33.3%). Asked about the added "Value of the practice of yoga" the participants showed the following benefits: "Relaxation and tranquility" (83.3%), "Spirituality" (33.3%), "Happiness" (8.3%), "Promotion of physical activity" (50%).

7 Discussion

The analysis of the results obtained from the "Flourishing Scale" and "Satisfaction with Life Scale" shows that, in general terms, the sample members present high levels in the satisfaction with life scale (subjective well-being), and that in the flourishing scale (Wellbeing Psychological) show few differences in the mean scores between men and women, but these differences are not statistically significant due to the size of the sample. These results are consistent with the authors studied: (1) There are few differences between genders in relation to general satisfaction with life or positive emotions [16]; and (2) demographic factors such as age, gender, income level, ethnicity, qualifications or marital status have little effect on people's subjective well-being [13].

Regarding the dimensions, "Perception of Flourishing", "Perception of Satisfaction with Life", "Practice of Yoga" and "Reflections" that were studied through content analysis, we can highlight some inferences that we present below. Regarding the "Perception of flourishing" we can say that the sub-dimension, "Positive interpersonal relationships", was mentioned (75%) of the times. This result is in agreement with Baptista [19, 20] who considers that flourishing depends on the presence of five elements in the life of the individual, that is, it results from a pleasant life, with meaning, with experiences of flow that presupposes a complete delivery to what it accomplishes, with feelings of accomplishment and success, and the presence of positive relationships with others. Regarding the Sub-dimension "positive emotions", mentioned (66,7%). This result goes to the enunciate by Diener [24] as a component of subjective well-being that includes positive affection and emotions with a pleasant subjective content.

The "Life purpose" most mentioned by the participants (33%) was related to "family and children" what is according to the authors [14]. Effectively, for the elderly, the family remains the main source of emotional support, safety, care and affection. Secondly, the sub-dimensions related to "Peace, harmony and happiness" (25%) were mentioned, agreeing with the investigation of flourishing [3]. Thirdly, the Sub-dimension "Positive attitude" appears in the "Face of life" (25%). Fourthly, the Sub-dimension "health" was not related to the studies presented in the theoretical framework [15]. According to the investigation, the psychosocial variables of the elderly who seem to predict better the satisfaction with life are: health, functional skills, social contacts and activities of the person.

The Sub-dimension disregarded "positivism" (75%) and "optimism" (66.7%), are in the line of flourishing characteristics [3]. With regard to "perception of satisfaction with life" it was found that in the sub-dimension of "Perception of satisfaction with life", (83%) of the participants are satisfied with life, and (16.7%) more or less satisfied. When questioned about what contributes to this satisfaction, it was mentioned: first, the aspects related to family and children, which is in agreement with the author s [14] who affirm that for the elderly, the family remains the main source of emotional support, safety, care and affection. Secondly, the aspects related to "assertiveness" and "Self-perception of satisfaction with life" were presented. This preference is in accordance with the research [13] that considers that of the two components of subjective well-being, the cognitive component is the main component. This is constituted by the "perception of satisfaction with life" that is, how much a person likes the life it takes. The data show that the perception that the participants have on this issue linked to life satisfaction is a decisive contribution to the promotion of successful ageing.

Regarding the "Practical perception of yoga", the interviewed elderly recognize the positive contribution of yoga to the improvement of quality of life, in order to make new friendships and practice physical and mental activity. All participants related the practice of yoga with well-being (100%.) In the Sub-dimension the "Yoga and the benefits" arises firstly the reference to the "Relaxation" and "Tranquility" that the practice provides. It follows the importance of having a "Physical activity", the relationship with "Spirituality", with "Positive emotions" and, with "Happiness". The elderly interviewed recognize the positive contribution of yoga to the improvement of quality of life, in order to make new friendships and practice physical and mental activity. These results are in agreement with the authors [27] who used the practice of yoga to know their influence on the quality of life of elderly women with depression. After the interventions, the Yoga group and those of the therapy group (exercise and stretching) improved the score on the Satisfaction with Life Scale (SWLS). This evidence also agrees with the investigation [28]. In the "Final Reflections", life histories were shared (25%), highlighting the serenity that the practice of yoga provides, the benefits of active ageing through the practice of physical activity and reflections on the philosophy of yoga.

8 Conclusion

Flourishing and satisfaction with life can be observed in people over 60 years of age, particularly in the elderly who participate in a social group, who have positive interpersonal relationships, which maintain an active ageing through the practice of a physical activity. They present themselves as people committed to a life purpose, are more positive and optimistic and with better quality of life and, therefore, with satisfaction for life. Thus, ageing becomes a stage of life that can be full of meaning and fully experienced. They are more valuable for older people, in social terms, new friendships, conviviality and relationships with others; and in personal terms, the importance of physical and mental health. All participants have in common a high satisfaction with life and the presence of aspects linked to human flourishing. They also comprise the practice of yoga as a positive experience to promote a successful ageing. If this process is continuous, the benefits are important because they contribute to the "improvement of cognitive functioning, health promotion, increased satisfaction with life, development of competencies of varying order and reinforcement of feelings of autonomy and communication capacity" [29].

Everything indicates that the investment in the practice of yoga promotes satisfaction with life and flourishing, quality of life, well-being and successful ageing. The testimonies of the participants of this study evidenced a need to create situations of conviviality, to have a better knowledge of the other, to share the experience of belonging to a social group and to the community. In this sense it would be interesting to invest in sociability and inclusion through the gathering of older people through rewarding activities, promoting a healthy and active ageing. Therefore, a course that bets simultaneously on the development of the "senior flourishing" and the stimulation of the continued practice of "Yoga" would be a good option to carry on. In this training would be contemplated the aspects of full attention – "Mindfulness"-which can be a bad value for the development of successful ageing.

Flourishing individuals report higher levels of satisfaction with life, involvement, meaning, more effective learning, healthier relationships, greater job satisfaction and longevity [3]. The evidence found in our study goes on this line; hence the proposal of an intervention project called "Senior Flourishing & Yoga" makes perfect sense.

Despite the difficulties inherent to the investigation process and the limited number of participants, it is considered that the realization of the study allowed achieving the formulated objectives and expanding the knowledge in the area of positive psychology and the psychogerontology.

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An Opportunistic Routing Solution to Monitor Isolated Elderly People in Rural Areas

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Abstract. Countries are experiencing a global population ageing. It is estimated that the percentage of third age people will notably increase in next decades, implying a difficult challenge to society. Rural areas are the most affected locations by these conditions. Currently, small villages are facing an increasing ageing of population where almost 40% of inhabitants are over 65. Medical needs are one of the most relevant aspects in this context. This factor, in conjunction with other reasons such as loneliness, motivates technological solutions. Despite this, Internet is not accessible from rural and low income areas, due to the lack of interest from the operator side to invest in these locations. In this paper, an opportunistic routing solution based on BLE is proposed, with the aim of monitoring loneliness population in order to detect potential emergencies.

Keywords: Elder healthcare · Opportunistic networks · Rural areas · Internet of Things · The ONE simulator

1 Introduction

Society is facing a widespread ageing. Only in Europe, around 30% of population is over 65, denoting a potential increasing trend for the forthcoming decades [1]. In this way, it is expected that this percentage of advanced aged people will reach 50% of population.

This context gets intensified at rural areas, where reports show that almost the half of population are third age people [2]. These locations are specially impacted by factors like isolation and loneliness which affect elders' daily routine. The problematic of solitude supposes a potential risk for elders [3], specially when health conditions are not optimal. The carelessness and lack of assistance can be triggering factors to fatal consequences. Improving elders' quality of life

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motivates the use of technological solutions in order to be aware about their health conditions.

Many elders in rural areas live alone in their homes thus, detecting possible critical situations can become a complex task. This way, a system that regularly monitors elders' vital signs can be a suitable solution. It is relevant to take into account the limitations the frequent lack of Internet in rural areas implies. This context motivates alternative purposes that explore technologies.

A communication platform based on short-radio technologies can be useful to transmit information about vital signs. Rooted in Delay Tolerant Network (DTN) [4] paradigm and the Internet of Things (IoT), the solution must guarantee an absolute success at messages reception. Since health data is transmitted, messages provide the information to detect possible critical situations. This way, a 100% in delivery probability is needed in order to know every elder's vital signs all the time.

In this paper, an opportunistic routing solution is proposed and evaluated on a realistic scenario. The performance of the idea is analyzed from the obtained results. The rest of the paper is organized as follows. Firstly, Sect. 2 describes the context that motivates the using of DTN technology, as well as alternative routing solutions. Secondly, the proposed solution is elaborately exposed in Sect. 3. Node types are specified and algorithm working is explained. Then, Sect. 4 includes the results analysis. Relevant parameters are considered and studied. Finally, Sect. 5 draws some conclusions about the paper and exposes future outlines and research lines.

2 Motivations

The lack of Internet connectivity at isolated rural areas motivates the use of other networking solutions, such as the DTN paradigm. Delay Tolerant Networks or Opportunistic Networks define a solution for remotely communicate devices without the need of relying on the Internet. This way, information is transmitted in messages that are distributed into moving nodes in an opportunistic way based on store-carry-and-forward method. Using low energy technologies such as BLE or WiFi, network components are able to distribute information until destination node.

The possibilities of interaction in DTNs are multiple. Routing algorithms define the message operation and the way the information is forwarded through the network. Several approaches and solutions exist and propose different networking philosophies. Next, different routing algorithms from [5] are exposed:

Direct Delivery Router is the most simple strategy to communicate a pair of remote nodes. The router is based essentially on the direct contact between the sender and receiver. This way, message copies are renounced. First Contact Router follows a philosophy similar to Direct Delivery. Message are not copied and they are sent to the first encountered node. Flooding algorithms are based on message replication. Three routing protocols based on epidemic floods are: PRoPHET, Max-Prop, Epidemic and Spray and Wait. The first one is based on hops estimation using the historical encounters. Max-Prop keeps the premise of cleaning the network from copies when messages reach destination. On the other hand, Epidemic Router distributes the messages to all reachable nodes. At last, Spray and Wait Router is based on a configurable limit of copies. This value specifies the number of replicated messages that are created.

In this work, the proposed solution is a routing algorithm which extends SACAR OCVN router, originally described in [6]. This algorithm is based on the Context Aware paradigm and its functioning is improved in this article. The operation of SACAR OCVN [6] is mainly based on the use of intermediate nodes. These elements forward messages using interests in order to reach a destination. A virtual profile is deployed in nodes in order to keep interests and preferences (Goal nodes) or abilities to modify the context (Skill nodes). This way, nodes can share preferences and communicate with devices which are able to change the context. In order to study SACAR OCVN results, several executions were performed over two representative scenarios (a smart office and a shopping mall) and the delivery average probability is around 50% [6].

In order to propose a solution for the problem of monitoring isolated elderly people at rural areas, it is critical to achieve a 100% delivery probability. This way, variables like reception probability has to be absolute even if other magnitudes are affected. Next section describes the developed solution as well as the new implementation of the algorithm.

3 Proposed Solution to Monitor Elders' Health

The raised system keeps a track over elderly population, monitoring vital signs and detecting possible problems in elderly health. Therefore, vital signs information is transmitted from the elderly to key points installed around the village such as reception beacons, checking elders' health and detecting possible dangerous situations. The main process of the proposed system is shown in Fig. 1.

This structure defines four component types with different objectives in the scenario. Next, these elements are described:

(1) Elderly nodes. Elderly population in the village wear a device that is able to monitor vital signs. This element creates messages which contain elderly vital signs and broadcasts them into the opportunistic network.

(2) Sink nodes. Sink nodes are the destination of the information. These devices are motionless and are installed in strategic points at the village such as the church, the town hall or the school. Internally, sink nodes keep a track over received information.

(3) Carrying intermediate nodes. These elements carry elderly information and share it with other carrying nodes or deliver it to the destination. This component represents volunteers who allow the use of their smart device in order to act as mule and broadcast elderly information. This type of node is a key element in the system.

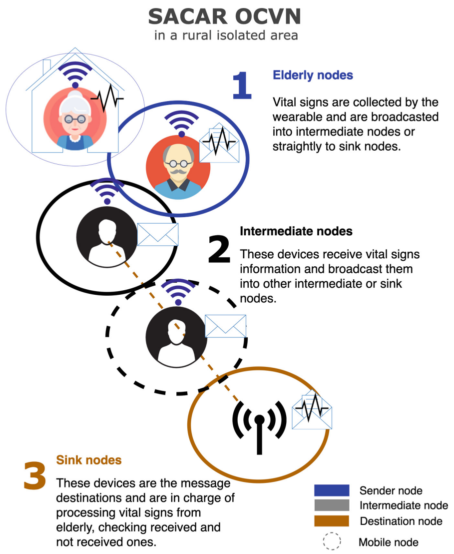


Fig. 1. Rural scenario overview.

(4) Non carrying intermediate nodes. These non cooperative nodes represent users who have not allowed using their phones or devices in order to route information. Although their presence is not critical, it is still an important part on simulations since it provides realism and increases the control traffic.

The working of the solution is fundamentally based on SACAR OCVN routing algorithm [6]. As introduced above, in this paper the algorithm logic is modified to broadcast elders' vital signs and to guarantee that the information is correctly received. The original implementation of the algorithm is improved by changing the assignation of destination node in messages. Originally, message destinations are selected in a set of nodes that are able to process the Goals (sink nodes). This way, since node destinations are fixedly identified in messages, other potential destination nodes are ignored when they receive the information. In the new version presented in this paper, this situation is tackled and the algorithm integrates the possibility of dynamically changing the destination, therefore improving the overall performance.

Taking this into account, the new version of [6] is applied in the exposed platform [Fig. 1] as a key component. This way, the routing tasks are carried out by the algorithm.

This solution is evaluated using The One on a scenario that represents a rural area in which the population is mainly elderly people living alone. This way, in the chapter, details about the simulation are drawn and results are surveyed.

4 Results

In this section, details about simulation in The ONE simulator are explained. Moreover, results from executions are analyzed and evaluated.

4.1 Simulation Setup

A small village has been defined, recreating an elaborated simulation of Nuñomoral, a location situated in Càceres province, Spain. This little town has around 300 inhabitants and it is a perfect context to simulate the implementation of the platform. Figure 2 depicts the simulated scenario.

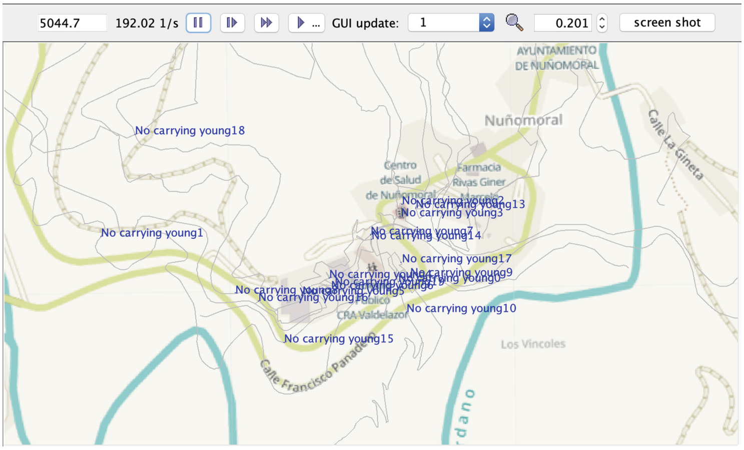


Fig. 2. Nuñomoral simulated in The ONE.

In order to perform the simulations, several variables are considered. This manner, considered factors are varied in order to study different situations and evaluate the best optimal conditions for transmissions.

The considered variables at executions are described next: (1) nodes proportion, (2) message generation interval and (3) number of destination nodes. These variables are used in order to simulate the scenario under several conditions. This way, optimal configuration can be evaluated, identifying the most favourable parameters and key variables.

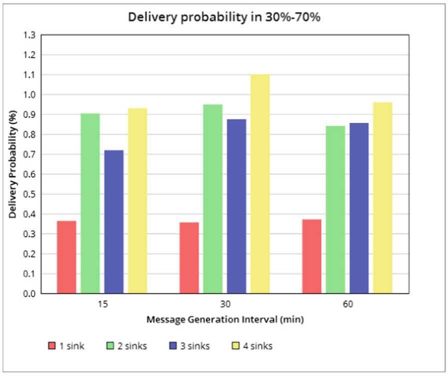
(1) Nodes proportion. Since different node type exists in simulation, proportions must be studied. It is relevant to determinate which is the most suitable proportion of nodes at communication success. This way, three proportions are defined: 30% elderly nodes and 70% intermediate nodes (50% carrying nodes and 30% non carrying nodes), 50% elderly nodes and 50% intermediate nodes (30% carrying nodes and 20% non carrying nodes) and 70% elderly nodes and 30% intermediate nodes (20% carrying nodes and 10% non carrying nodes). This percentages are specially representative since they keep a reasonable relation between sender nodes and intermediate nodes.

(2) Message generation interval. This parameter is crucial for the evaluation of the performance of the proposed algorithm. It indicates the time that the simulation waits till new messages are generated. This way, this value handles new messages creation so it is relevant to define realistic intervals that allow the system keep a fluid communication of elders' vital signs. The considered numbers for this parameter are 15 min, 30 min and 1 h.

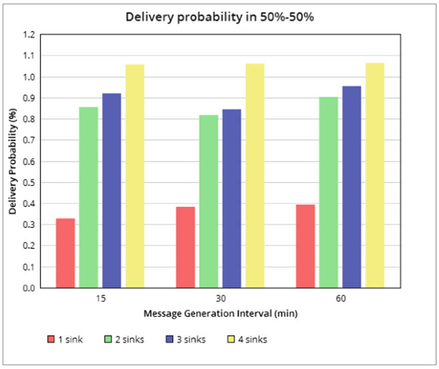
(3) Number of destination nodes. The destination nodes represent the devices in charge of receiving and processing elders' vital signs information e.g. located at the culture centre. For this reason, the number of possible destination nodes is quite relevant at routing performance because the possibility of receiving a message increase when multiple destinations are available. This way, several proportions has been considered at simulations increasing from 1 sink node to 4 sink nodes.

4.2 Performance Evaluation

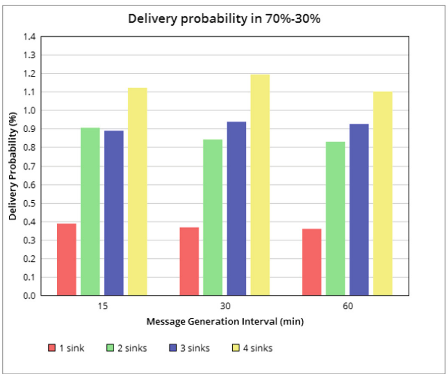
Simulation results are evaluated after running several executions. Two parameters have been considered: delivery probability shown in Fig. 3 and latency shown in Fig. 4.



(a) Delivery probability (30%-70%).



(b) Delivery probability (50%-50%).

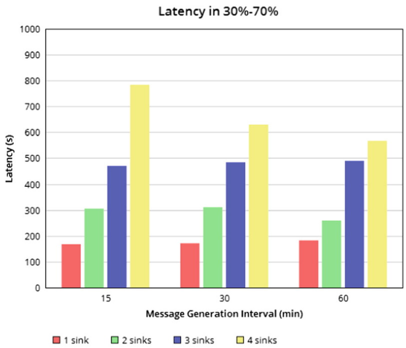


(c) Delivery probability (70%-30%).

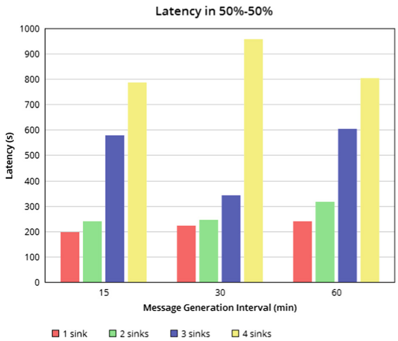
Fig. 3. Delivery probability for different distribution of nodes.

Figure 3 shows all delivery probability results. As can be seen in the figures, a clear pattern can be extracted for almost every message generation interval: the delivery probability increases with the number of sinks. This way, when 4 possible destinations are considered, the best results are obtained.

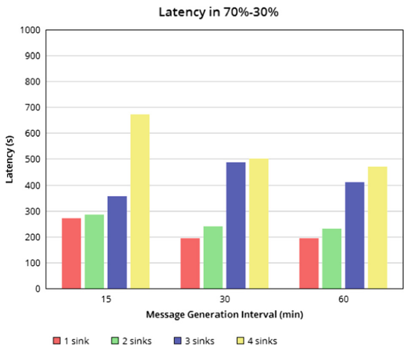
Since delivery probability is the most relevant parameter to analyze, the scenario which represents better results is 70%–30% where it is reached almost 120% of success. This value reflects the relation between received messages and sent messages. Moreover, the value is over 100% due to there are more received messages than originally sent. This happens because modified copies are considered as different messages by the simulator.



(a) Latency in 30%-70%.



(b) Latency in 50%-50%.



(c) Latency in 70%-30%.

Fig. 4. Latency in each simulation.

Latency results are shown in Fig. 4. This parameter is quite relevant in the system since messages contain health information. This way, it is significant to receive the message in a short period of time after it is sent.

Results show how the increase in the number of destination nodes affects negatively to latency. When only one sink is set in the scenario latency decreases but it augments when destination nodes are increased. It is important to appreciate that the best results in Fig. 3 results in with moderate values of latency. This condition is assumed taking into account delivery probability is the most significant parameter.

Guarantee of message reception is a critical aspect in order to consider the proposed opportunistic routing algorithm to be considered as successful. This way, results analysis shows that the routing algorithm works properly in the exposed context. Once several attributes and variables have been studied, some conclusions are drawn in next section.

5 Conclusions and Future Work

Rural areas are specially facing the ageing of population. Society has to deal with this difficult context where factors like isolation and solitude affect dangerously to elders' life. Many elders live alone in their homes without any assistance what can be critical in health emergencies.

Technology can be a suitable solution to the exposed context, providing a reliable option to detect possible fatal emergencies. However, there is an important lack of Internet infrastructure in many rural areas. DTN technology can be an appropriate alternative option. Using this paradigm, this work proposes a system that broadcasts vital signs from elders along the town population in order to reach key points. These destinations are in charge of processing the information and detecting possible dangerous situations. Since health data is being shared along the components, it must guarantee a 100% of success in receptions. This way, the system monitors every time the situation of the elders.

In order to implement the exposed solution, an improvement of [6] algorithm has been developed. The algorithm has been evaluated using The ONE simulator. Several conclusions have been extracted: a 100% of success in receptions is get in several executions with the highest number of considered sinks. Moreover, delivery probability is considered as the most relevant parameter in the scenario, while latency values are assumed to be high.

The work line started in [6] can be extended in future works, by adding features to the internal logic of the proposed algorithm in terms of (i) space information management and (ii) the use of prediction models. Nodes in simulation keep a behaviour based on mobility patterns and vectors. These elements can be taken into account in order to better select potential intermediate nodes, thus improving the broadcasting philosophy and reducing key parameters such as latency or hops number. On the other hand, the use of trained prediction models can improve the performance of the solution. In order to improve accuracy when choosing the destination or an intermediate nodes, models can provide substantial support at elections using historical information. In this way, parameters such as delivery probability and latency can be again improved.

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Earnings from Rehabilitation Nursing Care in People in Intensive Care with Respiratory Disorders Based on a Self-care Model

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Abstract. Background: The increase in the average life expectancy has increased the need for intensive care. In these units people remain under ventilatory support, remaining in bed for long periods. It is up to the rehabilitation nurse to intervene, reducing dependency and promoting self-care, conditioning a better quality of life. Objective: To identify the gains obtained through the intervention of the rehabilitation nurse. Methodology: Exploratory descriptive study following the methodology of Robert Yin's case study and Manuel Lopes's theory of medium range, using the ENCS scale and the Barthel Index as data collection instruments. Results/Discussion: It can be seen from the data analysis that the interventions of the rehabilitation nurse contributed to a functional improvement of the person, reducing dependence on self-care. Conclusion: All persons included in the professional intervention strategy improved functionally.

Keywords: Self-care · Functionality · Rehabilitation nurse

1 Background

Aging is characterized by the occurrence of morphological, functional, biochemical and psychological changes that affect the individual's adaptive capacity, conditioning a greater functional incapacity as well as a greater dependence on DLA's, increasing the demand for health care, namely of the ICU [1]. These units provoked an increase in the survival of the critically ill people due to both the inaugural episodes and the worsening of their comorbidities [2].

2 Main Text

The mean length of hospital stay in an ICU is 6 to 13 days. About 68% of the patients underwent sedation for an average of 2 to 6 days and were subjected to IMV for a mean duration of about 6 to 12 days [3].

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The main objectives of IMV are to maintain correct alveolar ventilation4. However, IMV is not risk-free, and complications may arise about the mechanisms of tracheobronchial hygiene, reduction of thoracic expansion, and mechanical injury to the airways [5].

In recent years several studies have revealed that muscle weakness is one of the main complications of people hospitalized in ICU [6].

More recent studies have shown that symptoms of difficulty in performing ventilatory weaning and generalized muscle weakness, which may lead to situations of muscular atrophy, are referred to as intensive care units acquired weakness (ICUAW) [6]. The ICUAW leads to a significant decay of functionality increasing hospitalization time and associated costs [7], affecting about 25% to 33% of people under IMV for a period of 4 to 7 days [8].

Prolonged immobility during hospitalization may condition a greater degree of dependence at the time of discharge, and the role of RN is to prevent side effects of the physical and cognitive domain that arise from this situation [9].

The intervention of the RN in the ICU is aimed at avoiding respiratory, motor and functional complications. It is therefore crucial to intervene as early as possible, reducing the impact of complications associated with this therapy and prolonged immobility [10].

3 Methods

The study is classified as a descriptive and exploratory study. A qualitative methodology was used based on the theoretical and methodological assumptions of the case study of Robert Yin (2003) in association with Manuel Lopes (2006). As such it was defined as a delineating question: "What are the gains of nursing care for rehabilitation in people with intensive care with respiratory disorders?"

3.1 Goals

The objectives were: To identify the gains of the intervention of rehabilitation nursing care based on the self-care model; Acquire and deepen skills in the provision of nursing care of Rehabilitation to the person in the ICU with respiratory disorders; Define intervention gains from rehabilitation nursing care based on the model described.

3.2 Target Population

The sample can be characterized as a non-probabilistic and convenience sample [13].

Inclusion Criteria: persons hospitalized at the intensive care unit of Hospital Beatriz Ângelo, aged over 18 years, submitted to IMV for more than 72 h, with respiratory pathology diagnosed, with changes in functionality and that are the target of rehabilitation care.

3.3 Data Harvest Instruments

The Elderly Nursing Core Set (ENCS) and the Barthel Index were used. The ENCS de Fonseca and Lopes (2014) has four main concepts subdivided into more items: self-care, learning and mental functions, communication and the relationship with friends and caregivers.

The Barthel Index assesses daily life activities such as feeding, bathing, dressing, urinary and intestinal control, toilet use, bed-to-chair transfer, stair climbing, mobility and personal hygiene, assessing the degree of independence of each person [15].

3.4 Ethical Considerations

The intervention project was submitted to evaluation by the Health Ethics Committee of the Hospital Beatriz Ângelo and a positive endorsement was obtained for the application of the research project.

4 Results

When analyzing the sociodemographic data, we can see that the average age of the participants was 68.7 years, with only 1 person out of the 7 included being of the female gender. Regarding the nationality variable, 100% of the population is Portuguese national. It is observed that about 71.48% of the population is married. The vast majority lives with their spouse and in what refers to the last variable the great majority is already retired (85.74%).

When observing the results obtained in each case it was verified that all obtained functional gains after the RN intervention, however in 4 cases the obtained gains were exponentially smaller when compared with the remaining 3, in this way the group was divided in two of form to be able to compare the gains obtained better.

Regarding the concepts of functionality, group A presented a complete problem about self-care, presented a serious problem in communication and learning and mental functions, with a moderate problem in relation to friends and family. At the level of dependence in DLA's the group had a total dependence. After the intervention of the RN the functionality increased, obtaining a gain of 48.7%. In terms of self-care, 67.5% in communication, 61.5% in learning and mental functions and 29.5% in friends and family. As for the dependence on DLA's, we obtained a gain of 26.2 remaining in a total dependence.

In group B, regarding functionality concepts, it presented a serious problem in self-care, communication and learning and mental functions, in relation to friends and family, the group presented a moderate problem. As for the dependence on DLA's, they had a total dependence. After the intervention of the RN, at the level of the functionality a gain of 64.4% was obtained. At the level of their concepts, gains were observed after the intervention of the newborn with about 71.7% in self-care, 56.4% in communication, 69.7% in learning and mental functions, and 25% in relation to family and friends. Regarding the level of dependence in the DLA's after the RN intervention, a gain of 76.6 was observed, with the group presenting a moderate dependence rate.

5 Discussion

Taking into account the reasons for hospitalization and their current health situation in both Group A and Group B, people had a complete self-care deficit, with a total dependency on DLA's, and it was the nurse's responsibility to ensure their satisfaction until that it can be autonomous in its self-care [16].

Starting with the approach of group A, because of their current health situation resulted in a decrease in functional mobility.

In this context, the interventions allowed the motor functional re-education of these people, focusing on muscle strengthening techniques and maintenance of joint amplitude in order to prevent muscle and tendon shortening [17]. Therapeutic massage was also performed to reduce edema and contractures and the body balance training was performed [17, 18]. These interventions allowed us to recover part of the range of movements using passive, assisted and resisted active mobilization techniques in the final phase of rehabilitation, resulting in an increase in flexibility, reduction of adhesions and muscle contractions, thus maintaining the integrity of functional structures [19].

The maintenance of joint mobility is extremely important for the training of DLA's and consequently for the maintenance of self-care. People were instructed, taught and trained to perform techniques of isometric contractions, active mobilization and resisted mobilizations (using the use of weights, elastic bands and the cycle ergometer) according to the person's tolerance [17, 20]. To improve body balance, the balance training was started in the sitting position and when possible in the orthostatic position.

When analyzing group B, these individuals had a decreased capacity for self-care due to tiredness and dyspnea felt during activities [17], filling in an intolerance to the activity due to respiratory factors and not muscular nature as in group A.

The intervention of the RN has undergone techniques of functional respiratory reeducation associated with energy conservation techniques. The exercises performed included the awareness and dissociation of breathing times, using frenolabial breathing and diaphragmatic re-education before, during and after exercise, or performing DLA's or self-care [17].

About energy conservation techniques, their teaching and training during their self-care was carried out, instructing them to carry out their routine activities in order to reduce their tiredness, encouraging them to perform these tasks slowly and without haste [21]. It has also been given great focus in the positions of rest and relaxation in order to decrease the psychic and muscular tension [5].

Self-care is an activity that implies that the person has decision-making capacity and cognitive abilities are necessary to perform it [16]. Cognitive rehabilitation is especially important in people hospitalized in the ICU because they are cognitively inactive for long periods, with the onset of delirium and confusion common [18]. Thus, the intervention of the RN to stimulate orientation, attention, awareness and memory is central.

In relation to the orientation domain, strategies were used to orient the person alopsychically using the updated information, always referring at the beginning of each session the day of the month, day of the week and hours, and instructing the rest of the team so that whenever they interact with the person to initiate discourse in this way also stimulating the function of memory [18].

The family members were also asked to bring personal objects by stimulating the reconstruction of self-image and memory. One should also encourage family members to address issues of interest to the person by stimulating memory with more personal issues [18].

In order for the person to adhere to the rehabilitation program outlined for it, it is necessary to take into account the psychological factors specific to each person such as personality, self-esteem, self-concept, motivation for recovery and confidence in oneself and the caregiver, believing that it is able to recover [22].

The people in group A were quite unmotivated with their current health status and dependency status being pessimistic about their recovery. Thus, it was necessary to find strategies to increase motivation, these strategies went through the correct control of pain and the establishment of a relationship of trust, having been defining achievable goals in both groups.

The behavioral domain refers to the skills needed to perform self-care in a timely manner and in a way to maintain adequate life and well-being. In this way, the intervention of the RN passed through the provision of strategies for a greater capacity for self-care considering the functional deficits of each person [16].

Interventions were implemented with the person and family in order to educate them through adaptive strategies for self-care, instruction of the use of devices and training with supervision during the use of the same [23].

6 Conclusions

Thus, through the care provided, we managed to achieve sensible gains in rehabilitation nursing care, increasing the general functionality and concepts to which it relates, and consequently improving the level of dependence on activities of daily living [14, 15].

All the people obtained functional improvements resulting from the intervention of the newborn. The ICUAW, despite being a frequent complication in ICUs, if it is diagnosed early, rehabilitation programs may reduce the complications associated with it [17]. Rehabilitation programs are safe and should be implemented early to reduce the complications associated with hospitalization in the ICU, reducing the days of hospitalization and functional deficits of the person [24, 25].

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Monitoring and Management of Chronic and Non-chronic Diseases

A Script for Nursing Intervention on Elderly People with Chronic Pain by Telephone Consultation

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Abstract. Chronic pain is a true problem for, at least, 50% of the elderly people. However, chronic pain in the elderly people is an undertreated and medically devalued situation, since only 20% of those persons take analgesic therapy. Guidelines for nursing intervention on elderly people with chronic pain in medical consultation made by phone have been also omitted from the literature, namely, guidelines supported on a partnership model with the elderly people and family where the Foucault's concept of *Care of the Self* is considered. A script for a systematic nursing intervention based on a partnership model that emphasizes the *Care of the Self* and help the elderly people continuing its project of live was developed and used in the Multidisciplinary Pain Center of a Portuguese's Hospital. The information collected contributed to a better understanding of the difficulties that the elderly people have to manage therapeutic plans, namely the complex ones, and improved the adherence to analgesic therapy, minimizing the chronic pain and the functionality of elderly people.

Keywords: Partnership · Script · Chronic pain · Elderly people · Care of the Self

1 Introduction

Chronic pain is a true problem for, at least, 50% of the elderly people. Chronic pain in these people may have harmful consequences, such as psychological disturbances, functional disability, social isolation, decrease the ability for self-care, and higher probability of institutionalization. This results in higher health costs and over burden the health care services [1–4]. However, chronic pain in the elderly people is an undertreated and medically devalued situation, since only 20% of these persons take analgesic therapy [1].

The Multidisciplinary Pain Center (MPC) of a Portuguese's Hospital provide, since 1995, the opportunity to the elderly people to ask questions by phone to the healthcare team and to get medical opinions on therapeutic plan, in addition to other technical advices. However, the team stated that elderly people followed in the MPC repeatedly

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reported high levels of pain [5, 6]. In view of this, the health team decided to proactively intervene in the control of pain and in the deleterious effects of it, implementing a new approach, called Telephone Consultation (TC). In this approach, the nurses periodically contacted by phone the elderly people and family to increase the adherence to analgesic therapy, control the chronic pain, and promoting *the Care of the Self*. However, guidelines for nursing intervention on elderly people with chronic pain in medical consultations made by phone have been omitted from literature, namely, guidelines supported on a partnership model with the elderly people and family where the Foucault's concept of *Care of the Self* is considered, such as proposed by Gomes [7]. This author developed a study aiming to understand the nature of the partnership in the relationship of care between nurses and elderly patients and concluded that the process of partnership has, as a key condition, the need to see the elderly person as a being of project and care. This condition point out the need of paying attention to the potential development of *Care of the Self*, which involves looking at the elderly patient as more than just a being with needs. Another essential condition that emerged was to have time and space to build a trustworthy relationship.

The structure on which the partnership process underlies has the potential to vary or change the type of action or interaction with the elderly people. Thus, when an elderly patient has autonomy, the strategy for building the partnership process in nursing care results in the construction of a joint action, which aims to enable people to take control of *Care of the Self*. When the elderly patient is dependent and has no autonomy, the strategy includes the construction of an action in which the nurse provides care for the Other, or training the family for doing it. These strategies leads to a more centered care in the elderly, enabling him to have more control over his life plan and health.

2 Objective

The objective of the study presented in this paper was to develop a script for a systematic intervention in nursing consultations made by phone based on a partnership model to help the elderly people with chronic pain in promoting the *Care of the Self*.

3 Materials and Methods

In this study were involved 18 elderly people and 5 expert nurses in pain, who signed an informed consent form. Semi-structured interviews to each nurse and a Focus Group were performed, audio-recorded, and transcribed. The transcriptions were analyzed using a qualitative descriptive approach, involving analytic immersion in the data, reflection, and achieving consensus around themes discerned from transcribed discussions.

After the first face-to-face consultation, 4 follow-up TC were scheduled to each one of the elderly people with chronic pain. The first TC was performed 15 days after the first face-to-face consultation and the remaining ones performed 1 month, 3 months, and 6 months later.

4 Results

The semi-structured interviews and the Focus Group highlighted the importance or the need of organize and systematize the TC so a script was structured in phases and steps in those phases as follows: Phase 1 - Preparation of TC; Phase 2 - Start of TC: step 1 - Engagement; Phase 3 - Development of TC: step 1 - Understanding, Evaluate, and Guide; step 2 - Commitments, to capacitate or to enable; step 3 - Validation of strategies and commitments; Phase 4 - Conclusion of TC. The procedures and guiding questions for each phase and respective steps are presented in Tables 1, 2, 3 and 4.

Table 1. Phase 1 - Preparation of TC.

– Patient process consultation (reading data collected at 1st and subsequent consultations) – Ensure agreement was reached with the patient at the first face-to-face consultation on consent to the consultation and the assessment tools to be used – Ensure yourself-availability – Protecting patient confidentiality and privacy in telephone consultations

The objectives of Phase 1 are the following:

– Provide an appropriate framework for effective TC.
– Know the patient, its health/illness context and the surrounding context.

Table 2. Phase 2 - Start of TC.

Step 1 - Engagement
– The nursing introduces himself to the patient, telling him/her his name, place of work, and communicates the purpose of the consultation. In addition, the nurse recalls the agreement established with the patient in the face-to-face consultation and summarizes the main points of the last meeting/consultation Examples of questions for the nurse proceeding with the TC are the following: *– Are Mrs. X / Mr. Y available to talk?* *– Do you have the therapeutic guide and the assessment tools (the Brief Pain Inventory, pain rating scale) delivered to you and explained at the CMDD in-person consultation?*

The objectives of Phase 2 are the following:

– Build a trusting relationship in a short time.
– Create the best conditions for proceeding with TC.
– Optimize the time for the TC.

Table 3. Phase 3 - Development of TC.

Step 1 - Understanding, evaluate, and guide
Examples of questions for this step are the following: *– Tell me how have you been?* *– Thinking back over the last week, how has pain affected your daily life? (welfare, mood, sleep, walking, socializing, …)* *– How do you perceive the cause of your pain?* *– Do you take the medication regularly?* *– What medication are you taking and how do you do it?* *– Does medication relieve pain? How long do you have not pain?* *– Since taking pain medication have you experienced any changes (or side effects)?* *– Since the last time we spoke, what can you do best in your daily life?*
Step 2 - Commitments, to capacitate or to enable
Examples of questions for this step are the following: *– Among all your problems you told me, which of them worries you the most?* *– How can I help you?*
Step 3 - Validation of strategies and commitments
Examples of questions for this step (*to clarify and explain, if necessary*) are the following: *– If I understood what you told me, does you …?* *– Would you mind to repeat the information I gave you?*

The objectives of Phase 3 are the following:

– Perceive the current problem (evaluate, guide, empower, …).
– Giving time to the person present and explain its/their main problem(s).
– Evaluate the problem, evaluate the patient's pain, adherence and management of therapy, functionality, and capacity to take Care of the Self.
– Validate the problem.
– To capacitate or to enable the patient and family in identifying the problem and strategies for solving it.
– Ensure that guidelines and commitments are clear to all (elderly people, its family, and nurse).

Table 4. Phase 4 - Conclusion of TC.

Examples of questions for this phase are the following: *– Do you have other questions for me?* *– Was this conversation important to you? Why?* After this, the nurse recalls the next consultation date as well as the assessment tools and therapeutic guide that patient must have during the next TC. Finally, the nurse says goodbye and shows its availability if the elderly needs help

The objectives of Phase 4 are the following:

- Evaluate the importance of TC
- Schedule next TC
- Optimize the time four the next TC
- Make records of the conversation and underline the topics/issues which need to be addressed in the next TC

Based on the developed script, 60 programmed TC were performed, encompassing 18 elderly people. Collected information provided evidences that nursing intervention using the TC have to be centered on how each elderly people lives his/her life and manages his/her chronic pain, so as to help them improving as much as possible their health and daily life. The parameters evaluated provide a better understanding of the reasons for non-adherence to analgesia by elderly people, namely the persistence of chronic pain, side effects of therapy, and the difficulty of elderly people in understanding the therapeutic plan.

5 Conclusion

Thus, nursing intervention made by phone must be based on a model where the elderly people's needs are the major health team's concerns, and not only the control of their pain. That model, supported on a relation of partnership with elderly people and family, must promote the Care of the Self and enable, as much as possible, the elderly people with chronic pain to care of themselves and continuing its project's life.

A script for nursing intervention made by phone was designed and used in the Multidisciplinary Pain Center of a Portuguese's Hospital to help promoting adherence to analgesic therapy, minimizing the chronic pain and the functionality of elderly people.

The information collected with the script contributed to a better understanding of the difficulties that the elderly people have to manage therapeutic plans, namely the complex ones, and improve the adherence to analgesic therapy and the functionality of elderly people with chronic pain. To refine the interaction with elderly people and family, helping them to understand how compliance with the therapeutic regimen and rescue therapy are decisive in analgesia, the team will continue to use the script and adapt them based on the analysis of collected information.

Telephone consultation based on the presented script revealed to be a tool to improve adherence to analgesic therapy and the functionality of elderly people with chronic pain. Thus, for future work, it is planned to use the script in other Multidisciplinary Pain Centers.

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A Microservice Architecture for Access Control Based on Long-Distance Facial Recognition

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Abstract. With each new year, the world's population is more aged and the birth rate decreases. That is why, in a not distant future, we will encounter the challenge that there will be many elderly people in our population and few young people to care for them. To help facilitate this task, the use of new technologies is increasing. Therefore, this paper proposes the use of a not intrusive system that, using a microservice architecture and long-distance, non-intrusive facial recognition, allows to control elderly assistance to their daily tasks in residences, facilitating the work of nurses. For example, to check that all the elderly regularly go to the dining room at meal times or to the gym if they should do some type of rehabilitation exercises. For this, the system uses security cameras that are installed in the access of the different zones to be controlled.

Keywords: Long-distance facial recognition · Microservice architecture · Access control · Elderly

1 Introduction

Nowadays, thanks to advances in technology, there are increasingly more advanced biometric recognition techniques [1]. This, in part, is due to the increasing use of these techniques in devices such as smartphones-fingerprint or facial recognition. That is why, each time, these biometric systems are more prepared to be used in any type of devices, without a need for specific equipment or high price [2].

Most of the population in developed countries is formed by elder people (65 years of older). It is estimated that by 2030 this age group may reach 26% of the population [3]. In Spain, since 2012, 75.9% of people over the age of 65 use a mobile phone and, in addition, the use of this device has become a daily habit for them [4].

In order to help this sector of the population, in addition to using biometric systems, more IoT (Internet of Things) devices are used everyday [5]. These devices are connected to everyday objects through the Internet to add new or improved funcionalities to them. Frequently, the elderly tend to interact with

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this type of device without being aware of it. For example, through medical care in intelligent homes, where the main objective of these systems is to have better control over the patient's health care, reducing hospital visits and improving their quality of life. Another example in which IoT devices are used is the intelligent medication service, since the success in the treatment of any person depends to a great extent on taking the prescribed medicines at the right time. Due to this, smart pillbox [6] or even smart pharmaceutical packaging were created. These devices need tecnical skills, since they must be initially configured so that they know how to satisfy their owners needs, for example the time at which the elderly should take their medicines. However, if these needs changes, the devices must be reprogrammed.

Having this into account, we can to take advantage of benefits of biometry [7] to develop a system that allows controlling access to areas of a nursing home. In this way, those responsible for the nursing home could control access to areas such as the dining room, to check that the elderly go it in the meal times; or like the gym, to check that the elderly perform their physical activities in the stipulated period. The use of biometry for recognize people, allows to develop a system where the elderly must not remember to take an external device or identification method (like RFID [8]) to guarantee the working of the system. The recognition of elderly is a crucially part of this system, because the controlled access.

There are many biometric recognition techniques. However, many of them are intrusive, and would require elders to interact with recognition devices, reducing the acceptance of the system [9]. To solve this, we will use innovative facial recognition techniques, which will allow us to identify people who pass through the flow of any camera from away. As it will see across our proposal, the system combine this facial recognition with other technologies like microservices architectures or states machines's implementations.

To present our proposal, the rest of the document is structured as follows: Sect. 2, summarizes the most relevant related works that focus on the use of facial recognition for other use cases. Section 3, details the technological background of this work focusing on the detection of people in an image and the recognition of people, using facial recognition; Next, as a subsection of this, it describes our proposal that highlights the architecture and a short description of each component. Section 4, summarizes the validation phase of the proposal. Finally, in the last section, the conclusions and future works of this paper are shown.

2 Related Works

Different systems can be found in the market that already use facial recognition as a verification technique of a person's identity, for access control. Most of these projects are **monolithic systems**, embedded on a *hardware* device with that is sold, whose biggest problem is that does not allow easy integration of new components or the reuse of components already existing outside the system. In addition, in many cases they deal with **intrusive** solutions, since they require a direct interaction between the user and the face recognition device.

However, the use of facial recognition is not only used for access control, but in the literature, we can find many proposals for systems of public and private organizations that, using facial recognition, make it easier (and safe) the process of identifying a person or client. Some examples, can be the following:

– China, uses facial recognition systems in government organizations, to identify the citizens of the country [10].
– In banks, facial recognition systems are used to verify the identity of people who use credit cards [11], thus avoiding possible fraud. The first of the banks to set up these systems - worldwide - in their ATMs, has been *CaixaBank* [12]. Another bank that uses facial recognition systems for account management is the BBVA bank. The latter allows you to open an account from a mobile device with a single *selfie* or a video call [13].
– At airports, it is beginning to be used to streamline the client boarding process [14]. With this, it is possible to verify the identity of users in a much faster way - and without the need for a boarding pass. It can be, from the examples provided, the one that comes closest to the system that is intended to be developed in this document. In Spain, the Menorca Airport has already launched this system [15].

We can see, thanks to the previous examples, that facial recognition is increasingly used, resulting in a good method of biometric recognition in many cases (taking into account the own dangers derived from using this method if it is not complemented with others, in environments maximum security).

3 Improving the Nursing Homes by Using Control Access Based in Facial Recognition

Taking into account the definition of the system to be developed and the current systems and proposals that use similar technologies, the solution proposal of this paper will begin to be described.

First, we explain which are the most relevant technologies used. Then, the architecture of the developed system is discussed, using the previously discussed and other technologies.

3.1 Technologies for Our Proposal

Each time, machine learning techniques advance more and specialize in the resolution of different types of problems. For the realization of this proposal, we will focus on the study of two problems where machine learning helps us to give a solution.

However, although in the following sections we study how we can detect the presence of people in an image and, following, recognize these people; there are a lot of more technologies that we will study and use for the realization of the proposal described in followings sections of this document. For example, technologies such as NoSQL databases, SQL databases, API REST definition tools, among others, will be used. All of them have been chosen after a study that is not reflected in the present document.

Techniques for Person Detection. The first type of technology that will be used, will be the technology that, for an image, you will be able to know when there is a person in that image or video frame.

For this, we will use an object detector, which allows us to give an image, know what is the nature of the objects that appear in it and the position they occupy. We can see if there is an object of the type "person" in the image, there will be a person (see Fig. 1).

To implement the component, we use a Python machine learning library that, with a trained neural network, it is able to detect several types of objects, among which is the "person" type. We will create an API REST over this library, so that the rest of the components of the system can consume and use it.

Fig. 1. Output of object detector for an image of a person

Techniques for Facial Recognition. With the previous technology, we can already know when we have a person in an image, but we still can not know who that person is. For this, we will use a facial recognizer (in addition, long distance facial recognizer, so that the elderly do not have to interact directly with a device, as we say in the introduction).

In the case of facial recognizers, technology has advanced a lot [16]. First, machine-learning was used (without deep-learning) for the recognition of people, using techniques such as decision trees, for example. However, these methods were not good with problems of "variability" [17]: changing environments, caused by environmental situations, or by the person to be recognized. To try to solve this problem, independent techniques were used that solved each type of "variability" separately. However, it was not a generalized solution.

To solve the deficiencies of the "classic" facial recognizers, deep-learning methods emerged that, using techniques such as convolution neural networks (CNNs), allowed us to create robust facial recognizers that were not affected by variability and did not need extra solutions to each situation of variability. It will be this type of recognizers that we study.

Knowing what kind of technology we were looking for, we researched facial recognition libraries, which simplified the work of developing a facial recognition component. After an arduous task of filtering technologies present in the literature, we were left with two libraries, which we compared in depth, through tests with datasets and stress tests (see Table 1). The others facial recognition libraries were discarding in the information gathering phase, because they had a very poor documentation or the installation process was very complex to opt for them.

After the comparison, we choose the recognizer of Adam Geitgey [18] because, as we see in the table, it allows us to recognize people with a single image of training. In addition, we can see in the Fig. reffig3 how we recognize a person at a long distance with the component that we have developed using it. Other of the advantage of use this recognizer is that we can add persons to the known

Table 1. Comparison of facial recognizers.

Feature	FR Adam Geitgey [18]	FR Cristian Domínguez [19]
Number of people known	It can variate without problems	It limited by the number of neurons of the last layer of neural network that implements
It's necessary re-fit the recognizer when change the people know	No	Yes
Time to fit	Low (encode people knows faces first time)	High
Time to recognize	Medium	Low
Images necessary to recognize	Very few (with 1 we can recognize a person)	A lot
Accuracy	High	We can't determinate precisely with the number of fit images that we have

collection without modify the definition of the neural network (and without need to refit all the neural network with the photos of all know people). The time necessary to recognize is smaller in the Cristian Domínguez library, but the times of Adam Geitgey's library is acceptable too (for this case of use).

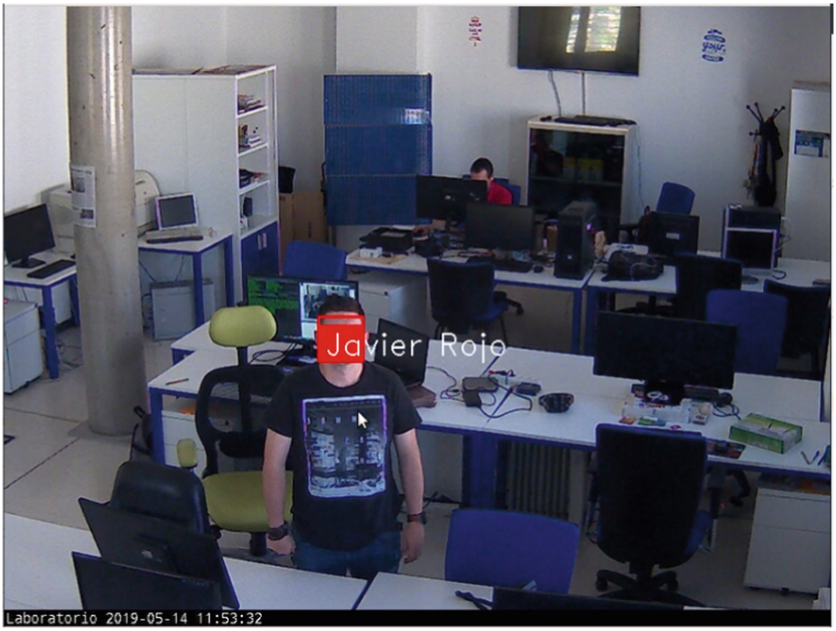

Fig. 2. Output of long distance facial recognizer

3.2 Architecture of the Proposal

With the technologies studied in the previous section and the premises that we expose, we will create a system capable of do the work we proposed in the introduction of this paper. To do this, we developed a microservice architecture, which will be explained below, where components dedicated to the detection of people and identification will be included from the facial recognition of long distance.

One of the biggest challenges, when defining the architecture of a **microservices-based system**, is to know how to define these microservices. That is, to know how many **components** are necessary, without developing components that perform too many tasks or components so simple that they lack meaning on their own.

Based on the description of the solution, and taking into account the previous premise, it has been completed making the following architecture (see Fig. 3), which will be explained below in broad strokes, explaining the work that each component will do.

As can be seen in the Fig. 3, the components have been organized in "layers", so that *each component will use components of lower layers (immediately inferior or not).* In the *red layer*, you can see three components at the same level. This is because they are independent of each other, having only one ("Face Recognition") an internal component ("DB persons"). These **dependencies of use between components**, are represented in the communications of the figure (see Fig. 3). The work of each component is as follows:

- The component "**DB persons**", allows us to store the people recognized by the system, as well as the facial encodings of their faces.
- The "**PyYolo**" component allows detecting when there is a person in an image, but not recognizing it.
- The component "**Face Recognition**" is the one that allows facially recognizing the people detected by "PyYolo".
- The "**DB configuration**" component is used to store the system administration information (access rules, registered cameras and other information). In addition, it also maintains the registry of accesses to each zone.
- The "**State Machine**" component is responsible for executing the actuators and really controlling the access, making use of all the previous components.
- The "**Web Application**" component is the web application with which the administrator (or administrators) of the system can manage the entire system, without computer knowledge.

All these components together, get an architecture based on microservices capable of controlling access to areas and buildings of an organization.

4 Validation

This section talks about the tests that have been carried out on the architecture and its components, in order to evaluate the quality and good functioning of the software developed.

4.1 Validation of the Components

Before integrating all the components of the architecture, specific tests have been carried out on each of the components (starting with the independent ones). These tests have consisted, for example, in visually assessing that the output was corrected - in the case of the facial recognizer - or in verifying the proper functioning of the REST APIs (employing, for example, Restlet Client). Before talking about the tests performed on the complete architecture, comment, a little more in detail, on the tests performed on each component, following the order in which it is developed in the proposed solution.

The more destacable components's test are the test over *Face Recognition* component, where test had employed images where no people appear, one person or more appears. In addition of images of people in different positions, looking for the positions in which they are recognized by the recognizer. Finally, test over fit process was made to add an image for one person, where no person appeared, or appeared several different persons.

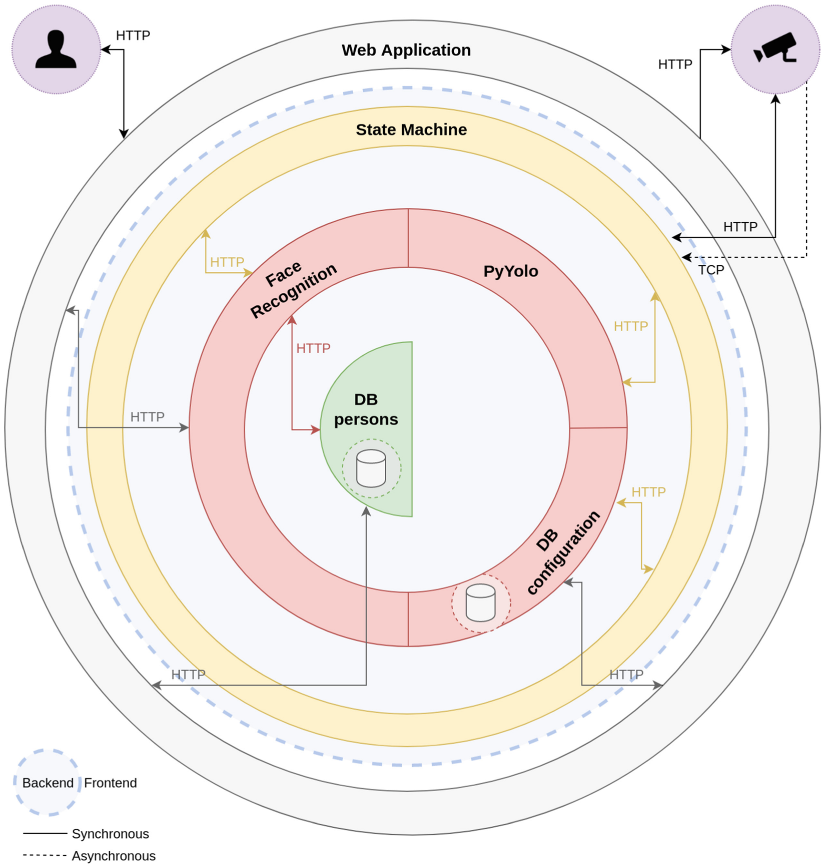

Fig. 3. Architecture of system with communications between components

4.2 Validation of the Architecture

After testing each component and ensuring the good functioning of all of them integrated, tests have been carried out on the entire architecture.

To do this, we add two cameras to an administrator of the system, of two different access's zones. With this, we do the following tests:

- Check operation when a single person entered or left across the camera's zone.
- Check operation when entering or leaving groups of people (from small groups to large groups).
- Check that, in the case of a fall of any component (so the connection at some point could not be made), the system did not registry the entry on the database.
- Check operation when the system integrate the facial recognition (Fig. 4), on both cameras.

With all these tests (and other minor ones, which are not indicated), it was possible to verify that the system works [20], always that the employed camera will had a good resolution.

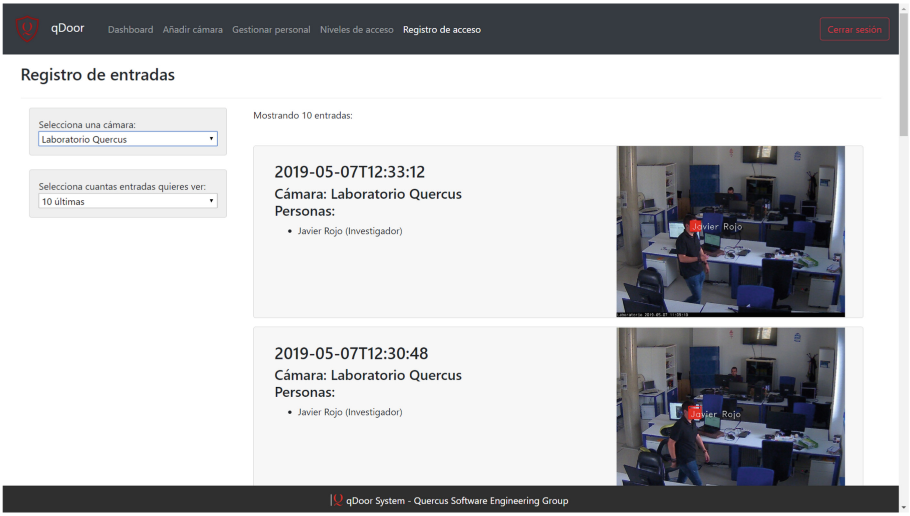

Fig. 4. Capture of the record, after testing within our laboratory

5 Conclusions and Future Works

The developed architecture allows to control the access to buildings, keeping a record of the entrances to the different zones, which will allow us to control if the elderly come to the dining room at meals or the gym, in case of having to carry out some kind of activity physical, in the established schedule.

The use of facial recognition has been correctly integrated with the rest of the system, working properly, provided that the cameras on which the system is running have sufficient quality to recognize people at the necessary distance.

The web application allows the system to be managed by administrators who do not have computer knowledge, beyond interacting with a simple web page.

There is still much work to be done in this project, especially in aspects of security and evaluation of its scalability to an environment with more people than the testing environment where it has been tested. It could even consider its use on homes, in addition to residences for the elderly, in such a way that we promote their independence.

To conclude, and as a personal reflection, after working on this project with microservice architectures, say that the power or advantages provided by this type of architecture, make the fact of programming great architectures (in the present and future) come linked to service orientation. Not in vain can be seen the ease with which we can integrate components with each other (with current technologies), making a system can be much more maintainable and extend its useful life (revising or changing the components that are obsolete, without needing remodel all the architecture).

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Psychomotricity in Elderly People with Hearing Impairment

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Abstract. During life, there are several stages where one of the endings is aging. This aging causes several changes in the motor, physical and cognitive levels. There are several types of aging, such as primary, secondary and tertiary.

During adulthood, there is a gradual hearing loss that intensifies around the age of 50 (presbycusis). These hearing impairments increase with age and can affect 31.6% of elderly people between 65 and 74 years and 62.1% with 85 years or more (data taken from the American population).

Objective: Identify the consequences that these hearing impairments have on the lives of elderly people and the role of psychomotricity and how it can minimize the impact of these impairments on their daily lives.

Methods: A systematic review of the literature was carried out through the EBSCO host (MEDLINE with Full Text and MedicLatina).

Results: Several consequences were found, with emphasis on: "Effects of hearing aids on cognitive functions and depressive signs in elderly people", "Falls in older people: epidemiology, risk, factors and strategies for prevention" and "Application of a computer-based neurocognitive assessment battery in the elderly with and without hearing loss".

Conclusion: Psychomotricity, can then, intervene with these people on an emotional level and even on the level of gait and balance. Therefore, it is an added value for these elderly people to benefit from a psychomotor intervention.

Keywords: Elderly · Hearing impairment · Psychomotricity · Rehabilitation psychomotor · Rehabilitation · Hearing loss

1 Introduction

During life, there are several stages where one of the endings is aging. Due to the increase in the average life expectancy, there is an increase in the aging of the aged (80 years or more), which causes a demographic aging, which translates into changes in the age bracket, something that happens more and more in Portugal. According to INE 2015 studies, between 1970 and 2014, the elderly population increased from 9.7% to 20.3% [1].

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Aging causes several changes at motor, physical and cognitive level. There are several types of aging, such as primary, secondary and tertiary [1, 2].

During the adulthood, there is a gradual hearing loss that intensifies around age 50 (presbycusis). These hearing deficits increase with age and can affect 31.6% of the elderly between 65 and 74 years and 62.1% with 85 years or more (data taken from the North American population) [1].

There's primary aging, which consists of an inevitable process of biological changes that happen gradually and progressively. Secondary aging is an aging process that can result in illness or bad habits that can often be avoided. Tertiary aging is a process where great physical and cognitive deteriorations occur that result from the accumulation of alterations, both of normal and pathological aging [3, 4].

These changes may be at the psychomotor level, which may affect vision and hearing (Pereira, 2018). Hearing loss can lead to the perception that the person is distracted, which impairs their well-being, affecting the people around them, making it difficult to remember what others are saying [5, 6].

Psychomotricity is a non-pharmacological therapy, which uses the body as a mediator and sees the individual, uniting the body to the mind - sees the person in a holistic way. It uses different techniques such as expressive and ludic activities and techniques of relaxation and body awareness, for example.

Psychomotricity is a practice of body mediation that allows the individual to rediscover sensory-motor pleasure through tonic movement and regulation, allowing later the appropriation of symbolic processes, with a strong accentuation of the ludic component [7].

2 Method

A systematic review of the literature was carried out, as Bachion and Pereira points out, translates into a review of studies through a systematic approach, with a clearly defined methodology, presenting as a way of developing the evidence that support for "evidence-based decision-making" [8].

The research was carried out in September 2019, through the database EBSCO-Host - Research Databases. From this scientific database it was possible to access the following databases: CINAHL, MEDLINE, Cochrane Database of Systematic Reviews, Nursing & Allied Health Collection: Comprehensive and MedicLatina, with the descriptors: "nursing", "rehabilitation Psychomotricity" "rehabilitation", "elderly" and "hearing impairment", with the boolean descriptors "and" and "or".

The descriptors were introduced into the database previously referred to in the following order [(elderly)] AND [(rehabilitation) or (rehabilitation Psychomotricity)] AND [(hearing) or (impairment)]. Inclusion criteria were: full text in the English language and publications in the last 8 years (2010–2019). Participants included only adults, preferably in surgical process, articles where Rehabilitation programs were applied in different surgical contexts and with conclusions that presented indicators that are sensitive to Rehabilitation care. Repeated articles and articles prior to 2010 were excluded [8].

The preliminary selection of articles was carried out by reading the title and abstracts. Subsequently, the articles were read in order to answer the question PI[C]O previously established.

The methodological quality of the articles were determined through a critical analysis of the articles, thus, the level of evidence presented was used, according to Melnyk and Fineout-Overhold [8], seven levels of evidence were identified: level I (Systematic Reviews of Literature or Meta-Analysis), level II (Controlled Randomized Studies), level III (Radomization-controlled study), level IV (Case-control study or Cohort study), level V (Systematic review of qualitative or descriptive studies), level VI (Qualitative or descriptive study) and level VII (Opinion or consensus) [9] and Briggs methodological quality evaluation, integrating articles that met more than 50% of quality criteria according to JBI - QARI Critical Appraisal Tools and JBI - MAStARI Critical Apprai-salt Tools [10]. All articles were analyzed by two authors. This way 9 products were found.

3 Results

Table 1 summarizes the articles results.

Table 1. Article Summary:

Title/authors/level of evidence	Goals	Results/Conclusions
Author: 1. Löhler, Cebulla, Shehata-Dieler, Volkenstein, Völter, Walther [11]. Methodology: Experimental Level of evidence: III Participants: Intervention Group 40 (severe bilateral hearing loss); Control Group 80 (normal hearing thresholds)	Evaluation of the use of a battery of neuro-cognitive skills tests in older patients, with and without hearing impairment, using a computer	It was observed that the hearing-impaired population (aged between 50 and 90 years) showed more difficulties than those without hearing impairment, in the field of cognitive abilities, mainly: short- and long-term memory, memory of work, attention, inhibition and other executive functions. It was also concluded that a computerized neurocognitive evaluation battery can help to draw the line between compromised cognitive and auditory abilities An assessment of computer cognitive abilities can help the otolaryngologist or rehabilitation specialist better distinguish between hearing and cognitive impairment In general, participants with hearing loss had a slower reaction time and 50% reduced accuracy. The strongest influence of auditory ability on cognitive capacities was observed in the verbal balancing task. Hearing impairment can have a relatively large impact on verbal fluency and memorization tasks. This may be due to the fact that the transfer of information to these people requires phonological memory, which can be altered by hearing loss in individuals with hearing loss Studies using a hearing-based cognitive training program have shown significant improvements in short-term auditory memory, sustained auditory and visual attention, processing speed, and speech perception in noise. Ferguson and Henshaw indicate that a combined cognitive and auditory training program is the most promising approach, offering generalized benefits to the daily lives of people with hearing impairment. Accurate knowledge about an individual's neurocognitive profile can help tailor rehabilitation programs to individual needs. Patients who are freed from attention problems may benefit from short sessions, while others with prolonged speech processing will require more time in individual sessions

(*continued*)

Table 1. (*continued*)

Title/authors/level of evidence	Goals	Results/Conclusions
Author: Wales, Salkeld, Clemson, et al. [12]. Methodology: Nonexperimental Level of evidence: III	Identify the major causes of falls in the elderly population	Falls, very common in the elderly population, tend to increase at 75 years. In falls, the causes are manifold, being that the most mentioned are environmental, changes in gait pattern, reduction of strength, posture control, balance and reflexes, among others. These declines will decrease the ability of older people to avoid falling. As impaired vision, hearing, and memory associated with age will tend to increase the prevalence of stumbling Problems in gait and balance have many causes and a therapeutic approach can be effective. These problems may arise from a decline in age or deficits in the vestibular, proprioceptive, central nervous, muscular, and other systems There are several possible treatments to prevent some pathologies that can cause falls, such as cardiac dysrhythmias should be treated with antiarrhythmics or pacemakers or Parkinson's that usually responds to a specific therapy. In patients with gait or balance problems there are also specific devices or even training programs to modify frailties and imbalances. However, it is more difficult to anticipate falls where the cause is not identified or are multiple cause, so it is important a careful search and correction of risk factors that may precede the fall such as hearing deficits. In these cases, where medication will not be beneficial, short-term rehabilitation can increase safety and decrease long-term disability
Author: Yurekli, Babademez, Karabulut, Karasen [13]. Level of evidence: V Methodology: Geriatric assessments and MMSE for cognitive performance and a test for depression (GDS) Participants: Group of 34 participants	To investigate sociodemographic and psycho-cognitive factors related to depressive symptoms in elderly people with hearing impairment	Many people with hearing impairment deliberately restrict their own physical activities and social contacts. Thus, hearing deficits will be for many elderly people a type of chronic disorder that will aggravate depressive symptoms, health conditions and performance as a member of society. For the elderly, sensory deficits, especially auditory deficits, negatively affect social interactions, which may lead to isolation and dependence (impair autonomy), which can progress to anxiety and depression The study was carried out with individuals aged over 65 years and moderate to severe sensorineural hearing loss, where the use of similar hearing aids was recommended. And the results showed that there was a decrease in the depressive signs and an increase of the cognitive functions with the use of the auditory devices. Both depression and deceleration of cognitive factors may represent risk factors for dementia

(*continued*)

Table 1. (*continued*)

Title/authors/level of evidence	Goals	Results/Conclusions
Author: dos Santos Baraldi, Castro de Almeida [14]. Methodology: Experimental Level of evidence: II Participants: 211 elderly, with a mean age of 75.24 years, 61 males and 150 females	To verify the degeneration of the auditory system throughout the age through supraliminary measures and auditory sensibility	Auditory alterations in the elderly population range from a decrease in audibility thresholds to significant difficulties in speech comprehension, which leads to the individual developing communication problems, which directly influence their social life. Because of these limitations the sooner the shorter diagnosis is done, the more negative the impact will be on the individual's life A prevalence of bilateral sensorineural hearing loss, with a downward configuration, with greater impairment in the high frequencies (4, 6 and 8 kHz) for both ears was observed in relation to the audiological profile of the population. Concerning the degree of hearing loss based on the average of frequencies of 500, 1000 and 2000 Hz, 32.2% of the participants had normal hearing, 28% had mild hearing loss, and 25.6% had moderate hearing loss, 6.2% moderately severe, 5.7% severe and 2.4% deep Considering the four age groups established (60–69, 70–79, 80–89 and >90 years), the audibility thresholds for the severe frequencies (250, 500 and 1000 Hz) were stable in the right ear, in the first three age groups, showing a marked decline of the threshold only in the age group >90 years. For the high frequencies (2, 3, 4, 6 and 8 kHz), there was a significant decline in the threshold in the 4 established age groups, with a significant difference between the groups for this frequency range, with the age group aged 90 years or older, presented the greatest hearing loss in all frequencies Similar values were observed in the left ear, considering the four age groups studied (60–69, 70–79, 80–89 and >90 years). There was a stability of audibility thresholds for the severe frequencies (250, 500 and 1000 Hz) in the first three age groups, showing a marked decline of the threshold only in the age group >90 years. For the high frequencies (2, 3, 4, 6 and 8 kHz), there was a significant decline of the threshold in the 4 established age groups In the results of the percentage speech recognition index, significant differences were observed in performance in the different age groups studied, with a decline in the discrimination with increasing values of age
Author: Da Luz, Da Silva, Scharlach [15]. Level of evidence: VI Methodology: Experimental Participants: 42 people	To study the benefit obtained with the use of hearing aids	The sensorineural hearing impairment causes problems such as difficulty in understanding speech, in the presence and absence of noise, isolation, embarrassment, decreased social participation and loss in family interaction, severely harming the quality of life and the integration of the individual in society With the use of sound amplification, it is expected a reduction in the restrictions of participation in activities of daily living, since the objective of hearing rehabilitation is to minimize the effects of hearing loss and the difficulty in detecting and understanding the acoustic signal, as well as the emotional and social

(*continued*)

Table 1. (*continued*)

Title/authors/level of evidence	Goals	Results/Conclusions
Author: Knopke, Olze [16]. Level of evidence: VI Methodology: Experimental Participants: Group indefinite	To describe the relationship between cognitive functioning with hearing disorders and cochlear implants (CI)	The success story of CI, an auditory neuroprosthesis, has been described many times. The authors of this paper were able to show the gains in terms of speech comprehension, health-related quality of life (HRQoL), degree of depression, anxiety, stress and tinnitus overload in different age groups. When improvements in speech understanding are measured in the cohort, the question regularly arises as to why patients with comparable audiological input criteria experience different gains with CI Initial explanations suggest that both physical and psychological comorbidities are causally responsible. For example, hearing loss should be mentioned in the case of highly deaf people. In addition to the loss of sensory information with alterations in the auditory cortex, influences on neurocognitive functions of a higher order are still being discussed. This hearing loss also leads to social isolation, which in turn leads to a reduction in HRQoL and an increase in depression scales IIt was observed that reduced cognitive skills preoperatively improve after cochlear implantation
Author: Bruce, Aponte, St-Onge, Phillips [17]. Level of evidence: III Methodology: Experimental Participants: 29 younger adults, 26 older adults, and 32 older people with age-related hearing loss (PARI)	To investigate in an experimental way the hypothesis of cognitive compensation, in which the decrease in hearing function and motor function are compensated by the recruitment of cognitive resources	This study complements the epidemiological evidence relating hearing loss and reduced mobility (Viljanen et al., 2009), and provides new experimental evidence showing competition for common cognitive resources in the context of simultaneous hearing and motor demands, even after correction of individual differences in hearing acuity For the elderly with a slight impaired hearing, this competition for cognitive resources was even more apparent, suggesting that the risk of falls or reduced working memory efficiency could be exacerbated during daily activities. Evidence of the interdependence of sensory, motor and cognitive factors in old age could be used to inform rehabilitation programmes in the areas of physiotherapy and audiology, incorporating cognitive training (Li et al., 2010). Future research is needed to determine whether cognitive training can therefore reduce the risk of falling, particularly in older people with hearing loss
Authors: Stark, Hickson [18]. Level of evidence: III Methodology: Experimental Participants: 131 people, 88 men and 43 women	The present study examined the effect that hearing loss and hearing rehabilitation have on the person with hearing loss and on the quality of life with their spouse	To point out the significant effects that the hearing loss has on the person with the impairment and the spouse, and the effectiveness of the hearing rehabilitation involving the assembly of the hearing aid(s), for both the person with hearing loss and the spouse

(*continued*)

Table 1. (*continued*)

Title/authors/level of evidence	Goals	Results/Conclusions
Authors: Barreto Nascimento, de Oliveira Schiling [19]. Level of evidence: II Methodology: Descriptive-exploratory and quantitative-qualitative research Participants: 29 deaf people	To investigate the perception of deaf adults about communication strategies established with health professionals during care.	Of the participants, 59% were teachers and 41% were students. Age ranged from 19 to 53 years, with 73% having profound sensorineural hearing loss, 86% never attended by a professional who was a sign language, and 45% had given up on care due to communicative difficulties. Among the difficulties in access to health care, 25% pointed to the waiting room, 23% difficulty understanding the professional's explanations, and 23% lack interpreters

4 Discussion

The main objective of Psychomotricity is to promote development in multiple domains (psychomotor, cognitive and socio-emotional), developing the communicative aspect of the body, giving the individual the possibility to dominate his body, to save his movements (because they are more effective), to think about his gestures, thus increasing his effectiveness and harmony, learning, deep down, to (re)inhabit his body. The psychomotricity also allows us to adapt the individual's capacities to the difficulties he presents, helping the person to adapt his life in order to make it more pleasant [12].

Psychomotricity in the elderly allows the stimulation of the psychomotor domain, allowing the elderly to adopt strategies that decrease the probability of falls, relational domain and improve self-esteem (among others), causing him to enjoy this stage of his life with more pleasure and less pain, so that it is lived with more dignity. The possibility of the onset of hearing loss increases with advancing age, and most of the elderly suffer from this deficiency [13, 14].

The consequences of hearing impairment in the life of the elderly can be quite severe, among them the decrease in physical activity and social interaction (family and friends) undermines their quality of life and their inclusion in society [15].

In fact, they may aggravate their health conditions, because the lack of social interaction can cause isolation and dependence, which can result in anxiety and depression disorders [16, 17].

Hearing difficulties in the elderly population may also lead to difficulties in understanding speech, which leads the individual to develop problems in communication, affecting directly their social interactions [18].

Psychomotricity, like other areas of health, must respond to the needs of these patients. However, for this to be possible, further research into psychomotricity and hearing impairment is required. For any therapeutic intervention to be effective, it must be supported by theory. Thus, we can consider that psychomotor intervention in the hearing-impaired population will benefit if there's an interest in knowing more about sensory impairment [19].

5 Conclusions

A large part of that population was never attended by a professional who mastered sign language; we believe that the mastery of this language by the psychomotor rehabilitation technician would be an added value for their intervention, since it facilitates communication with their client and, in turn, allows building a better therapeutic relationship. This domain would complement the psychomotor practice, since this technician dominates communication through body expression.

The results of these studies confirm the relationship between cognitive performance and hearing loss. Processing speed and working memory are among the capacities most affected by aging processes, and working memory is considered responsible for speech understanding. These studies have shown that potential mechanisms for the relationship between hearing loss and cognitive decline/dementia include cognitive load, functional and structural changes in the CNS and decreased social participation. The few articles found on the relationship between cognition and cochlear implantation in the elderly show a significant positive correlation.

We concluded that deafness is a path of great difficulty, as has already been mentioned throughout the work, deafness is a difficulty that also leads to other areas being affected and thus there are other problems such as imbalances and falls, psychological diseases such as depression and isolation, among others.

Thus, the psychomotor intervention should allow the elderly to build a body image that contradicts or minimizes the real existence of a weakened body that has suffered successive losses, in order to acquire a continuity in the reason for its existence. In this way, it will replace suffering, fear or anguish with the pleasure of living.

Psychomotricity can then intervene with these people at an emotional level and even at the level of gait and balance.

There is then a contribution to the affective development of deaf elderly people, promoting emotional integrity, for example, through working with peers. This leads to a decrease in depression and isolation.

There may also be a work at a more motor level, helping to prevent falls, since hearing loss has a major impact on the vestibular system, which helps us to balance.

It is, therefore, an added value for these elderly people to benefit from a psychomotor intervention.

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Early Weaning of People Undergoing Invasive Mechanical Ventilation: The Impact of Rehabilitation Nursing Interventions

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Abstract. Objective: to identify the impact of rehabilitation nursing interventions on early weaning of people undergoing invasive mechanical ventilation. **Method:** a descriptive and cross-sectional pilot study applied to persons undergoing invasive mechanical ventilation in an accidental sample of five people. Modified Borg Scale, Glasgow Coma Scale and Pain Scale were used. **Results:** through the interventions included in the early rehabilitation program, there was an improvement in the dyspnea index, with a direct relation to the success rate in weaning the person undergoing invasive mechanical ventilation. **Conclusion:** the patients included in this study underwent an effective ventilatory weaning process and the extubation procedure was successfully performed, being transferred from the Intensive Care Unit to their destination inpatient services, no need for mechanical ventilatory support. The most significant gains in respiratory function were the gains in symptomatic pain control and level of consciousness.

Keywords: Rehabilitation nursing · Intensive care unit · Invasive mechanical ventilation · Ventilatory weaning · Respiratory functional reeducation

1 Introduction

The concept of prolonged invasive mechanical ventilation (IMV) is defined as the need to maintain mechanical ventilatory support for 21 days or more for more than six hours daily [1].

Ventilatory weaning corresponds to a gradual reduction in ventilatory support, until the need for ventilatory assistance is no longer necessary. This process is considered a priority, considering that, despite being a fundamental technique for maintaining life, it can cause physiological and psychological complications that must be minimized [2]. In this context, it is important to perform early ventilatory weaning, either to promote spontaneous ventilation after extubation or to avoid complications associated with this therapy.

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Overall, for all persons undergoing invasive mechanical ventilation, 40% to 50% of the total time of this ventilatory support is spent in the weaning process [2].

The need for early rehabilitation programs is transversal to several authors [3], and it is recommended to implement strategies to reduce length of stay in the intensive care unit (ICU), increase muscle strength and functional capacity, as well as in decreased duration of effective ventilatory weaning. These strategies should be aimed at ICU patients and aim to improve residual capacity, preventing complications associated with decreased muscle strength due to ventilatory dependence and prolonged immobility. They also contribute to a lower functional deficit after hospital discharge [4].

Respiratory Functional Rehabilitation (RFR) in patients undergoing IMV is appropriate for ventilator preparation and adjustment, intubation, invasive ventilation, ventilatory weaning and extubation [5]. RFR objectives [6] aim at:

– Prevent and correct ventilatory disability and musculoskeletal disorders;
– Improve respiratory muscle functionality;
– Maintain airway permeability;
– Re-educate in the effort;
– Promote ventilatory weaning.

Ventilatory weaning should be a gradual technique and it is essential to observe step by step the adaptation of the person to spontaneous breathing and to the surveillance of signs of tiredness [6].

For effective ventilatory weaning, the reason for mechanical ventilation must be known and normal respiratory stimulation must be present. The patient should have a state of consciousness that allows collaboration and sedative therapy should be suspended. Effective cough reflex capacity should also be present in order to mobilize secretions, and hemodynamic stability should be checked and maintained [5].

The most frequently used methods of ventilatory weaning in the person undergoing IMV include Constant Positive Airway Pressure (CPAP), Synchronized Intermittent Mandatory Ventilation (SIMV) and Pressure Support (PS), as shown in Table 1. Simultaneously, they should be instituted. spontaneous T-piece ventilation periods, which should be associated with RFR techniques, in particular, respiratory muscle strengthening therapy, diaphragmatic rehabilitation, in order to increase tidal volume and promote alveolar expansion and training in airway cleansing techniques, especially through the use of the directed and assisted cough technique [5].

After mechanical ventilation, the objectives of the rehabilitation nursing specialist nurse (RNSN) in this phase of ventilatory weaning are to reduce anxiety and fear, reduce respiratory work, maintain airway permeability, prevent and correct vicious and anti-allergic positions. and focus on stress rehabilitation techniques [5].

Based on the presented assumptions and assuming the relevance of the RNSN role in the development of professional intervention strategies that potentiate the ventilatory weaning process and that are determinant in the optimization of the ventilatory pattern and the restoration of spontaneous ventilation, the following research question emerges:

– What is the impact of Rehabilitation Nursing interventions on the early weaning of people undergoing Invasive Mechanical Ventilation?

Table 1. Main methods of ventilatory weaning [6]

Weaning method	Description
Constant Positive Airway Pressure (CPAP)	The patient controls respiratory rate, inspiratory flow, and the relationship between inspiration and expiration (although the ventilator maintains positive pressure during spontaneous inspiration)
Synchronized Intermittent Mandatory Ventilation (SIMV)	The patient remains connected to the ventilatory prosthesis and progressively reduces the number of synchronized mandatory breaths
Pressure support (BP)	The patient remains connected to the ventilator and the preset positive pressure level is progressively reduced - up to 7 cmH2O
Tube in T	In order to maintain spontaneous breathing, the patient is disconnected from the ventilator and fitted to a T-tube (connected to an enriched oxygen source). If the patient is able to maintain adequate breathing for at least two hours, the weaning process is considered effective and possible extubation is assumed

Assuming the importance of identifying the impact of rehabilitation nursing interventions on early weaning of people undergoing IMV, focusing on respiratory function, we believe that the results of this study may be extremely relevant to reflect on this issue and the skills of these specialists. in rehabilitation nursing in this praxis, and for a comprehensive and excellent intervention.

2 Method

This is a pilot study with a descriptive and cross-sectional approach.

The sample was accidental, consisting of five patients who were admitted to the ICU between September 17 and November 25, 2018, who underwent IMV and agreed to participate in the study.

Inclusion criteria were only patients in whom a rehabilitation intervention plan could be implemented for at least three days, presenting clinical criteria for performing the ventilatory weaning procedure, as well as hemodynamic stability and without contraindications to perform Respiratory Functional Reeducation (RFR).

As data collection instruments, we used the Glasgow Coma Scale for assessment of consciousness level, the Pain Intensity scale for pain assessment and the Modified Borg scale for dyspnea assessment. In addition to these scales, the study participants were characterized in relation to the variables age, gender, marital status, education, medical diagnosis, personal history and methods used for ventilatory weaning.

Data was collected through direct observation in the context of care delivery. Two data collection moments were structured. The first moment before the RFR performed by the Rehabilitation Nurse (RN) (pre-intervention), a second moment after the RFR (post-intervention). Thus it was possible to evaluate the interventions of the rehabilitation program implemented.

For this study, the opinion of the Ethics Committee of the institution involved in the study was requested. Participants were voluntarily integrated into the study after they and their family members were informed about the research and that the data collected would be used only in the study and after signing the informed consent document.

3 Results

The patients were between 48 and 76 years old, with a mean age of 64.2 years. Most patients (3) were male and three were married. Regarding the level of education, predominated people (3) with the 1st cycle of education.

Regarding the medical diagnosis, which motivated the need for IMV, we verified through Table 2 that two patients had respiratory failure, both with COPD as antecedents. In the remaining cases, the diagnosis was hypoxemic pneumonia, septic shock and metabolic acidosis associated with acute kidney infection.

Table 2. Medical diagnosis and personal history

Patients	Medical diagnoses	Personal history
P1	Hypoxemic pneumonia	Hyperuricemia, dyslipidemia and high blood pressure
P2	Accute breathing insufficiency	Smoking COPD, hypertension, dyslipidemia, left knee total prosthesis (2014)
P3	Septic shock	HIV infection, diagnosed in 2015, had splenectomy
P4	Accute breathing insufficiency	COPD, dyslipidemia, high blood pressure, and congestive heart failure
P5	Severe metabolic acidosis and acute kidney infection	Ischemic stroke (2016), diabetes mellitus (Type II), high blood pressure, dyslipidemia and COPD

Regarding the patients who were included in the sample, three of them did not have hemodynamic instability criteria that made the ventilatory weaning process impossible in the first 72 h of ICU stay. Rehabilitation nursing strategies were initiated, adjusted to each person in order to successfully perform ventilatory weaning and subsequent endotracheal extubation. Two patients had hemodynamic stability conditions favorable to ventilatory weaning, after 72 h of hospitalization.

Through respiratory functional rehabilitation interventions, the ventilation/perfusion ratio and airway permeability were improved, and mobilization and secretion elimination techniques were promoted. The use of Motor Functional Reeducation (MFR) interventions associated with Respiratory Functional Reeducation techniques has improved mobility and effort readaptation as well as patient adaptation to the ventilator to achieve arterial gas improvement and total reversal, or partial, of the cause that motivated the use of invasive mechanical ventilation, enhancing the weaning process. Ventilation modalities were varied, being evident from Table 3, the importance of the rehabilitation nursing strategies implemented in the evolution to the ventilatory weaning process.

Table 3. Ventilatory weaning methods used

Patients	Initial evaluation	Ev. after RN strategies
P1	Invasive Mechanical Ventilation, with Vent Pressure Support mode	– Placed in T-tube (2nd day of RE), with oximetries in the order of 96–98%. Endotracheal extubation after two hours of hemodynamic stability
P2	Invasive Mechanical Ventilation, with Pressure Controlled Ventilation Mode	– Ventilating prosthesis in support pressure mode (3rd day of RN); – Placed in T-tube (6th day of RN), with oximetry values in the order of 96%. Was extubated after two hours of T-tube tolerance
P3	Tracheostomized, with Invasive Mechanical Ventilation with Support Pressure Ventilation	– Closure of tracheostomy for short periods (5th day of RN), with O2 delivery at 5 l/min by nasal probe and 99–100% oximetry; – Connection to IMV in CPAP mode at night (9th day of RN); – Closure of tracheostomy tube without adaptation to ventilatory prosthesis (10th day of RN)
P4	Invasive Mechanical Ventilation with Synchronized Intermittent Mandatory Ventilation	– Ventilation in assisted ventilation mode (3rd day of RN) for 48 h and gradual reduction of O_2 supply – Placed in T-Tube (5th day RN) and extubated later
P5	Invasive Mechanical Ventilation, with Pressure Controlled Ventilation Mode	– Ventilatory prosthesis in Support Pressure mode (10th day RN), with 100% O_2 saturation – Placed in T-tube (15th day of RN) and with oximetry in the order of 97%, without oximetric aggravation, so after two hours it was extubated

Through Table 4, we found that in the entire sample it was possible to acquire neurological status compatible with spontaneous ventilation (applying the Glasgow Coma Scale). Patient P5 was the only one who did not reach the maximum score in the final evaluation, considering that despite presenting spontaneous eye opening and following simple orders, he maintained periods of confusion in the verbal response.

It is emphasized that three patients in the final evaluation had no pain. Patient P3 had mild pain (2) associated with a process due to immobility and muscle weakness, and patient P5, whose pain intensity (1) was not rated as significant.

Thus, it was found that in the entire sample it was possible to perform ventilatory weaning and safe and effective extubation decision, and a significant improvement in the dyspnea index assessed by the Modified Borg Scale was documented. In the final evaluation, although an improvement in the values of this scale was evident, patient P2 still had a severe dyspnea index (5) and patient P3 had a mild dyspnea index (4).

Table 4. Assessment of Glasgow Scale, Pain Intensity Scale and Modified Borg Scale

Patients	Glasgow Coma Scale		Pain Intensity Scale		Modified Borg Scale	
	Initial Ev.	Final Ev.	Initial Ev.	Final Ev.	Initial Ev.	Final Ev.
P1	11	15	2	0	5	2
P2	12	15	0	0	8	5
P3	12	15	3	2	5	4
P4	15	15	1	0	9	2
P5	10	14	3	1	7	3

4 Discussion

In the context of the discussion of the results obtained, the impact of Rehabilitation Nursing interventions on early weaning of people undergoing invasive mechanical ventilation was analyzed, based on the descriptive utterance categories of the Specialized Rehabilitation Nursing Care Quality Standards Regulation [7].

Functional Reeducation

For the patients included in this study, and as previously mentioned, four of the patients started the rehabilitation program within the first three days of ICU stay. According to the clinical situation, RN strategies involving RFR were devised in order to wean as early as possible, but also the motor functional rehabilitation (MFR) aiming at maintaining/recovering/improving their physical capacity, enhancing the attainment of a globality of factors that would allow a decrease in ICU stay and consequently the period of hospitalization, with attenuating evidence of functional disability at the time of hospital discharge.

The patients who participated in this study had the potential to participate in the rehabilitation nursing program [8], given that there is evidence of increased motor functional capacity [9] and respiratory functional capacity, with improvement in ventilatory performance and favorable conditions of an effective ventilatory weaning [3].

As the five sample elements, as provided for in the inclusion criteria, were subjected to IMV, RFR interventions were designed to:

– Promote synchronization and ventilator adaptation (positioning techniques with promotion of thoracic and diaphragmatic expansion, breathing control techniques and respiratory rehabilitation exercises);
– Improve ventilation/perfusion ratio (flexibilization exercises and increased chest expansion);
– Maintain airway permeability (deep breath training), promoting mobilization and elimination of secretions (postural drainage, accessory maneuvers, cough reeducation techniques);
– Prevent and correct vicious and antalgic positions (postural correction, osteoarticular mobilization and selective and global costal opening).

Interventions were also performed with the objective of improving mobility, strengthening and readjustment to effort (through postural correction, passive and active mobilization, balance training and lifting, gait training, use of cranks, among other support devices).

RFM interventions were also delineated involving positioning techniques, mobilization of the body segments involved in ventilation, thus minimizing the risk of disability of the adjuvant breathing muscles.

After the application of these interventions, and by analyzing the data obtained, it is possible to verify, in addition to the data presented above, that the mean time of IMV to which the sample was submitted was eight days, in which two patients had a lower hospitalization than ten days, and effective ventilatory weaning was performed in less than seven days; one patient was hospitalized within ten days and underwent IMV for eight days. It is noteworthy that two people had need to maintain IMV for more than ten days (one specific patient was only included in this study at the 31st day of hospitalization).

The implemented strategies allowed the reduction of the dyspnea index (evaluated in the modified Borg Scale) in all patients who participated in this study.

Functional readaptation

Since one of the inclusion criteria is evidence of need for IMV, at baseline all patients had significant changes in dyspnea index on the modified Borg scale, where one patient had a dyspnea index 9 (very, very severe), two patients with very severe dyspnea and the other two with an index of 5, corresponding to severe dyspnea.

At the time of the initial evaluation, and after evidence of criteria for ventilatory weaning, interventions were designed to allow effective, efficient and safe performance. These interventions were based on the prevention and correction of ventilatory incapacity and musculoskeletal alterations, focusing on the promotion of respiratory muscle functionality and maintenance of airway permeability, thus acting on stress re-education and thus promoting ventilatory weaning.

Through rehabilitation nursing interventions, including different types of mobilization, early lifting, strengthening of respiratory muscles, respiratory training and airway clearance, it was possible to shorten the time needed to maintain IMV, also witnessing a success rate in ventilatory weaning, which in itself conditions the ICU stay [10].

Early implemented rehabilitation nursing strategies are feasible, safe and effective [11], resulting in a significant increase in functional capacity that will enable a period of clinical stability to be initiated [3] and reducing the risk of maintaining and/or to restart the IMV for a period of time greater than seven days, which leads to a significant ventilatory weaning success rate [12].

Complication Prevention

In the selected sample, and in an initial assessment, four patients with variations in the Glasgow Coma Scale were identified, all patients showed significant changes in the dyspnea index assessed by the modified Borg Scale and four manifested pain, also assessed by previously selected scale (Pain Intensity Scale).

During an acute condition, and referring to the patient in need of IMV, it is common to see processes of neuromuscular atrophy, neuromuscular dysfunction and paralysis of the musculoskeletal system, due to prolonged hospitalizations with inevitable associated immobility [12]. To ensure the prevention of this type of complications, priority was given to the implementation of early mobilization rehabilitation nursing strategies, whose gains were reflected in the maintenance of the previous motor functional capacity [12].

Scientific evidence points to shorter hospital stays in patients in a rehabilitation program, where they also perform the first lift in less time [8]. Thus, by establishing intervention strategies for critically ill patients, expanding the mobilization and training approach, the functional risk is reduced [13], as well as the consequences associated with immobility and commonly associated with the patient undergoing IMV [3].

Through the implementation of RFR techniques, which included the prevention and correction of ventilatory disability and musculoskeletal disorders, the improvement of respiratory muscle functionality, the maintenance of airway permeability and effort reeducation exercises, it was possible to achieve a 100% success rate in the ventilatory weaning process, in which all patients included in the sample were effectively and efficiently extubated without the need for endotracheal reentubation and IMV. Patients who underwent this set of interventions had a shorter hospital stay, with a small percentage of patients experiencing permanent changes or death [13].

Well-being and Self-care

The outlined interventions were crucial for optimizing and/or re-educating motor, sensory, cognitive and cardiorespiratory functions in order to promote well-being and ensure their quality of life. In addition, having contributed to the reduction of the time required for invasive mechanical ventilation and consequently hospitalization in the context of ICU [8], were crucial in reducing complications associated with immobility [10]. These data suggest increased functional capacity and improved functional performance at discharge [8]. However, given the context in which these intervention strategies took place, the functionality of these patients and the speed with which their ICU transfer/exit occurs after ventilatory weaning, and the difficulty in implementing some self-care promotion techniques, there are no guarantees for a consistent assessment of a person's functional capacity at discharge (at the ICU).

Through the rehabilitation nursing strategies initially defined and adjusted to the needs of the patients included in the sample, it was possible to symptomatically reduce the initial cause that motivated the IMV in all patients, and for three patients a dyspnea index was reached with compatible values. with the expected autonomy capacity for the current care context (in this specific case the ICU). Strategies to prevent changes in functionality have been instituted, but for the above reasons we have difficulty assessing their impact on each patient's self-care ability at ICU discharge.

5 Conclusion

In summary, at baseline, four of the patients had quantifiable changes in the Glasgow Coma Scale, four had pain, and all showed significant changes in dyspnea index when applying the Modified Borg Scale.

After the development of rehabilitation nursing strategies, which included RFR and RFM interventions, focusing on interventions that promoted successful ventilatory weaning, it was found that four of the patients reached a state of consciousness compatible with a score without changes in Glasgow Coma Scale.

Regarding the Pain Intensity Scale, all patients experienced improvements in pain intensity, and three of these patients were transferred from the ICU with a zero-intensity pain record.

With regard to the dyspnea index assessment, all patients who participated in this study underwent an effective ventilatory weaning process. All patients were successfully extubated and transferred from the ICU to their destination inpatient services without the need for mechanical ventilatory support.

Thus, the most important gains in respiratory function were the gains in symptomatic pain control and level of consciousness.

It can be concluded that the timely rehabilitation nursing strategies, with interventions designed according to the clinical situation and adjusted to the hemodynamic conditions of the critically ill, proved to be safe, effective and efficient in obtaining respiratory and motor functional gains. These gains will influence the rehabilitation process and subsequent health gains.

From this study emerges the need for valorization by health institutions of the RNSN competences in the early weaning of people undergoing invasive mechanical ventilation.

In order to enhance RNSN training, it is necessary to include training plans in the context of Intensive Care Units in order to optimize the intervention of this specialist in ventilatory weaning to critically ill patients.

The consistency of the results obtained is insufficient due to the small number of people who participated in the study and the type of study, with limited time period for its development.

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Health Interventions to Support Caregivers of Elderly People

Towards an Automated Management of Well-Being Goals in Nursing Homes

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Abstract. Nursing home culture change movement advocates for care that is less hospital-like, and more patient-centered. Despite being a step towards the good direction in providing a proper service for elderly people, considering their well-being is not easy due to a number of factors as: specific treatments with a high price; the number of involved stakeholders (e.g. patient, doctors, relatives, nursing home clerks, funding organisations, etc); or the difficulties to gather an accurate measure for the patients well-being. In current position paper we devise some potential challenges that arise in this context and we provide our insights on potential techniques to solve them by means of a framework to automate the management of well-being goals in nursing homes.

Keywords: Well-being · Nursing-homes · IoT · Analysis

1 Introduction

The Nursing Home (NH) culture change movement is a grassroots effort that began around the turn of the century and advocates for care that is less-institutional, less hospital-like, and more patient-centered [1]. Despite the efforts and the best intentions, focusing the well-being of NH residents and their families remains a challenge for many reasons, including the need for coordinating a large number of people with different formal and informal roles (e.g. patient, doctors, relatives, NH clerks, etc), the lack of staff and resources in most NHs, the difficult medical conditions of the residents and the high costs involved in their care.

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As an example, the monthly increase in price for residents with Alzheimer or other types of dementia ranges in the US from $3,165 (in Idaho) to $5,800 (in Maine) [2]. Such costs cover the many additional care activities such as: memory care at nights (e.g. calming down when they are affected by the sleep dysrhythmia), sensory stimulation (e.g. watching or listening to preferred films or songs, respectively), as well as any other evening activities helping to reduce the sleep problems like walking outdoor trough green areas.

In such a scenario, NHs face many challenges in managing and ensuring the well-being of elder patients: (i) how to establish the proper services considering the different actors and their responsibilities? (Ch1); (ii) how to keep costs to a level that is sustainable for institutions and families? (Ch2); (iii) how to measure the residents well-being accurately and ensure that the data collected are accurate? (Ch3); and how to control the evolution of patients well-being? (Ch4). In order to face these challenges, in this position paper we propose the notion of Well-being Goals (WG) that are established by involved participants (nursing homes, patients, doctors and relatives) as first-class citizen that would formally state the explicit actions and metrics for a given patients in order to ensure its medical and well-being needs.

As potential benefit, WG would represent an appropriate framework to have a tailored set of services depending on each patient: for example, if a patient does not require assistance during meals then they may be entitled to a discounted rate. In addition, governmental or private organizations may establish specific goals within the WG in order to provide funds.

From an operational point of view, the price of specialized services affecting the patient well-being is typically high since they involve special care and monitoring (e.g. nurses have to manually perform several actions [4] as: record when a patient has a sleep dysrhythmia; control the heart rate meanwhile an exercise is taking place; or the participation in a social event). However, nowadays there is a plethora of Internet of Things (IoT) devices that may help measuring the elderly medical well-being meanwhile mentioned services take place and many techniques have been proposed [3]. For instance, bracelets tracing geolocalization and hearth rate, glucometers to measure if a proper diet is being applied that is specially interesting for diabetes patients, etc. These connected IoT devices would generate automated events log avoiding manual measures of nurses and therefore reducing the price of these services and thus facing aforementioned second and third challenges (e.g. assuming an average salary of €34k[1] and a reduction of 0.5 h/day; the cost would be reduced in more than €2k/year per worker). Furthermore, having these events logs available the fourth challenge would be faced by both: an automated checking of WG compliance, and developing dashboard with the WG compliance status that would be very appealing for nursing home managers (e.g. to control staff duties), doctors (e.g. to change current treatment when appropriate) and even it may ease sending monthly reports to relatives (e.g. to inform on the patient well-being).

[1] https://www.payscale.com/research/IE/Industry=Nursing_Home/Salary.

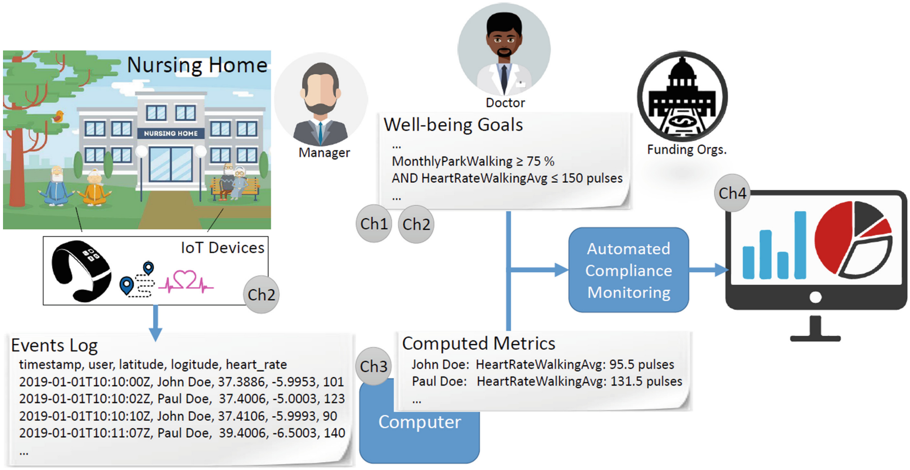

Fig. 1. Outline of our approach to face the challenges

Following our expertise in the automated management of Service Level Agreements (SLA) [5–7], including monitoring, compliance analysis and enforcement, our hypothesis is that WG-IoT-based gerontechnology may not only help assess the evolution of a patient by doctors and nursing home staff, but also to make specialized services cheaper, and possibly even facilitate the involvement of the residents' family in the care process if they are willing and able to do so.

The paper is structured as follows, Sect. 2 exposes how we propose to measure and compute the required information to monitor the patients welfare (c.f. Sect. 2.1); and how we propose to monitor and show the services compliance (c.f. Sect. 2.2). Finally, we outline the conclusions in Sect. 3.

2 A Framework to Automate Well-Being Goals Management

Current section exposes the elements depicted in Fig. 1 proposed to face in further research the aforementioned fourth challenges. Thus, In Sect. 2.1 we face challenges Ch1, Ch2 and Ch3, and Sect. 2.2 faces challenge Ch4.

2.1 Well-Being Goals

Our vision of WG goes beyond a simple list of well-being goals for the patients. WG must refer to specific services with three main features facing Ch1 and Ch2: (i) they are specially interesting and important for the patients well-being, from the perspective of their doctors and relatives; (ii) they can be automatically measured with connected IoT devices, and (iii) They must include responsibilities of the involved participants.

A WG could include as one goal the goal included in Fig. 1: "*MonthlyParkWalking* $\geq$ *75 % AND HeartRateWalkingAvg* $\leq$ *150 pulses*" that is defined on both: the percentage of park walkings performed at a month; and the monthly hearth rate average in park walkings. Note that these metrics are related to the health-care aspect of the patients well-being, because it is not easy to find existing IoT devices retrieving information in other aspects of the patients well-being as mood or depression. Nevertheless, there are methods such as "Beck Depression Inventory (BDI)" [10] in which it is indicated how to measure these other aspects of the well-being. Although as far as we know such a method cannot be directly applied with IoT devices, a first step can be the parametrization of mood and depression through smartphones or any other applicable IoT device.

In addition, the multiparty responsibility should be established and this could be solve by using Responsible-Accountable-Support-Consulted-Informed (RASCI) matrix in a similar solution as provided in business processes [8].

Technology can help reduce the cost of monitoring health and well-being indicators, which in turn can help reduce costs (Challenge Ch2). For instance, as Fig. 1 shows, a variety of sensors can collect information about location, heartrate, blood pressure and more, and relay this information without the NH staff having to enter such information manually. This is a huge advantage for NH staff, both because it saves precious time but also because it prevents errors and omissions - provided of course that sensors are accurate and properly used. Note that we propose reducing at most interactions between elders and IoT devices being the staff member who perform required actions at the end of the day, namely: (1) set them up as required, or (2) charge the batteries, between others. The challenging part here is in identifying those sensors that are easy to maintain and operate, otherwise they became a headache instead of a resource.

Once sensor measures are available, then it also becomes easy to transform data (e.g. filtered by patient and gathering a mean value for computed metrics in Fig. 1) into adherence to goals (Challenge Ch3).

Additionally, in further research we will explore how to ensure the unalterability of the data involved in the NH services that is inputted in the NH information systems by different actors such as doctors or nurses. We devise the potential application of blockchain and smart contracts technologies as performed by Dumas et al. for BPMS in [9]. However, it is an open research question how the smart contracts could include the RASCI matrix and well-being goals.

2.2 Well-Being Goals Tooling

Once metrics are computed from the events log, we propose the usage of automated techniques developed in the context of SLAs for iAgree [7] in order to monitor the WG compliance. That compliance provides information regarding the fulfillment of nursing homes with the goals on the welfare services they provide for an specific patient.

In such a context, based on the operational framework of WG Analysis an appropriate tooling can be developed to assist the different stakeholders (Challenge Ch4). As depicted in the mockups of Fig. 2 we can see three different

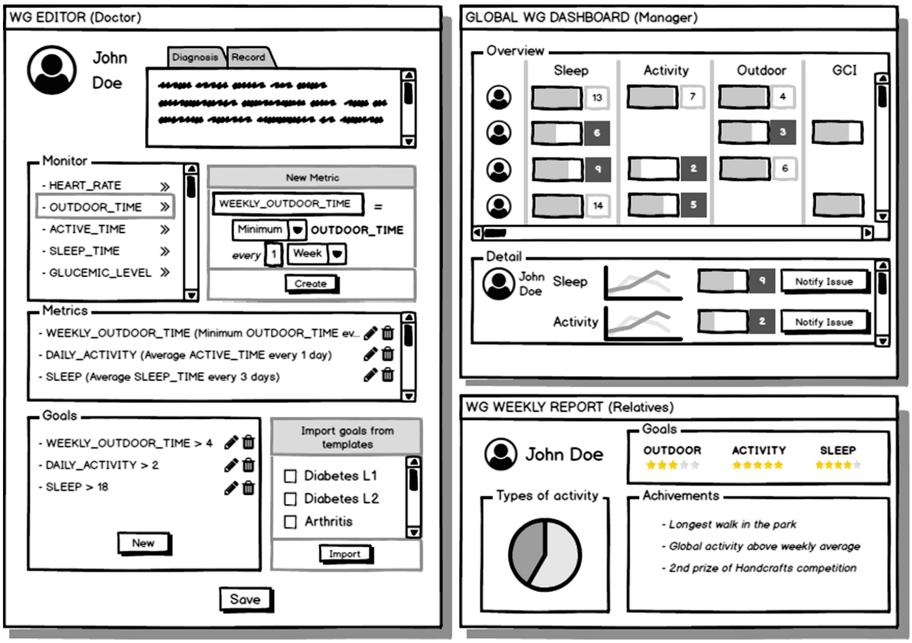

Fig. 2. Mock-up of supporting tooling

views: the doctors would edit the appropriate WG for a given patient (left view at the figure) specifying their tailored metrics and goals or import some standard templates for different conditions; the nursing home manager (top-right view at the figure) could control the different goals of the patients and report problematic situations; finally relatives (bottom-right view at the figure) could have an high-level overview report of the goals and achievements of their elders. In this context, it is important to highlight that this approach also paves the way to additional dashboards for the Public Administrations in a regional level so they can have a detailed information of center operation and subsequently address a better decision-making concerning funds and/or resource allocation.

3 Conclusions

Our hypothesis is that using WG-IoT-based gerontechnology as we propose could benefit the health-care related well-being of patients in nursing homes with: (i) Ad-hoc services guaranteed by the nursing homes that improve the patients well-being and ease decreasing cost avoiding to pay for unnecessary services. (ii) Reducing working time of nursing home workers by the use of connected IoT devices that may help reducing the price to pay for the service. (iii) WGs established by all participants, namely doctors, nursing home managers, and even funding organisations. (iv) Dashboards to control the services compliance that is available and useful for every participants in the patients well-being: doctors, relatives, and nursing home managers. (v) A doctor could adapt the WGs by means of an analysis of how metrics captured by IoT devices are evolving. For instance, if the average of heart rate of a patient is increasing compared with previous months, thus the doctor could adapt the WG by reducing the allowed value for the average heart rate in park walkings.

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Study of Accessibility to the Home of Dependent Elderly People in Rural Areas

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Abstract. Increasing numbers of dependent people are estimated in rural areas due to increased life expectancy. Most of the population residing in rural areas is elderly, which is why many of them are in a situation of dependency. The objective of this study was to analyse accessibility and barriers present in the home and environment of 30 users of the dependency system living in rural areas of an area with high geographic dispersion. For the study, home visits were conducted, and the data were obtained through interviews and observations. Information was gathered regarding the sociodemographic and clinical variables of the users, as well as the present barriers and the use of support products, assistive technologies and sensors, either in the home environment and/or in monitoring systems of body movements. The average age (standard deviation) of the sample was 85 years (±6.7). The majority of users (n = 17, 56.7%) had degree II or III dependency. A total of 56.7% of the users used call-for-help telecare devices without knowledge of other types of systems. All users presented comorbidity. The use of support products and the presence of barriers were frequent.

Keywords: Accessibility · Dependency · Barriers · Support products

1 Introduction

Accessibility is a fundamental characteristic of built environments that makes it possible to arrive, enter, exit and use spaces [1]. An important aspect that interferes with the functioning of a dependent elderly person is accessibility [2]. The state of a home can allow, or not allow, users to perform activities autonomously. In our country, the set of conditions of comprehensibility and usability that must be met by the environment, spaces, buildings, etc. so that all people can use and enjoy them safely, comfortably and in the most autonomous and natural way possible are regulated by each autonomous community; however, accessibility in buildings under a horizontal property regime is regulated by a state norm [3], which leaves the decision to carry out works or establish new common services that remove architectural barriers that hinder people's access or mobility

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in the hands of neighbourhood communities. This regulation does not affect single family homes; however, since 2017, home-owner associations should comply with universal accessibility requirements [4]. Even so, only 1% of homes in Spain meet the required conditions of accessibility for people with reduced mobility or disability [5].

These barriers not only pose an obstacle for the users but also for their caregivers and family members because in many cases, the barriers hinder the help and care that they are to provide [6]. Furthermore, a highly geographically dispersed population implies a negative impact on access to health services [7]. As the distance between places of residence and health centres increases, the use of health services decreases [8].

The "dependency law" [9] created the Spanish framework for the promotion of autonomy and care for dependents, a set of services and benefits that aims to ensure personal autonomy as well as the protection and care of people in a situation of dependency through duly accredited public and private subsidized services. The normative development of this law involves applying scales to assess the state of dependency [10]. This assessment includes the completion of a questionnaire by interview and observation by the people who request it. The assessment is carried out by specifically trained personnel who collect data related to the ability to perform basic tasks of daily life as well as the need for support and supervision, the type of help needed and the frequency of required help, establishing a score corresponding to a degree of dependency ranging from "no dependence" to the highest degree of dependency possible, "grade III" [10].

The loss of autonomy can be aggravated by the physical or social conditions of the environment, i.e., architectural, transportation, ecological, communication barriers, or simply barriers of attitude or rejection, as well as by interactive barriers [11], which imply, among other issues, difficulties in the use of information and communications technologies (ICTs). The use of specifically designed technology could have a positive influence on the autonomy and self-care of individuals. Thus, the use of assistive and sensing technologies in the home environment and/or systems for monitoring the body movements of people has been shown to increase the sense of security in the home [12].

The objective of this study was to analyse the characteristics of accessibility and barriers in the home and surroundings and the use of support products and technology by elderly people in situations of dependence in rural areas with high geographic dispersion.

2 Materials and Methods

Using convenience sampling, 30 dependent individuals were selected; they were residents in a rural context in areas of high geographic dispersion in Extremadura, Spain. Specifically, 16 municipalities from the province of Cáceres belonging to the Tajo-Salor Commonwealth and Sierra de San Pedro region were visited. For the data collection, interviews and direct observation of the participants' environment were carried out. Data collection was performed using an ad hoc questionnaire that included the collection of sociodemographic and clinical variables, the degree of dependency, barriers, support products used, the presence of family/informal support, and the use of assistive technologies and/or sensors.

The data collection was carried out with the consent of the study participants and in compliance with the Declaration of Helsinki, respecting at all times the anonymity of the participants through anonymous questionnaires according to the Organic Law 3/2018, of December 5, on the Protection of Personal Data and Guarantee of Digital Rights.

The data were analysed using IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY (IBM Corp. software, released 2016).

3 Results

For the 30 individuals interviewed, the age range was between 71 and 101 years, with a mean age and standard deviation (SD) of 85 (±6.7). The majority were women (n = 19, 63.3%). The most frequent marital status was "Widowed" (n = 17, 56.7%), followed by "Married" (n = 11, 36.7%) and "Single" (n = 2, 6.7%). Each individual had more than one pathology; the most prevalent illness were mild cognitive impairment (n = 14), followed by atrial fibrillation (n = 10), pulmonary hypertension (n = 7), knee osteoarthritis (n = 7), chronic obstructive pulmonary disease (n = 7), moderate cognitive impairment (n = 6), hemiparesis (n = 5) and, less frequently, illness such as diabetes, osteoarthritis, and heart failure (n = 4) and, in 3 or fewer individuals, kidney failure, loss of visual acuity, hip prosthesis, hypoacusis, depression, osteoporosis, dyslipidaemia, severe cognitive impairment, Alzheimer's disease, dementia, and Parkinson's disease.

The majority of the users studied (n = 17, 56.6%) had a degree II or III dependency (Fig. 1).

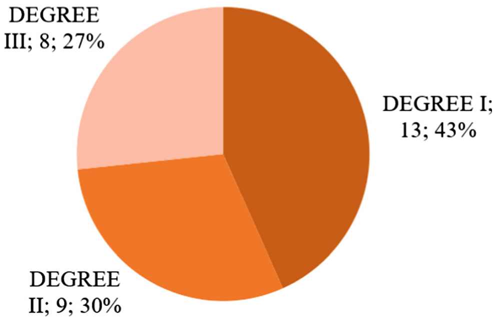

Fig. 1. Degree of dependency

The most frequent barrier to the functionality of the individuals studied is the bathtub, which makes autonomous and independent washing impossible. The second most frequent barrier was the steps and stairs to the house (Fig. 2).

The most commonly used support products among the studied population were a cane and wheelchair because most functional problems were related the individual's ability to move around (Fig. 3).

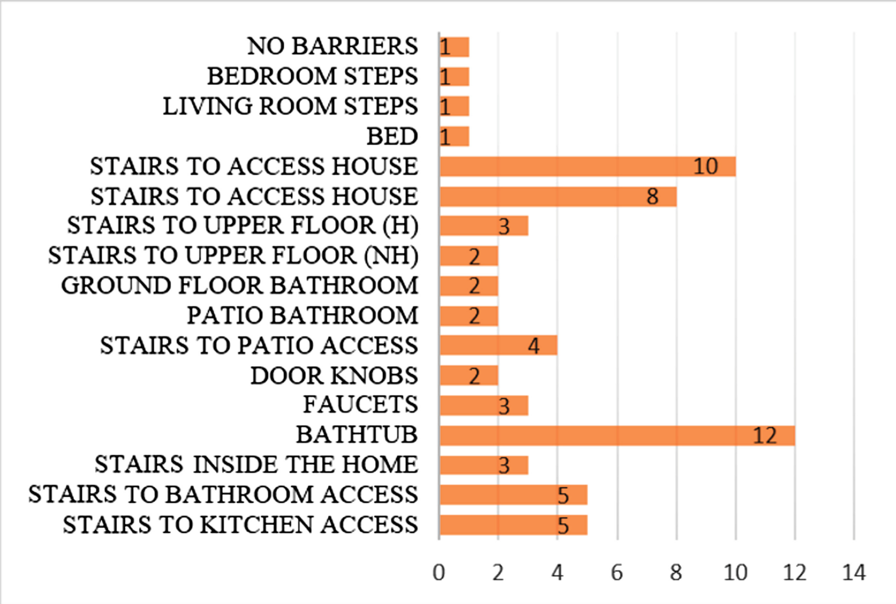

Fig. 2. Detected barriers

There was a low frequency (n = 5) of shower trays in bathrooms because the bathtub was a significant barrier when cleaning.

Regarding the use of assistive technologies and/or sensors, the only one found was the telecare push-for-help system, which was used by more than half of the individuals included in the study (n = 17, 56.7%), and no other devices were used or installed in the home.

The majority of the population studied resided in their family home with their partner and/or children (n = 15, 50%), with the spouse being the primary caregiver in 81.8% of cases when the user was married. Seven (23.3%) of the individuals in the study lived alone with outside help and, to a lesser extent, in the home of one of their children (n = 5, 16.7%) or in the home of another relative (nephews, siblings) (n = 3, 10%). Only 2 elderly people had 24-hour in-home assistance.

4 Discussion

From the results of this study, it can be deduced that among the elderly individuals studied, it is common to find barriers in the home that limit their mobility and functionality, either autonomously, with the help of support products or assisted by third parties.

The dependency of the users interviewed by the evaluators characterizes this population as highly dependent and in which various illness and realities of social and structural environments concur. These data coincide with those found by other studies that find that in addition to these factors, the situation of high geographic dispersion complicates the adequate attention of the most fragile components of society [13].

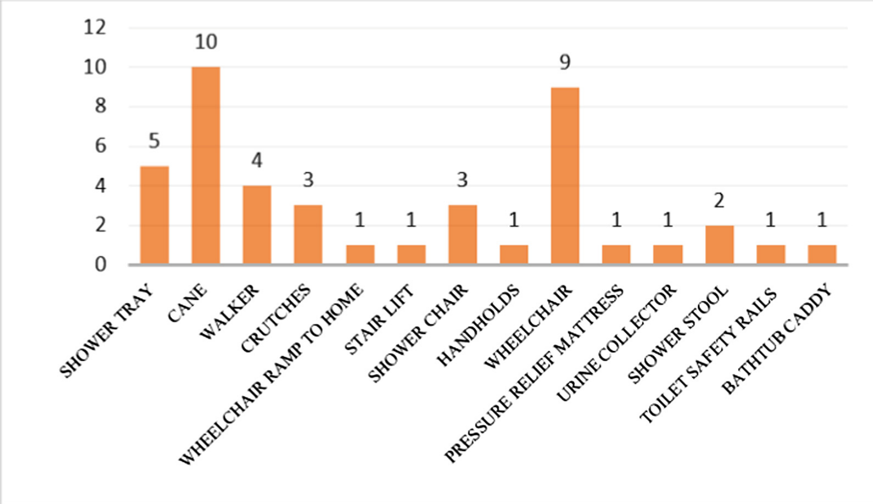

Fig. 3. Use of support products

The main barriers faced by people in situations of dependency in the home are stairs and steps, whether as access to the home or inside the home. The most common barrier present in almost all homes visited during the study was the bathing area and the use of a bathtub. To overcome these barriers, the most commonly used support products were those that facilitate mobility, such as canes, walkers, and wheelchairs.

Due to policy considerations and geographic characteristics, it is necessary to determine a dynamic model of care that takes into account multiple factors and whether these users can benefit from the technological advances of support, surveillance and monitoring provided by society [12]. In this sense, although almost half of the elderly individuals in this study were users of the telecare system, the fact that none of the users used other devices indicates that there is still a long way to go in this regard.

All people in situations of dependency had several illness, many of which have a significant impact on functionality and performance, illustrating the level of complexity of care required by these users and how the public health system should adapt to meet the care demands of these users, ensuring that quality of care is not jeopardized due to being far from health centres [8]. Considering that in-home care is related to higher quality of life [14], caring for an ageing population in a rural region such as the one studied presents enormous challenges, which must be addressed by taking into account the expectations of care but also by considering the direct and indirect economic costs as well as the burden for caregivers.

The development and promotion of the use of technologies designed to mitigate barriers to accessibility and promote autonomy is one of the possible paths, given that best practices and decisions in the development of public health interventions usually come from innovative initiatives that include clear guidelines for developing environments that support healthy ageing [15].

This study has important limitations in terms of the external validity of the results, both in that it presents a reality of a reduced sample of users from a specific region. Although we believe that the results will reflect similar realities in other rural areas of our region, more studies are necessary to obtain a sufficiently representative sample and with a sampling method that allows generalizable conclusions to be reached.

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Conflict of Interest. The authors declare that they have no conflict of interest.

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Structured Proposal for Rehabilitation Nursing (RN) Care Intervention: Sensitive Gains to RN Care for the Person with Self-care Deficit and in the Surgical Process

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Abstract. Surgical needs have been growing in Portugal due to the aging population, the increasing number of people with acute and chronic disease with consequent acquisition of deficiencies and restrictions, being verified dependence on self-care of the people in surgical process. The purpose of rehabilitation nursing intervention is to enable the person to perform his/her self-care and demonstrate the sensitive results to rehabilitation nursing care, allowing the quality of care provided to be proven. Objective. To evaluate the functionality of the person in the surgical process and the gains gained in the rehabilitation nursing care verified after the implementation of a structured proposal of intervention of nursing care of Rehabilitation. Methodology. The study is descriptive and exploratory, using the qualitative methodology of Robert Yin (multiple case studies), Lopes' medium-range theory and the self-care model of Fonseca and Lopes, based on the nursing theory of the self-care of Orem. Results. There was a significant increase in the functionality of the person and the sensitive results to rehabilitation nursing care. Conclusion. The intervention of Rehabilitation Nursing through the application of a structured intervention plan, with the objective of enabling the person and caregiver to achieve maximum functionality and independence, translate into positive sensitive results to nursing care.

Keywords: Nursing care · Rehabilitation · Self-care · Surgery

1 Introduction

The scientific and technological evolution, especially at the surgical level, has made possible a greater survival of the person to potentially incapacitating health problems such as degenerative, cerebrovascular and tumor diseases, denoting a greater need of investment in this area in order to guarantee the full recovery of people with surgical needs who may have their independence in the execution of self-care compromised,

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either by the pathology that affects them, or by the surgical restrictions it entails or by the complications that may result from these interventions [1, 2].

Rehabilitation Nursing (RN) has a preponderant role in the reacquisition of functional losses and consequent dependence on self-care, and complementary therapies such as therapeutic massage and the application of neuromuscular bands (NMB) have shown positive results in increasing the functionality and pain control, and can offer a positive contribution as adjunctive therapies to the practice of RN [3].

The Lopes's medium range theory [4], the model of Fonseca and Lopes [5] and the nursing theory of Orem's self-care deficit [6] guided the entire study and, based on these was made a proposal for a model to the person in surgical process in order to demonstrate to other profissionals the percourse performed.

This study was developed with the objective of evaluating the sensitive gains to the RN care in people with deficit in self-care and in surgical process through the elaboration and implementation of a structured proposal of RN intervention. With the specific objective to evaluate the functionality of the person in the surgical process.

2 Theoretical Framework

The number of people in a situation of dependency with a consequent loss of capacity to carry out their self-care has been increasing steadily over the years, mainly due to the increase in people with chronic illness and the aging of the population, that can be verified in worldwide and in particularly in Portugal, where there is a functional deficit in this age group due to the decrease in physical and mental abilities, as a result of the increase in age [1].

Taking into account the increase in surgical interventions performed worldwide and particularly in Portugal, in addition to the progressive aging of the Portuguese population, which entails greater needs in this area, given the increasing number of comorbidities in this age group where people are frequently identified who need surgical intervention [7], we denoted a need to understand how RN intervention may be beneficial to the person undergoing surgery and with a deficit in self-care, taking into account the characteristics of the Portuguese population and considering the nurse's performance specialist in RN, which focuses on the person, throughout their life cycle, in the different contexts of clinical activity, namely, in the hospital context and throughout the surgical process, but also in every person with a deficit in self-care, their integration into society, with the aim of capacitate the person, maximizing its functionality that can be compromised both by the health breakdown and the limitations imposed by the treatment of this [8].

A model of professional nursing practice can be defined as a conceptual framework that aims to share, with other professionals, the practice of safe and quality nursing care performed, centered on the person being cared for [9]. Thus, a proposal of a model of RN care to the person in surgical process is presented, based on the Lopes medium-range theory [4], the Fonseca and Lopes model [5] and the nursing theory of the self-care deficit of Orem [6] (Fig. 1).

Thus, in the sense of identifying the needs of the person, as Lopes [4] points out, in the process of diagnostic evaluation, we intend to understand what the person knows, what worries him and the capacities he presents. This diagnostic evaluation process is

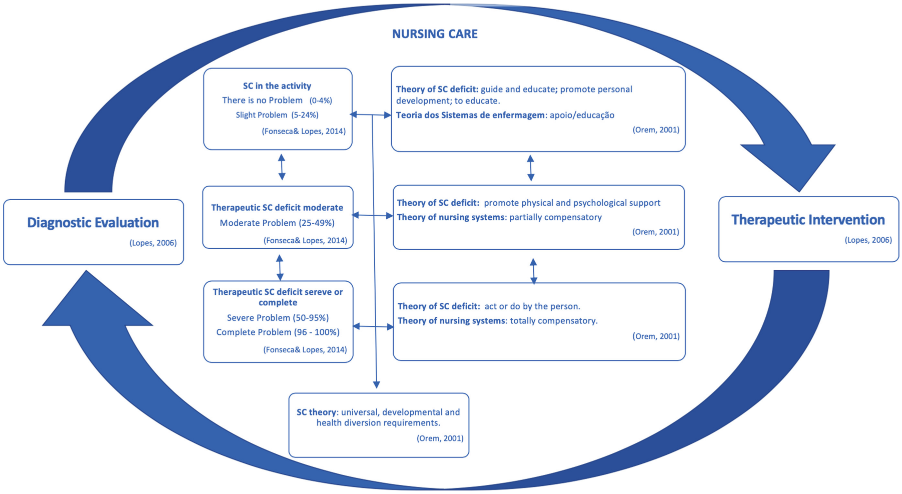

Fig. 1. Proposal of a model of professional practice of RN.

performed continuously and/or whenever there are significant changes in the person's needs, throughout the execution of the RN program. The process of therapeutic intervention, according to the same author, refers to the execution of the nursing care aimed at the diagnostic evaluation, being addressed to the person and/or caregiver, making the connection between them and the organization/community [4]. This reassessment also allows monitoring of the results obtained with the intervention, such as the satisfaction index of the person and/or family, gains in capacity to perform self-care and gains in knowledge about techniques and use of support products, ensuring the quality of their execution [10].

Fonseca and Lopes [5] developed a model that makes correspondence to the needs of nursing care (which we can identify in the diagnostic evaluation process) with the functional profiles, namely, self-care in the activity to the functional profiles no problem (0–4%) and slight problem (5–24%), the moderate therapeutic self-care deficit, to the moderate functional problem profile (25–49%) and the problem of severe or complete therapeutic self-care, to severe functional profiles (50% to 95%) and complete problem (96–100%).

Finally, nursing theory of Orem's self-care deficit [6] makes it possible to perceive the factors that influence the person in meeting their needs in the various domains and how the RN can maximize the caregiver's capacities, in order to guarantee the effective self-care.

After the diagnosis of the person's and the caregiver's needs for self-care (self-care in the activity or a moderate or severe/complete therapeutic self-care deficit), the RN program is established, determining the therapeutic intervention.

The proposed model is dynamic, aiming to progress in therapeutic interventions in order to achieve self-care in the activity and can integrate the various interventions in the different care needs (self-care in the activity and moderate and severe/complete therapeutic self-care deficit), being multidirectional depending on assessed or revalued needs.

3 Methodology

The present study is descriptive and exploratory, based on the qualitative methodology of the case study (multiple case study method) of Yin [11] and Lopes's medium range theory [4] based on nursing theory of the deficit of the self-care of Orem [6].

Yin advocates that a study project be established first. In this multiple case-studies, empirical data are related to the study's research questions leading to research through the data collection, analysis and interpretation of observations [11]. The question of research defined in this study was to identify the gains that are sensitive to the cares of RN (what) in the person in the surgical process (to whom) in the hospital setting (in this neurosurgery study) (where) after implementing of a RN structured intervention plan (how). The use of this methodology (multiple case studies) allows the exploration of objective and subjective data, such as document analysis, interview, quantitative analysis of compiled data and the collection of field notes [11].

Lopes' medium-range theory made it possible to perceive the importance of establishing a therapeutic relationship based on the trust of the person/caregiver in relation to the care provided, thus ensuring the achievement of results that meet the specific goals of the person in need of intervention of specialized nursing in rehabilitation [4], allowing to gain the sensible gains to the nursing care rendered, through the model of Fonseca and Lopes [5].

In this way, Lopes's theory of medium range [4] and the model of self-care of Fonseca and Lopes [5] complement the study, helping to understand the importance of the relationship established with the target person of care and the evaluation of the identifiable deficits in self-care and measurable, that allow to draw the therapeutic intervention of nursing and the results sensible to the nursing care that the interventions of RN bring.

Data collection is performed through the interaction and observation of the individual, taking into account the behavior, attitude and perceptions of each individual [11] and through the collection of objective data taken from the physical evaluation, field notes, customer process records and relevant diagnostic exams.

The data collection instruments Erderly Nursing Core Set (ENCS) [5] and the Functional Independence Measure (FIM) [12] were applied three times, at the initial evaluation, approximately 72 h after and prior to leaving the hospital with the objective of measuring the person's progress and the corresponding rehabilitation intervention performed.

The instruments used (ENCS and FIM) use ICF (International Classification of Functioning, Disability and Health) language that is standardized and allows to describe the domains of health and health states [13]. Functionality is understood as the set of functions of the body (physiological functions of the organic systems), activities (accomplishment of tasks) and participation (involvement of the individual in daily life) [13].

Participants. The study included adults, hospitalized in the neurosurgery department, in the surgical process, with functional alterations, with deficits in self-care and the need for interventions of RN, 6 people with the characteristics described previously were selected, of intentional sampling, where the researcher knows the population and its characteristics [14].

Thus, a sociodemographic characterization of the chosen participants was carried out, which is presented in Table 1.

Table 1. Sociodemographic characterization of participants.

Case studies	Age	Gender	Nacionality	Marital status	Household	Educational level	Job
B1	70	Male	Portuguese	Married	Lives with his wife	Basic Education	Retired
B2	71	Male	Portuguese	Married	Lives with his wife	7th grade schooling	Retired
B3	58	Male	Portuguese	Married	Lives with his wife and son	Higher Education	Attorney
B4	60	Female	Mozambican	Widow	Lives with his son and daughter in law	Higher Education	Teacher
B5	37	Male	Portuguese	Married	Lives with his wife	Higher Education	Factory worker
B6	43	Male	Capeverdian	Single	Lives alone	Basic Education	Construction worker

Ethical Considerations. In order to guarantee the fundamental principles of dignity and freedom, equality, truth and justice, solidarity, excellence of care, professional ethics and the deontological duties inherent to the nursing profession throughout the projection and development of the study [15], situations that could compromise ethics in the execution of the project were identified, and probable issues were discerned in this area that could arise in the various stages of the project, as well as ensuring that there was no legal non-compliance or moral offense. The ethical principles regarding nursing research have also been ensured, such as confidentiality, truthfulness, evaluation of maleficence, fidelity, justice and beneficence [16].

The confidentiality and privacy of the participants was guaranteed through the codification of the data (anonymous treatment of the data).

4 Results

Following the methodology of Yin [11], which recommends a description and reflection of the case studies, these are presented below.

4.1 Case Study B1

In the initial evaluation, on the first postoperative day, the patient was calm and awere of space and person, with sporadic lapses of memory related to the orientation in time and with periods of emotional lability associated to the feeling of dependence. In the physical examination/evaluation of the person, he presents tetraparesis of left predominance and right descoordination, with dysmetria in index finger-nose (Tables 2 and 3).

Table 2. ENCS applied to case study B1.

ENCS	1st evaluation (diagnosis)	Final evaluation
Overall Score of Functionality	Severe Problem (51%)	Slight Problem (14%)
Self Care	Severe Problem (94%)	Moderate Problem (38%)
Learning and memory functions	Slight Problem (17%)	There is no Problem (0%)
Communication	Moderate Problem (25%)	There is no Problem (0%)
Relationship with friends and caregivers	Moderate Problem (33%)	Slight Problem (6%)

Table 3. FIM applied to case study B1.

Evaluation	1st evaluation (diagnosis)	Final evaluation
Self Care	6	30
Sphincter control	2	12
Mobility	3	12
Locomotion	2	7
Communication	13	14
Consciousness of the outside world	15	17
Total	**41**	**92**

When the person was transferred to another hospital, the person had 4/5 strength in the limbs and improved coordination in the index finger-nose also maintained fine motor changes in both hands.

4.2 Case Study B2

In the initial evaluation, preoperative period, the person was calm and aware of space and person, periods of emotional lability, with depressed mood, associated to periods of intense pain (Numerical pain scale between 7 and 9, varying throughout the day). In the physical examination/evaluation, the person presents grade 4 force in the left hand, with alteration of the fine motor, with strength and sensitivity maintained in the remaining limbs. It presents an alteration in balance and a high risk of falling (Berg Balance Scale (BBS) = 15 points) (Tables 4 and 5).

Table 4. ENCS applied to case study B2.

ENCS	1st evaluation (diagnosis)	Final evaluation
Overall Score of Functionality	Moderate Problem (43%)	Slight Problem (6%)
Self Care	Complete Problem (96%)	Slight Problem (15%)
Learning and memory functions	Slight Problem (12%)	There is no Problem (0%)
Communication	There is no Problem (0%)	There is no Problem (0%)
Relationship with friends and caregivers	Slight Problem (6%)	NoProblem (0%)
Function of pain	Complete Problem (100%)	Moderate Problem (25%)

Table 5. FIM applied to case study B2.

Evaluation	1st evaluation (diagnosis)	Final evaluation
Self Care	6	38
Sphincter control	2	14
Mobility	3	15
Locomotion	2	12
Communication	14	14
Consciousness of the outside world	15	20
Total	**42**	**113**

At the moment of discharge, the person was euthymic, with strength maintained in the limbs, controlled pain (Numerical pain scale = 3, without analgesia) (execution of therapeutic massage and application of NMB in the cervical region), with acceptable balance and medium fall risk (BBS = 36 points).

4.3 Case Study B3

In the initial evaluation, on the third day of hospitalization, the person was calm and aware of time, space and person, periods of emotional lability associated to re-hospitalization. He presents 3/5 grade strength in the lower right limb, with motor discoordination of this limb, maintaining strength 5/5 in the remaining limbs (Tables 6 and 7).

Table 6. ENCS applied to case study B3.

ENCS	1st evaluation (diagnosis)	Final evaluation
Overall Score of Functionality	Moderate Problem (29%)	Slight Problem (11%)
Self Care	Complete Problem (69%)	Moderate Problem (29%)
Learning and memory functions	There is no Problem (4%)	There is no Problem (0%)
Communication	There is no Problem (0%)	There is no Problem (0%)
Relationship with friends and caregivers	There is no Problem (0%)	There is no Problem (0%)

Table 7. FIM applied to case study B3.

Evaluation	1st evaluation (diagnosis)	Final evaluation
Self Care	13	34
Sphincter control	6	12
Mobility	3	12
Locomotion	2	5
Communication	14	14
Consciousness of the outside world	15	17
Total	**53**	**94**

Has clinical discharge to a rehabilitation center with the same motor deficits.

4.4 Case Study B4

In the initial evaluation, on the third postoperative day, the person was calm and aware of space and person, with sporadic lapses related to the orientation in time, presenting anomic aphasia, with fluent speech, repetition and understanding maintained, fulfills simple and complex orders. It presents central facial hemiparesis, dysphagia for liquids, hemiparesis of the right upper limb with force degree 1/5 and hemiparesis of the right lower limb with force of degree 3/5, having force maintained in the left side of the body (Tables 8 and 9).

Table 8. ENCS applied to case study B4.

ENCS	1st evaluation (diagnosis)	Final evaluation
Overall Score of Functionality	Severe Problem (54%)	Slight Problem (16%)
Self Care	Complete Problem (98%)	Moderate Problem (33%)
Learning and memory functions	Moderate Problem (29%)	There is no problem (0%)
Communication	Moderate Problem (25%)	Slight Problem (6%)
Relationship with friends and caregivers	Moderate Problem (38%)	Slight Problem (6%)

Table 9. FIM applied to case study B4.

Evaluation	1st evaluation (diagnosis)	Final evaluation
Self Care	6	29
Sphincter control	4	14
Mobility	3	15
Locomotion	2	9
Communication	9	12
Consciousness of the outside world	7	18
Total	**31**	**97**

She is clinical discharged home, with speech with some pauses, but improved, with hemiparesis of the right side with brachial predominance, with strength grade 3/5 in the right upper limb, of distal predominance, with alterations in the fine motor and strength grade 4/5 in the right lower limb.

4.5 Case Study B5

In the initial evaluation, on the fifth postoperative day, a person calm and awere of time, space and person, depressed mood, eupneic. He refers moderate to severe low back pain when performing the movement, with frequent need for analgesia, with little effect. The therapeutic massage and NMB application were performed in the lumbar region, with pain reduction from grade 7 to grade 2 (numeric pain scale). It has strength maintained in the limbs, but moderate functional dyspnea in gait training (score 3 on the Modified Borg Scale) (Tables 10 and 11).

Table 10. ENCS applied to case study B5.

ENCS	1st evaluation (diagnosis)	Final evaluation
Overall Score of Functionality	Moderate Problem (30%)	Slight Problem (11%)
Self Care	Severe Problem (67%)	Moderate Problem (27%)
Learning and memory functions	Slight Problem (8%)	There is no Problem (0%)
Communication	There is no Problem (0%)	There is no Problem (0%)
Relationship with friends and caregivers	Slight Problem (13%)	There is no Problem (0%)
Function of pain	Severe Problem (75%)	Moderate Problem (25%)

Table 11. FIM applied to case study B5.

Evaluation	1st evaluation (diagnosis)	Final evaluation
Self Care	11	32
Sphincter control	12	14
Mobility	3	15
Locomotion	2	8
Communication	14	14
Consciousness of the outside world	11	17
Total	**53**	**100**

At the moment of clinical discharge, for home, the person was eutímic, walks with the aid of a person and present improved functional dyspnea in the training of gait (score 1 in the Modified Borg Scale).

4.6 Case Study B6

In the initial assessment, person calm and awere of time, space and person, but apprehensive by the bodily imbalance and loss of autonomy present. It presents strength grade of 4/5 in the several segments, fine motor alterations and high risk of fall due to the decrease of the balance (BBS = 18 points). He had urinary retention requiring the placement of a cystocateter (Tables 12 and 13).

Table 12. ENCS applied to case study B6.

ENCS	1st evaluation (diagnosis)	Final evaluation
Overall Score of Functionality	Moderate Problem (43%)	Slight Problem (11%)
Self Care	Severe Problem (81%)	Slight Problem (17%)
Learning and memory functions	Slight Problem (13%)	There is no Problem (0%)
Communication	Slight Problem (19%)	There is no Problem (0%)
Relationship with friends and caregivers	Moderate Problem (44%)	Moderate Problem (44%)

Table 13. FIM applied to case study B6.

Evaluation	1st evaluation (diagnosis)	Final evaluation
Self Care	12	38
Sphincter control	4	14
Mobility	3	21
Locomotion	2	12
Communication	13	14
Consciousness of the outside world	13	16
Total	**47**	**115**

At the time of the high clinic, the person presents strength grade 5/5 in the lower limbs, strength grade 5/5 in the proximal segment of the upper limbs and 4/5 in the distal segments, with improved fine motor change and low risk of fall, presenting good balance (BBS = 44 points). It is autonomous in sphincter control.

5 Discussion

In all case studies, according to the ENCS [5] instrument, we can verify the significant increase in general functionality and in particular the capacity to self-care execution, corroborated by the FIM evaluation scale [12]. The learning and mental functions, also as communication, relationship with friends and family and pain dimensions, present improvements. This is in keeping with Orem's claim that the self-care agent (the person) has the capacity to develop self-care behavior in the various domains (cognitive, emotional, behavioral and physical). These domains are predominant in order to obtain independence by the person [17].

The interventions were aimed at the various domains, individualizing the care plan according to the changes found.

In all the case studies, a complete or severe problem [5] in self-care was observed, requiring the implementation of a total or partially compensatory system by the health team [6]. Limitations in the various domains have contributed to this problem, but mainly in the physical domain, with the observation of physical limitations, such as a decrease in limbs strength and a decrease in balance (Tables 14 and 15).

Table 14. Structured intervention plan

Interventions	Goal
– Provided quiet environment with adequate temperature [18] – Explained and discussed with the person the RN intervention plan, identifying their needs, goals and expectations [19] – Explained the importance of the intervention of the RN, allowing him to express doubts [19]	– Promote relaxation and well-being [18] – Establish individualized objectives for the intervention plan [19]
– Respiratory functional rehabilitation [18, 20] • Consciousness and control of breathing with respiratory training (5 to 10 min)/Teaching of diaphragmatic breathing with expiration with semi-closed lips (5 to 10 min) • Global costal reeducation with a wand (5 respiratory cycles)	– Improve alveolar ventilation [18] – Preventing postoperative respiratory complications [18]
– Teaching about the importance of body alignment and principles, objectives and importance of mobilization [21] – Encouraged to perform movements throughout the day [21]	– Promote the mobilization and continuation of the plan by the person [21]
– Therapeutic massage and NMB application [22]	– Decreased pain [22] – Sensory stimulation [22]
– Passive and/or active assisted and/or active resisted mobilization (depending on the strength presented by the person) of the various body segments, in the different planes (10 times), initiating mobilizations of the proximal joints for the distal ones, performing smooth and rhythmic movements [20]	– Maintain/restore joint mobility and prevent loss of joint function [21] – Preventing contractures, musculo-articular deformities and skin changes [21] – Stimulate circulation and nerve endings [21] – Maintain the notion of movement, proprioception and increase resistance [21]
– Performing isometric exercises in the body segments (10 repetitions), maintaining the contraction for 6 s, followed by a brief rest period [23]	– Maintain tone and muscle mass [23]
– Taught about lateral displacement in the bed, placements and how the person can collaborate [21]	– Allow the person to collaborate/perform in the alternation of decubitus [21]

(*continued*)

Table 14. (*continued*)

Interventions	Goal
– Therapeutic exercises in bed [24]: Bridge, Rolling (when a person presents hemiparesis/hemiplegia, the professional positions himself on the affected side and assists in the exercise)	– Prepare person to lift, sitting and orthostatic position - Balance training [24] – Strengthen trunk muscles [24] – Stimulate postural sensitivity [24]
– Exercises of Balance with the person sitting in the wheelchair or in the bed with feet on the floor or another surface that allows stability [21]	– Improve static and dynamic trunk balance [21]
– Training of transfers of the bed for wheelchair and sanitary/bath chair and contrary transfer [25]	– Train of transfer [25]
Standing balancing exercises leaning on bar, the person performs the exercises slowly and holding position for a few seconds (5 times on each lower limb) [26]	– Balance training [26] – Strength training - muscle strengthening [26]
– March training - encouraging postural correction with or without grid mirror [27]	– March and balance training [27] – Postural correction [27]
– Promote independence in activities of daily living (ADL's) by stimulating the use of person's functionality, using/caring for the affected body and providing technical aids such as adapters to make cables thicker, such as brush cables and cutlery (if hemiparesis/hemiplegia) [26] – Train the realization of personal hygiene [26] – Train dressing/undress [24] – Train feeding in the sitting and aligned position [28] – Train bladder and bowel elimination control and sanitary use [29] – Transfer training [24] – Locomotion training with and without gaiters (previously described) [27]	– Train of ADL's [24, 26] – Acquisition of the maximum possible functionality [26, 28] – Re-educate for the effort [26]
– Stretching according to muscle group worked [23] – Relaxation exercises [23]	– Muscle relaxation [23]
– Register procedures	– Enable continuity of care

Table 15. Gains obtained with the application of functional NR intervention programs through the application of the ENCS instrument.

ENCS			Gains
Case studies	Initial evaluation-diagnostic	Final evaluation (post-intervention)	
B1	– General Functionality – 51% Intervention areas – Self-care – 94% – Learning and mental functions – 17% – Communication – 25% – Relationship with friends and caregivers – 33%	– General Functionality – 14% Intervention areas – Self-care – 38% – Learning and mental functions – 0% – Communication – 0% – Relationship with friends and caregivers – 6%	37%
B2	– General Functionality – 43% Intervention areas – Self-care – 96% – Learning and mental functions – 12% – Communication – 0% – Relationship with friends and caregivers – 6% – Function of pain– 100%	– General Functionality – 6% Intervention areas – Self-care – 15% – Learning and mental functions – 0% – Communication – 0% – Relationship with friends and caregivers – 0% – Function of pain – 25%	37%
B3	– General Functionality – 29% Intervention areas – Self-care – 69% – Learning and mental functions – 4% – Communication – 0% – Relationship with friends and caregivers – 0%	– General Functionality – 11% Intervention areas – Self-care – 29% – Learning and mental functions – 0% – Communication – 0% – Relationship with friends and caregivers – 0%	18%
B4	– General Functionality – 54% Intervention areas – Self-care – 98% – Learning and mental functions –29% – Communication – 25% – Relationship with friends and caregivers – 38%	– General Functionality – 16% Intervention areas – Self-care – 33% – Learning and mental functions – 0% – Communication – 6% – Relationship with friends and caregivers – 6%	38%
B5	– General Functionality – 30% Intervention areas – Self-care – 67% – Learning and mental functions – 8% – Communication – 0% – Relationship with friends and caregivers – 13% – Function of pain – 75%	– General Functionality – 11% Intervention areas – Self-care – 27% – Learning and mental functions – 0% – Communication – 0% – Relationship with friends and caregivers – 0% – Function of pain – 25%	19%
B6	– General Functionality – 43% Intervention areas – Self-care – 81% – Learning and mental functions – 13% – Communication – 19% – Relationship with friends and caregivers – 44%	– General Functionality – 11% Intervention areas – Self-care – 17% – Learning and mental functions – 0% – Communication – 0% – Relationship with friends and caregivers – 44%	32%
Global average of functionality	42%	12%	30%

Table 16. Earnings obtained with the application of functional RN intervention programs through the application of FIM.

FIM			Gains
Case studies	Initial evaluation- diagnoses	Final evaluation (post intervention)	
B1	41	92	51
B2	42	113	71
B3	53	94	41
B4	31	97	66
B5	53	100	47
B6	47	115	68
Average scores	**45**	**102**	**57**

The person being cared for is encouraged to perform the exercises at least twice a day and continue after the discharge, at least 3 times a week.

The following tables present the gains obtained with the application of RN programs performed.

Table 16 shows that the intervention of the RN results very positive results, resulting from the implementation of intervention programs of functional RN, regarding the general functionality of the individuals, with a mean of gains of 30%.

Also noteworthy are the gains obtained in self-care, and all individuals have gone from a *"severe problem"*, with dependence values, in this dimension between 67% and 98% to a *"slight problem"* with values of dependence on self-care less than 38% and it can be said that we fulfilled the objectives of implementing this intervention proposal.

With the objective of reducing pain, two of the case studies stand out, with a good response to the complementary intervention performed (therapeutic massage and neuromuscular bands), which allowed for the execution of the intervention plan. With the controlled pain the person is able to carry out their self-care in a more autonomous way, associating also an improvement in motivation and relational dimensions, as in learning and mental functions and in the relationship with friends and family.

6 Conclusion

Taking into account the population needs, and in particular those of the persons in the surgical process, it is imperative the intervention of Rehabilitation specialised nursing to improve the deficit in self-care, since the RN specialist nurse functions include promoting the maximization of greater functionality possible and consequent independence in ADLs, in order to achieve the highest possible quality of life of these people and their reintegration into the society that involves them.

The nursing theory of Orem's self-care deficit allowed us to identify the needs of the person in the surgical process and to design an intervention project taking into account this same needs, allowing the person to progress in order to reduce the amount of help and increase their autonomy. Thus, in this article, we presented summarily the several intervention programs were carried out of the RN to the person in the surgical process (the programs were individualized to each person).

With the application of this structured proposal of intervention of care of newborns can also be verified improvements in outcome indicators such as gains in knowledge of the person/caregivers on muscle and joint exercise techniques, gain in knowledge about auxiliary devices (for example to eat and drinking), gains in adaptive knowledge in ADLs (e.g. walking) and gains in adaptability in ADLs/to perform ADLs/to use ancillary devices.

It was also possible to understand the importance of the use of non-pharmacological methods, such as therapeutic massage and neuromuscular bands, in terms of symptomatic pain control and the reacquisition of functionality and how they can be a valuable complement to rehabilitation specialist nurse in the execution of the planned RN plans.

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Benefits of Nursing Interventions in Preventing Complications in the Elderly with Alterations in Swallowing After Stroke

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Abstract. Introduction: Stroke, the most common cerebrovascular disease in the elderly population, is the leading cause of death in Portugal. Changes in swallowing, one of the most common sequelae of this neurological event, have a negative impact on the person's prognosis, contributing to high morbidity and mortality rates, due to the risk of dehydration, malnutrition and aspiration pneumonia. Nurses, the health professionals who participate more actively in feeding and patient supervision, may play a key role in the early detection of swallowing changes in this population. **Objective**: To identify the benefits of nursing interventions in the prevention of complications in the elderly with changes in swallowing after stroke. **Method**: Systematic review that led to the search in the EBSCOHost search engine, in the databases CINAHL Complete and MEDLINE Complete, to identify studies published between 2015 and 2019, using the descriptors "stroke", "intervention", "nurse" " and "deglutition disorders ". After implementing the inclusion and exclusion criteria and evaluating the methodological quality of the results obtained, three studies were selected. The levels of evidence were assured by the levels of evidence proposed by Melnyk and Fineout-Overholt. **Results**: Nursing interventions for the elderly with changes in swallowing after stroke can contribute to improvements in the prevention of complications, well-being and self-care, health promotion and continuity of care. **Conclusion**: The benefits of nursing interventions to the elderly with changes in swallowing after stroke are evident. However, in view of the scarcity of studies on the subject, it is suggested that more quantitative studies be carried out, with more representative samples.

Keywords: Stroke · Swallowing · Elderly · Nursing · Nursing interventions

1 Introduction

This study is part of the Interreg España-Portugal project of the International Institute for Research and Innovation in Aging.

In recent years, in Portugal, there have been demographic changes that translate into the modification of the age pyramids, which reflects a progressive and marked increase

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in the elderly population, resulting from a greater human longevity, which is associated with dependence indices as a result of worsening morbidity [1].

The health status of the Portuguese, given the current demographic context, is characterized by a significant increase in chronic diseases and the high number of people with multiple pathologies, which requires greater complexity of care [2]. Most elderly people suffer from at least one chronic illness, which may limit their autonomy, independence and thus reduce their quality of life [3].

In 2015, stroke was the most frequent cerebrovascular disease in the elderly population, being the leading cause of death in Portugal. In the European Union, Portugal is the country with the highest mortality rate due to stroke due to the prevalence of risk factors such as hypertension caused by obesity, physical inactivity, alcoholism, smoking and unhealthy eating [4]. Currently, this pathology is one of the most frequent and represents a major impact on public health worldwide as it is the main cause of motor, cognitive dysfunction, neurological disability and hospitalizations.

The neurological changes caused by occlusion or haemorrhage in the cerebral circulation depend on the affected area, severity of injury and health status of the person. These determine changes in motor, sensory, perceptive, and behavioural, among others [5].

Swallowing impairment in the person after stroke is one of the most frequent sequelae and has a negative impact on the person, contributing to the high morbidity and mortality rates due to the risk of dehydration, malnutrition and aspiration pneumonia. Aspiration pneumonia is considered in people with dysphagia the most common cause of mortality, and deaths that occur after stroke are related to pneumonia [6]. With regard to the elderly, this risk increases six times from the age of 75 [7].

Early identification of dysphagia has been shown to be effective in reducing the rate of aspiration pneumonia, reducing the number of hospitalizations and therefore increasing the average life expectancy [6, 8]. In this sense, it is necessary to have an early swallowing assessment in order to detect impairment and avoid future complications [6]. This assessment is a priority and should be performed within 24 h of admission by a trained professional [9]. Thus, when there is compromise in the swallowing process, it is crucial that the multidisciplinary team can identify its clinical signs as well as the consequences of this change [10].

The diagnosis of dysphagia is fundamental in the acute phase of stroke, but also in the process of recovery of the clinical condition, so that after its detection, rehabilitation may be initiated, acting to prevent possible complications. Although dysphagia assessment requires a multidisciplinary approach, nurses with differentiated and specialized training play a privileged role in monitoring and observing the person through continuous monitoring. In addition, nurses are the health professionals who participate most actively in patient feeding and supervision, and play a key role in early detection of swallowing disorders in this population. In this sense, the development of knowledge and research on this topic is an added value for the care of the elderly with swallowing alteration after stroke, aiming at preventing complications and identifying the gains for it through the nursing care provided.

2 Objective

To identify the nursing care intervention gains in the prevention of complications in the elderly with altered swallowing after stroke.

3 Research Question

For the selection of articles and formulation of the research question, we used the methodology PI [C] OD, being target population (P), type of Intervention (I), comparisons (C), the result - Outcome (O) and the type of study - design (D). The following question was formulated to answer the outlined objective that served as the guiding thread for this integrative literature review: What are the gains from nursing care intervention in preventing complications (Intervention) in the elderly with swallowing disorders after stroke (Population)?

4 Methodology

After formulating the starting question, a research on the topic under study was carried out. The EBSCOHOST database was used and MEDLINE COMPLETE and CINHAL COMPLETE databases were selected, with the following descriptors:

- “Stroke”; “Intervention”, “nurse”, “deglutition disorders”
- The descriptors were searched at EBSCO in the following order:
- [(Stroke) or (Cerebrovascular Accident) or (cva)] AND
- [(Intervention) or (treatment) or (therapy) or (program) or (strategy)] AND
- [(Nursing] or (Nursing care) or (Nursing Intervention)] AND
- [Deglutition disorders].

The descriptors were searched in full text and searched retrospectively until 2015.

Inclusion criteria were: articles with quantitative and/ or qualitative methodologies, full-text that focused on the object of study, academic journals (reviewed by experts), and references available and with publication date between January 2015 and March 2019.

In the exclusion criteria, we considered all articles with ambiguous methodology, repeated in both databases, without correlation with the object of study and with dates lower than 2015.

The bibliographic search in the databases was performed on April 18, 2019, where the selection of articles involved the evaluation of the title and the analysis of the abstract to verify if they met the inclusion and exclusion criteria. When the title and abstract were not enlightening, the full article was read to minimize the loss of important studies for this integrative literature review.

Twenty-six articles were identified from the databases, MEDLINE COMPLETE and CINHAL COMPLETE. In the first phase, there were 8 articles after reading the titles; In a second phase, after reading the abstracts, a potential interest for 5 articles was justified.

From these, 3 articles were selected resulting from the methodological quality analysis, after full reading of the article.

Taking into account the selected articles, the critical analysis of the methodological quality focused on the assessment of the evidence levels of each article. Thus, the contributions of Melnyk and Fineout-Overholt [11] were used to identify the types of knowledge production that are implicit in it. These authors considered the following levels of evidence:

- Level I - Systematic reviews (meta-analyzes, clinical practice guidelines based on systematic reviews);
- Level II - Experimental Studies;
- Level III - quasi-experimental studies;
- Level IV - non-experimental studies;
- Level V - Program evaluation reports/ literature reviews;
- Level VI - Opinions of authorities/ consensus panels.

In this process, two synthesis tables were constructed: the first to describe the studies and the second to summarize the results.

5 Results

In order to answer the starting question, several articles were read, aiming at the analysis of their content. The results obtained are summarized in Table 1.

Table 1. Literature Review Results

Authors/Method/Level of Evidence	Objectives	Results
Hines, Kynoch & Munday (2016) [12] **Method:** Systematic Literature Review **Level of evidence:** I	Evaluate the role of nursing professionals and their interventions in the recognition and management of dysphagia in adults with acute neurological impairment	The implementation of guidelines in health institutions for the assessment of dysphagia influences the detection of dysphagia upon admission, which may reduce the number of deaths, lung infections and even influence the destination after discharge, but scientific evidence is insufficient. Training nurses to detect swallowing disorders is effective, reducing the waiting time for initial swallowing assessment. This assessment can also reduce the number of days a person is without food and hydrate orally. However, it apparently has no influence on length of hospital stay. Although nurses carry out this initial evaluation, the authors do not exclude the need for an evaluation by other health professionals

(*continued*)

Table 1. (*continued*)

Authors/Method/Level of Evidence	Objectives	Results
Palli et al. (2017) [13] **Method:** Experimental study with randomly selected participants divided into two groups (experimental group and control group). **Level of evidence:** II **Participants:** 198 patients admitted to the department with a diagnosis of ischemic stroke from January to May 2015 (prior to the training of nurses to assess swallowing disorders) were the control group; 186 patients admitted to the department from January to May 2016 (after training nurses to assess swallowing disorder for 24 h/7 days) constitute the intervention group	Demonstrate that training nurses to perform dysphagia assessment in people with stroke allows swallowing assessment for 24 h under 7 days leading to a lower rate of pneumonia and reduced length of hospital stay compared to standard dysphagia detection test performed by speech therapists only during their working hours	This study reveals that for the intervention group the time for swallowing assessment was reduced to an average of seven hours (assessment of swallowing change performed by nurses 24 h under seven days) compared with 20 h in the control group (standard assessment of change in swallowing performed by speech therapists only during their working hours). The intervention group has a lower pneumonia rate (3.8% - intervention group and 11.6% control group), a shorter hospital stay and a lower mortality rate. Notably, the length of hospitalization may vary due to different reasons including severity of disability, other complications that may arise or even due to social support. In addition, the observed difference in mortality should be interpreted with caution, as the available data do not allow a lower mortality rate to be associated with a decrease in the rate of pneumonia, as it was not possible to know all causes of death of the people. Although pneumonia was present in both groups, it occurred less frequently in the group in which they were evaluated early by nurses. In this sense, early detection of dysphagia promotes the implementation of prophylactic aspiration strategies, which may decrease the rate of pneumonia
Seedat & Penn (2016) [14] **Method:** Almost Experimental Study **Level of evidence:** III **Participants:** The study consists of two groups of participants, both with oropharyngeal dysphagia. The experimental group consists of a consecutive sample, in which 23 patients received regular oral care and only ingested water (all other liquids were restricted); and the control group was obtained through a retrospective review, where the 23 patients received poor regular oral care, ingested all types of fluids and had a restricted diet	To evaluate the outcome of implementing an oral hygiene regimen combined with providing water to people with oropharyngeal dysphagia in aspiration pneumonia	This study demonstrates evidence that it is possible to reduce the adverse effects of aspiration including mortality by implementing an oral hygiene protocol for the person with dysphagia. Providing oral hygiene care and water supply as well as increasing adherence by the person successfully prevents aspiration pneumonia from occurring. When oral care is implemented (e.g. after meals), the oral cavity remains clean, avoiding aspiration of food residues left in the oral cavity. Regular oral care shows a decrease in respiratory pathogens that may cause lung infection

6 Discussion

Following the analysis, four categories emerged, supported by the indicators below systematized in Table 2.

The indicators were defined through an inductive process based on the results of the different studies selected. For the definition of categories, we used the descriptive statements of the quality standards of nursing care, defined by the Order of Nurses [15]. Thus, the different indicators found (nursing care gains) due to their common characteristics were aggregated in the descriptive statements (categories), which best represented the nursing care gains in preventing complications in the elderly with swallowing alteration after stroke.

Although this research is focused on the prevention of complications, as a priority in providing care to the elderly with swallowing changes through a stroke, we considered pertinent to understand the nature of the elements associated with it in the professional intervention of nurses.

In the analysis of the articles, the following categories emerged: Prevention of Complications, Health Promotion, Well-being and Self-Care and lastly, Continuity of Care, as expressed in Table 2.

Table 2. Nursing care gains in preventing complications in people with swallowing disorders after stroke

Categories	Indicators
Prevention of complications	• Decreased lung infections [12–14] • Reduction in the number of days without oral feeding and hydration [12] • Decreased time for swallowing assessment [13] • Decreased length of stay [13] • Decrease in mortality [12–14]
Health Promotion	• Promotes the implementation of prophylactic aspiration strategies [13]
Well-being and self-care	• Promotes patient and caregiver/family adherence to care [14]
Continuity of care	• Influence on destination after discharge [12]

6.1 Complication Prevention

There has been a decrease in lung infections, a reduction in the number of days without oral feeding or hydration, and a reduction in the mortality rate due to the implementation of dysphagia assessment guidelines in health institutions [12]. These guidelines refer to the training of nurses to detect swallowing impairment, which proved to be effective, however, according to the authors, although there is this assessment by nurses, an assessment by other health professionals is not excluded.

Pneumonia was found to be less frequent in people who received an early swallowing assessment by nurses. Associated with a lower rate of pneumonia, this study reports a reduction in length of stay and a lower mortality rate due to early detection of dysphagia, as well as the implementation of prophylactic aspiration strategies [13]. However, length of stay may vary due to other reasons such as social support, severity of disability and/ or other complications. Currently, there is no consensus, nor is it defined the best instrument/ scale to assess swallowing disorders. Therefore, in this study, the GUSS (Gugging Swallowing Screen) scale was used because it has high sensitivity for any swallowing dysfunction. However, scientific evidence is insufficient to evaluate the effectiveness of this intervention in relation to the incidence rate of pneumonia.

Implementation of an oral hygiene protocol has shown a decrease in the adverse effects of aspiration as well as the mortality rate. Providing oral hygiene care has shown a reduction in oral residues remaining in the oral cavity after feeding, decreasing the risk of aspiration, as well as the presence of respiratory pathogens that may lead to the development of lung infections [14]. Thus, the benefits associated with oral hygiene are confirmed, assuming this as a priority in the nursing care provided. However, the successful implementation of an oral hygiene protocol for people with dysphagia cannot be achieved by just one professional, but by an entire multidisciplinary team.

6.2 Health Promotion

Training nurses to assess dysphagia in people with stroke for 24 h/7 days allows early and timely detection of stroke, promoting the establishment of prophylactic strategies against aspiration, both in people who eat via such as those requiring a nasogastric tube. Early implementation of prophylactic strategies may decrease the rate of aspiration pneumonia and length of hospital stay compared with the standard assessment performed only by speech therapists [13].

6.3 Wellbeing and Self Care

In the Seedat & Penn study [14], people in the intervention group were observed at least one meal a day. Before each meal they were repositioned/ seated on their bed or chair. Those who could not feed themselves were fed by the nurse. Some strategies were implemented by the nurse during meals, namely: correct confirmation of food consistency before the start of the meal, assessment of the person's state of consciousness and wakefulness, monitoring of the given food volume, providing sufficient time to swallowing and ensuring the cleanliness of the oral cavity. Each participant received oral hygiene care, i.e. brushing teeth before breakfast and after each meal and even before drinking water. Participants and their caregivers/ family members implemented this routine in addition to nurses and researchers [14].

People adhered to the recommendations on oral hygiene care and water supply. This adherence is due to the understanding of the importance of the implementation of oral hygiene care, since they present alterations in swallowing and such care will decrease the risk of aspiration. In this sense, they understood the importance of providing them with thickened water because they had dysphagia, also reducing the risk of aspiration. Thus, these cares became part of their daily routines. Therefore, the involvement of the person and caregiver/ family in decision making and the nurse's role in dysphagia management generated a more positive prognosis. Hence, the importance of adherence by the person and the caregiver/family, throughout the process. However, there is still a great need for information dissemination among nursing professionals, as well as the involvement of people with commitment to swallowing and their families in the provision of care [14].

6.4 Continuity of Care

Training nurses to detect swallowing impairment reduces the waiting time of the person to be assessed upon admission, reduces the number of deaths, lung infections, and decreases the number of days without food and hydrate orally, proving effective. In addition, early swallowing assessment may influence the person's fate after discharge. Thus, with early detection of dysphagia there is a significant decrease in the number of people transferred to specialized nursing care units after discharge [12]. However, the study by Hines and colleagues [12] is the only one that provides information about the destination after discharge, so it is necessary to produce scientific evidence on the relationship between the nurse's assessment and length of stay as well fate after discharge.

7 Conclusion

The Integrative Literature Review made explicit the gains that exist for the elderly with altered swallowing after stroke in terms of prevention of complications, health promotion, well-being and self-care and continuity of care.

Evidence showed that at the level of complication prevention, early assessment of dysphagia by trained and trained nursing professionals decreased the waiting time for swallowing assessment upon admission; the number of days the person has been without oral food and hydration; the mortality rate; the number of days of hospitalization and also the reduction in the number of pulmonary infections and aspiration pneumonia. However, a person's length of hospitalization depends not only on early assessment but on other factors, such as social and clinical factors. In terms of the mortality rate, there is a decrease, but it is also not accurate since it was not possible in the studies to be fully aware of the cause of the deaths that occurred. Swallowing assessment, although timely, allows for the implementation of prophylactic strategies to minimize complications. As an example, we have the implementation of specific oral hygiene protocol for people with dysphagia, where it is possible to specifically prevent the occurrence of aspiration pneumonia due to food residues that remain in the oral cavity.

The assessment of swallowing alteration by nurses has been shown to be effective, making the existence of guidelines in health institutions as well as a well-defined assessment instrument essential. Therefore, there is a need to promote training for nurses on this issue, since it is a necessity in the hospital context, translating into the best interest of patients. In addition, the involvement of the person and their caregiver/ family in the whole decision making and care process together with the nurse in managing dysphagia presents a more positive prognosis for dysphagia.

Despite being a current theme there is little scientific production about the gains of nursing care. Thus, it is essential to carry out research to highlight the gains and impact that nursing care has on the quality of life of people with dysphagia and prevention of complications. In addition, it is essential to understand the relationship between early assessment and care provided in decreasing mortality, length of hospital stay, decreasing lung infection rate and aspiration pneumonia.

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Rehabilitation Nursing in the Elderly with Mobility Deficit Due to Fracture of the Femur

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Abstract. The Portuguese population is becoming increasingly aged, so all the changes concerning this process led to an increase of the risk of falling. The reduced mobility after undergoing a surgical process led to the development and implementation of a rehabilitation nursing programme especially directed to the elderly suffering from femur fracture. The specialist nurse's skills were developed through the implementation and evaluation of a plan of intervention using evaluation instruments depending on the identified focus and diagnosis. The intervention programme had as a result a functional improvement of the elderly people lives concerning mobility, balance, muscular strength and range of movement, allowing them to become more independent on their daily life activities as well. Through a specialized intervention, the rehabilitation nurse helps elderly patients to achieve health gains after having suffered from reduced mobility due to a femur fracture.

Keywords: Rehabilitation nursing · Elderly · Femur fracture

1 Introduction

For the United Nations Population Fund (UNFPA), population aging has a major and far-reaching implication in all areas of society and is a significant 21st century trend. It is a growing phenomenon that cannot be ignored. The increasing trend in the number of elderly people has been aggravated, and by 2050 the population over 60 is expected to reach 20% [1]. According to the World Health Organization (WHO), the population over 60 years old increases faster than any age group [2]. Portugal, like the other countries of the European Union, has witnessed striking demographic changes in society, with the rapid and sharp increase in the elderly population associated with longevity in which the birth rate cannot keep up with this increase in the aging population. In 2015, the population aged 65 and over represented over one fifth of the Portuguese population [3].

Aging is associated with a complex set of changes. Biological and physiological changes lead to an increased risk of developing pathologies, as well as a general decline in their physical and intellectual abilities. Aging is considered a dynamic and progressive process characterized by morphological, functional, biochemical and psychological

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changes that determine the gradual loss of adaptability to the environment. Hence, there is a greater vulnerability and higher incidence of pathological processes, with decreased functional capacity. Functional capacity decreases and dependence gradually increases as one gets older. These are some of the biggest aging-related health adversities. These lead to restriction/loss of ability or difficulty/inability to perform daily life activities [4]. Diseases arising from the aging process, such as changes in vision, hearing, movement, neurological diseases associated with poly-medication, can alter the balance leading to falls, as well as risky behaviors inside/outside the house [5].

In Europe, approximately 105,000 people die each year from accidents of which 85,000 are unintentional, with falls being the leading cause of injury or even death in people over 65. One in twenty falls results in fractures, the most frequent being fractures of the femoral neck, wrist, humerus or pelvis [5]. Bone fractures interfere or may interfere with mobility in various ways [6]. Deficit in physical mobility related to the disease/trauma or as a result of the aging process has consequences on human physiology at the level of the various organ systems, the musculoskeletal system being the most affected due to decreased muscle contraction, loss of strength and muscle mass, contractures and osteoporosis [7].

Rehabilitation is aimed at restoring functionality in the shortest possible time and is conceptualized as a multidisciplinary process consisting of specific procedures and knowledge that help people with disabilities or their sequelae to maximize their functional potential and independence, and therefore the Rehabilitation Nursing Specialist Nurse (EEER) designs, implements and monitors rehabilitation nursing plans based on people's problems in order to promote health, prevent complications, treat and rehabilitate, maximizing their potential [8, 9].

Therapeutic interventions for mobility and self-care are the fundamental core of rehabilitation nursing practice [10] and, therefore, the foundations of intervention in elderly patients with mobility deficit due to femur fracture and/or undergoing femoral fracture surgery are mobility and self-care. The EEER has a major role in the rehabilitation of the elderly with this problem, considering its intervention as fundamental in the preoperative, postoperative periods and in the continuity of the rehabilitation program at home. The EEER intervention is based on the rehabilitation of these people, maximizing their potential through the implementation of functional rehabilitation programs and self-care training, where teaching and training are evident. Respiratory Functional Reeducation and Motor Functional Reeducation programs are fundamental to help restore the functional capacity of the elderly prior to the fracture, in order to obtain health gain [11].

Preoperative and postoperative respiratory functional rehabilitation of the elderly undergoing surgery aims to prevent and correct postural changes and ventilatory defects that may result from surgery, maintain airway permeability, and re-educate the person on exertion [12], depending on its effectiveness from the early institution of the program and the person's adherence. Motor functional reeducation is based on therapeutic exercises. The therapeutic exercise consists in the planned and systematic accomplishment of body and postural movements, aiming to prevent/reduce deficits, risk factors, improving functional limitations. There are several therapeutic exercises aimed at reducing deficit and predominantly improving range of motion, strength and balance [13, 14].

The mobility deficit due to the surgical process led to the development and implementation of a rehabilitation nursing intervention program aimed at the elderly with femur fracture. The preoperative program or the first 24 postoperative hours involves the following:

1. Evaluation activities: assessment of MMSE (Mini-Mental State Examination), muscle strength (Lower Scale), joint amplitudes (Goniometry), balance (Berg Scale), functional independence (Barthel Index) and of pain.
2. Teaching and training of respiratory functional rehabilitation exercises (awareness of breathing and dissociation of breathing times, diaphragmatic abdominal breathing and cough).
3. Teaching and training of motor functional rehabilitation exercises (Table 1)

Table 1. Preoperative motor functional rehabilitation program

Isometric Exercises	• Isometric contraction of the abdominal, gluteus and quadriceps muscles (10 repetitions, 5–10 s each repetition, twice a day);
Isotonic Exercises	• Upper limbs and unaffected lower limb: free/assisted/resisted active mobilization of unaffected limbs; • If, fractured lower limb: active-assisted or passive mobilization of the tibia-tarsal joint with dorsiflexion and plantar flexion (5 repetitions twice a day); • If, operated limb: active-assisted or passive mobilization of the tibia-tarsal joint with dorsiflexion and plantar flexion, active-assisted mobilization of flexion/extension of the hip joint with flexion/extension of the knee and abduction/adduction of the hip joint to the midline of the hip. body (5 repetitions twice a day);
Teaching of:	• Positions in the bed/sit in the chair/sit in the toilet (movements and positions to avoid in the total hip prosthesis); • Transfer bed/wheelchair, wheelchair/bed; • Walking with a walker and crutches; • Wheelchair care and fall prevention in a hospital setting

The postoperative rehabilitation nursing program involves the following activities:

1. Assessment of muscle strength (Lower Scale), joint amplitudes (Goniometry), balance (Berg Scale), functional independence (Barthel Index) and pain.
2. Strengthening and training of respiratory functional rehabilitation exercises, involving breathing awareness and dissociation of breathing times, diaphragmatic abdominal breathing and cough.
3. Reinforcement and training of motor functional rehabilitation exercises, as defined in Table 2.

In view of the above and assuming that femoral fractures in the elderly cause high mobility deficits, with repercussions on their functional independence and that the nurse

Table 2. Postoperative motor functional rehabilitation program

Isometric Exercises	• Isometric contraction of the abdominal, gluteus and quadriceps muscles (10 repetitions, 5–10 s each repetition, twice a day);
Isotonic Exercises	• Upper limbs and unaffected lower limb: free/resisted active mobilization of unaffected limbs; • Affected/operated limb: free active mobilization of the tibia-tarsal joint with dorsiflexion and plantar flexion, passive or active assisted mobilization of flexion/extension of the hip joint with flexion/extension of the knee and abduction/adduction of the hip joint to the midline of the body (5 repetitions twice a day); • Trapezius lumbopelvic extension (5 repetitions twice a day)
Reinforcement and/or teaching of:	• Bed positions; • Lift technique: the first lift should take into account the specifics of the surgery, in addition to concerns with the stockings, hemodynamic stability and balance; • Transfer bed/wheelchair, wheelchair/bed; • Walker and crutch walking (taking into account balance, strength, type of load); • Daily Life Activities (AVD's) [transfer, clothing (dressing/undressing), chocking, bathing (washing/drying), getting in and out of the bathtub, positioning, getting in/out of the car, going up/down stairs]; • Guidelines for the discharge to the person and family/caregiver about ADLs, assistive products according to the specific needs and housing conditions of the household, as well as prevention of falling at home

specialist in rehabilitation nursing can play a decisive role in the rehabilitation of the person, through an evaluation process and reeducation, which involves a set of therapeutic rehabilitation exercises for the person, we defined as the central question for this study: "What are the gains of providing rehabilitation nursing care to the elderly with mobility deficit due to femur fracture?".

We believe that the results of this study, which aims to identify the gains of nursing care for people with mobility deficits, resulting from the implementation of a rehabilitation nursing program, constitute an important contribution to the reflection on this issue and the relevance of the intervention. Rehabilitation Nursing, aiming at the implementation of interventions adjusted to the care needs of each person.

2 Methodology

This pilot study has a descriptive and cross-sectional approach. It was conducted between September and November 2018 and involved elderly people with mobility deficit due to femur fracture, admitted to the orthopedics service of a hospital in southern Portugal.

The inclusion criteria defined for sample selection were: people over 65 years old and diagnosed with femur fracture. An accidental sample consisting of ten people who met the inclusion criteria in a target population involving a total of 45 patients was used.

The exclusion criterion used was the Mini-Mental State Examination (MMSE), to assess cognitive status. Of the 45 people to whom the scale was applied, 35 people were excluded because they had cognitive impairment, and the final sample consisted of ten people. The selected sample was exposed to the purpose of the study and given informed consent. This was duly signed in compliance with ethical principles for research.

The observation and application of the previously defined measurement scales took into consideration the study variables. The measurement instruments used in the study were: Mini-Mental State Examination (MMSE), Berg Balance Scale (BSE), Lower Scale, Goniometry and Barthel Index. Figure 1 represents the flowchart of the relationship between the foci and the measurement instruments used in the study.

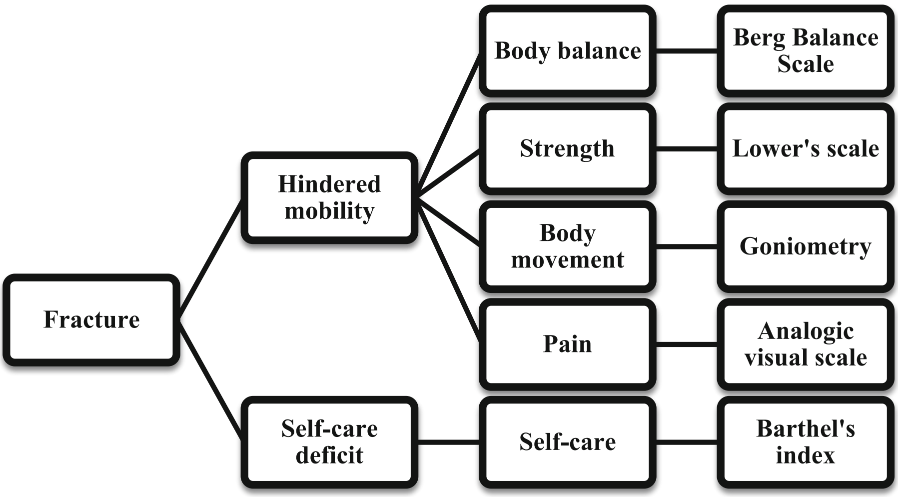

Fig. 1. Flowchart of relationship between foci and measuring instruments

3 Results

In order to respond to the proposed objectives, we will initially present the characterization data of the subjects and then the results that allow us to identify the gains of rehabilitation nursing care for people with mobility deficits. In these, the two evaluation moments are taken into account, the first evaluation (T0) corresponding to the first lift and the second assessment (T1) corresponding to the discharge of patients operated for femoral fracture.

The ten (10) elderly people who participated in the sample underwent femoral fracture surgery and will be identified by the letters: A, B, C, D, E, F, G, H, I and J.

Sample Characterization

Table 3 allows us to verify that the sample is mainly composed of elderly women (60%), with an average age of 79.1 years and in which 70.0% are 75 years old or over, having the majority of people (60%) only the 1st cycle of schooling. Most people (60%) had only the first cycle of education. Most of the subjects suffered femoral neck fracture (40%) and trochanteric fracture (40%) and underwent surgery with pin placement (50%) and total hip prosthesis (30%).

The dependence of these people before the fall was provided by themselves and according to them it was concluded that 20% were dependent on caregivers and the remaining 80% were independent. The 20% who were dependent lived in the Home and used walking aids (cane and walker or wheelchair). Of the 80% independent, 10% used walking aids (walking stick). At discharge, 90% returned to their initial residence with a difference of 10% to the institution defined by their families. Of the most common personal history, 60% had hypertension, 30% had stroke, 20% had vertigo syndrome, and 10% had Parkinson's disease. All patients presented as a reason for fracture the fall in which 90% happened inside the homes and 10% abroad.

Hindered Mobility

Regarding pain, at T0, all patients had "average pain" and at T1 all patients had "mild pain".

The average assessment of lower limb muscle strength operated at T0 is 3/5 and the average assessment at T1 is 4/5. The muscle strength of a patient's operated limb ("H") was not evaluated because the patient had cruro-podalic plaster splint on the limb.

The flexing hip joint amplitude (ROM) was evaluated with the flexing knee with a minimum of 0° and a maximum of 125°. At T0 assessment, ROM ranges from 75 to 90° with an average of 83 and at T1 assessment, ROM ranges from 90 to 105 with an average of 93. One patient's ROM ("H") was not assessed because knee joint flexion due to presence of cruro-podalic plaster splint in the operated limb.

Regarding balance and risk of falling, in the T0 assessment the total BSE values range from 1 to 12 values, with an average of 4.9. At T1 evaluation the final BSE values range from 10 to 35 values with an average of 21.4.

Using Barthel's Index, mobility was assessed at two moments and it was found that at T0 evaluation, 1 of the patients was assessed as immobile and the remaining 9 as wheelchair independent with an average of 4.5. At T1 evaluation, 5 of the patients were dependent on verbal or physical walking aid and the remaining 5 independent on walking, and the use of walking aids was possible, with an average of 12.5.

Self-care Deficit

In order to verify the EEER care gains, the results of functional independence of the elderly operated on the femur fracture are presented using Barthel's Index in Table 4. In

Table 3. Sample characterization

Gender	Male: 4 (40.0%)
	Female: 6 (60.0%)
Age	65–69 years: 3 (30.0%)
	70–74 years: 0 (0.0%)
	75–79 years: 3 (30.0%)
	≥80 years: 4 (40.0%)
Schooling	1º Cycle: 6 (60.0%)
	2º Cycle: 2 (20.0%)
	3º Cycle: 2 (20.0%)
Fracture	Femoral neck: 4 (40.0%)
	Trochanteric: 4 (40.0%)
	Sub-trochanteric: 1 (10.0%)
	Femoral condyle: 1 (10.0%)
Surgery	Total Hip Prosthesis: 3 (30.0%)
	Hip Partial Prosthesis:1 (10.0%)
	Peg: 5 (50.0%)
	DHS: 0 (0%)
	Screws: 1 (10.0%)
Walking aid	Walking stick: 2 (20.0%)
	Walker/Wheelchair: 1 (10.0%)
	Without walking aid: 7 (70,0%)
Place of residence prior to hospitalization	Institution: 2 (20.0%)
	Home: 8 (80.0%)
Place of Residence after hospitalization	Institution: 3 (30.0%)
	Home: 7 (70.0%)
Dependence before hospitalization	Dependent: 2 (20.0%)
	Independent: 8 (80.0%)
Common priors	HTA: 6 (60.0%)
	CVA: 3 (30.0%)
	Vertiginous Syndrome: 2 (20.0%)
	Parkinson's disease: 1 (10.0%)
Reason of Fracture	Fall: 10 (100.0%)
Fall location	Inside the house: 9 (90.0%)
	Outside the house: 1 (10.0%)

the T0 evaluation, 8 of the patients are moderately dependent on the performance of the ADLs if 2 are severely dependent. The average value of the final Barthel's Index at T0 is 42.5 and the standard deviation 6.02. At T1 evaluation, 2 of the patients are moderately dependent and 8 are slightly dependent. The average final value of the Barthel's Index is 73.5 and the standard deviation 15.10.

Table 4. Functional independence values of elderly operated on femoral fracture

Functional independence of the elderly (Barthel's index)	T0		T1	
	n.º	%	n.º	%
Fully dependent (<20)	0	0	0	0
Severely dependent (20–35)	2	20	0	0
Moderately dependent (40–55)	8	80	2	20
Slightly dependent (60–90)	0	0	8	80
Independent (>90–100)	0	0	0	0

4 Discussion

The aging process associated with chronic diseases and environmental factors contribute to the occurrence of falls in the elderly, predisposing them to musculoskeletal disorders, such as lower limb trauma [15]. The most prevalent chronic disease in this sample is hypertension [15]. Similar to other studies, the cause for the largest number of hospitalizations in the elderly is the fall, with less than 1 m in height (91.9%) and of the patients admitted by fall, 50.6% had femoral fracture [16]. The fall is the main reason for femur fracture [17].

This data corroborates the findings of other studies [15, 16], and it was found that of the elderly who underwent surgery for lower limb trauma, there was a higher prevalence of women and an average age greater than 75 years. The type of fracture in this study did not differ from other studies [16, 17], with upper femoral fractures (80%) being more frequent than sub-trochanteric fractures (10%).

Regarding the mobility focus, there was an improvement in the balancing ability expressed in the increase of the average between evaluations and a gain of 16.5 points in the Berg equilibrium scale (BSE). Considering a score below 45 in BSE with higher risk of falling, the value evident in T0 indicates risk of falling, and despite its increase in T1, it remains below the cutoff point 45. There was an improvement in balance and decreased risk. However, this risk is still present at the clinical discharge of the participants in this study, similar to the study by Asplin and colleagues [18], who found in their comparison study between a group that received rehabilitation intervention and a group of In the control group that received conventional intervention, most patients in both groups had BSE values below the cut-off point at fall, which decreased after one month. Although these ten participants maintained risk and balance deficit with values below the cutoff point stipulated in T1, the performance of the rehabilitation nursing expert improved and improved health for the patient in these factors.

The findings of this study in relation to body balance are in line with those of other studies [18, 19], where it was found that the intervention groups, which received rehabilitation care, had fewer falls compared to the control group. (conventional intervention) and comparing the two groups, it was found that the intervention groups had a lower risk of falling than the control groups, decreasing in both [18], with improved balance in the intervention group compared with the control group [19]. It should be noted that in a systematic literature review study [20] on the effectiveness of balance training in people with femoral fracture, it was found that balance training leads to an improvement in overall physical function, to an increase in lower limb strength and improved performance of ADLs. In several studies, improved mobility is associated with improved balance [19], lower risk of falling [18], fewer falls [18, 19] and improved walking/walking [18, 21].

Regarding pain intensity in the postoperative period of femur fracture, there was an improvement in T0 for T1, with pain relief, where in T0 pain intensity is considered as “moderate pain” and in T1 as “mild pain”. Similarly to other studies [22], the specialized rehabilitation nursing intervention involving the active and assisted mobilization of the operated limb hip joint were decisive in reducing pain and improving muscle strength [23].

In this study, mobility was also assessed using Barthel’s Index presenting an average of 4.5 in T0 and 12.5 in T1. This increase in the average from T0 to T1 evaluation indicated an improvement in mobility. Specialized nursing rehabilitation care was crucial for this improvement in mobility, control and gait efficiency [24], with repercussions on its functional independence.

The results obtained in the evaluation of the participants’ functional independence showed that in the T0 evaluation, 80% of the participants are moderately dependent on the performance of ADLs and the remaining 20% severely dependent. After implementation of the EEER intervention plan, most of the elderly were discharged with slight dependence (80%) and the remaining 20% with moderate dependence. At discharge, participants are dependent on performing ADLs, but there is a substantial improvement in their dependence on performing ADLs, as demonstrated by the interpretation of mean values at T0 and T1. The average at T0 is 42.5 which correspond to a moderate dependence and at T1 of 73.5 which corresponds to a slight dependence. The 20% of participants with moderate dependence corresponded to institutionalized patients, who according to their own presented this level of dependence before the fall. The remaining 80% were, according to their own independents, in performing the ADLs. Most of these independent pre-fracture people achieve the same level of post-fracture independence [21].

It should be noted that the data from this study are corroborated by other studies [25], which highlight a decrease in Barthel’s index, comparing the pre-fall index with the post-fall index. The average Barthel’s Index score is found to be moderately dependent and therefore a high percentage of postoperative persons are dependent on caregivers.

The compromise of mobility and disability in self-care are interrelated. Similar to another study [26], which compares the existence of mobility limitations (balance and gait speed) with disability in the elderly population, it is found that balance limitations are associated with a higher probability of developing deficit or inability to perform ADLs.

5 Conclusion

The early intervention of the rehabilitation nurse is an important foundation in empowering patients' autonomy in the face of their biopsychosocial changes, as well as their family/caregiver. Considering the central objective of this study, the functional independence of the elderly with mobility deficit due to femur fracture was improved and instruments that allowed the evaluation of the rehabilitation nurse's interventions were used for its implementation. The results obtained from this evaluation confirm that the care provided by this specialist nurse contributes to health gains with a clear improvement in the functional independence of elderly people with mobility deficit due to femur fracture.

The consistency of the results obtained is considered insufficient due to the small number of study participants and the type of study, with limitation of the time period, as well as the high vulnerability of the patients.

The importance of conducting further studies on this subject over a longer period of time is confirmed, as well as the need for a larger sample, in order to evaluate and validate the intervention of the rehabilitation nurse in improving the care provided to the elderly patient with mobility deficit due to femur fracture, in a hospital context and also in a community context. It is essential that after hospitalization, there is a scenario of care for the elderly with mobility deficit due to femur fracture and/or undergoing orthopedic surgery, in their community context that allows them to ensure a properly structured rehabilitation process. This implies the need for an organized health system for the health needs of the elderly and their families, capable of responding to the multiple situations of illness and problems and ensuring a continuum of organized, integrated and articulated care between themselves. In this process of transition from person to community, we assume that the rehabilitation nurse is a structuring element in the recovery and integration of health care. We also consider that in this process of continuity of care, the skills of this specialist are crucial in the management of elderly care with this issue and in supporting informal caregivers and other professionals involved in elderly care in their social context.

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Public and Other Health Initiatives

Technology and Rural Elderly Loneliness. Thinking About Analog Solutions for the Community

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Abstract. Loneliness has been raised in recent years as one of the main problems affecting older people. A 2017 study by the Madrid City Council shows that 6.8% of surveyed population had feelings of loneliness, rising to 14.2% in over 65 population. Most of the approaches that deal with the problem of loneliness do so from biomedical positions. Social sciences can offer approaches towards community oriented solutions. Most approaches do not delve into the structural causes and factors that appear in modern loneliness. In this text we try to point out some ideas of the relationship between loneliness and technology and how in recent years technological solutions appear to alleviate loneliness in elderly people. In rural contexts such as the one in which we are developing the 4IE project (the regions of Extremadura, in Spain, and Alentejo, in Portugal) older people still use analogue technologies, like television. We try to point out the importance and centrality of these technologies in the contexts and how relevant are when developing technological solutions for elderly people loneliness.

Keywords: Aging · Loneliness · Anthropology · Sociology · Technology

1 Introduction

In recent years, loneliness has been defined as "disease" or "epidemic" from the headlines of the major media in the West [1–3]. "The body of an elderly person who lived alone found dead" is a headline repeated with some frequency in newspapers, something that points to the serious problem of personal relationships and care that is already appearing in our times. Death may be the most extreme and ultimate consequence, but we cannot forget all the problems and difficulties associated with being older and living alone. Some studies point to the correlation between this fact, living alone, and the growing feeling of loneliness at the elderly. A 2017 study by the Madrid City Council shows that 6.8% had feelings

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of loneliness, rising to 14.2% of the population over 65 [4]. The media, the academics and public authorities are paying attention to the problem. There are doubts as to whether this generalized approach to loneliness can offer the most comprehensive analysis.

Most of the research has been developed from medicine, nursing, psychology and other health sciences, "diagnosing" rather than offering explanations. Almost nobody hesitates to put social explanations as the origin of loneliness. However, there is a void in how the concept has been constructed academically. The scientific literature points to an extensive list of health problems related to loneliness such as cognitive impairment [5], depression [6], increased blood pressure [7], neurodegenerative diseases such as Alzheimer's [8] or worsening immune function [9]. As noted in an analysis of systematic reviews, loneliness would imply an increased risk of mortality, cardiovascular disease and mental health problems, with less evidence in relation to other physical health conditions and behaviors [10]. Several studies indicate that loneliness has a significant relationship with increased use of medical services [11–13]. The medical sciences often seek their space when defining concepts and, in the case of loneliness, the construction of their definition has always maintained this biomedical aura. Most approaches do not delve into the structural causes and factors that appear in modern loneliness.

From social sciences we can offer analyses that focus their gaze on fundamental aspects that underlie phenomena such as modern loneliness. In this sense, we must analyze how loneliness affects the context in which it appears and how it influences the processes of linking and disassociating these social groups. It is extremely important since even from other scientific disciplines and with methodological assumptions different from those of our discipline, it has been pointed out that culture appears as a differential factor to be taken into account in the study of loneliness. A study carried out in Europa [14], for example, shows how there are differences in the feelings of loneliness in northern and western societies. In Mediterranean cultures, such as the Spanish, loneliness seems to have a greater incidence. Since they are more familiar societies, there are fewer resources when it comes to dealing with social isolation. This may lead to more older people in these contexts claiming to feel lonely. Older adults in northern European countries, who are seen as the most individualistic [15], tend to be less alone than older adults in southern European countries, who are seen as the most strongly united to the family. The analyses that we can offer from anthropology must open up new avenues for research through the classical categories that discipline offers us. These analyses can also make contributions in relation to the relevance of the solutions proposed from different fields, critically evaluating the steps that have been taken so far in this direction.

2 Objectives

This text is an approach to how technology has been able to influence certain modern processes of social dissociation that may be related to feelings of loneliness. This vision, however, does not leave aside the possibilities that technology offers when looking for solutions to overcome this situation. We will try to point out how, from some researches, it emerges as a solution to rebuild social relations. We will also rely on some of the notes and bibliographic reviews developed at the project "International Institute for Research and Innovation on Ageing (4IE)".

3 Technological "Consumption" and Social Life

We are immersed in continuous processes of dissociation. Some of the old spaces in which individual identities traditionally merged with group identities have disappeared. In this sense, technology now plays a central role. In ancient societies collectivities were above the subject, the collective prevailed over the individual [16]. The arrival of modernity presents a process of change in which old social structures begin to break down. A process of individualization is then set in motion, which separates the subject from society and translates into a transition from traditional to modern societies. This implies a liberation of individuals from these old communal structures [17]. In this way, there is a slow process of dissociation that distances the individual from his group structures, replacing them in many cases with more open structures, but where individual feelings of loneliness are more and more present.

Pre-modernity defined identities as linked to community institutions such as the church, the family or the village. This process of individualization and dissociation full of uncertainty generates subjects who are increasingly solitary and distant from one another. Our modern societies can be defined by their systemic production of disassociation, of rupture of social relations, something that permeates all the society. The community, the family, those groups that made up the centre of life have begun to become less and less visible. Loneliness has a material base that we do not notice, it is a consequence of the decisions we make in the social organization of our life and the material environment we endow ourselves with: loneliness is a production [18]. Bauman [19], coined the term "massive loneliness" to refer to that feeling of loneliness in company generated by new social relations through devices and platforms of network communication. Turkle observes how the use of the Internet and social networks isolate us from communication with the world around us. He proposes how, unlike mobile communication, face-to-face communication does not allow us to rectify and think about our answers, but is too "alive" [20].

Contemporary Western societies are characterized by precarious or very lax social ties, historically high levels of mobility of both capital and labour, and an increasing number of single-family dwellings. This new form of social structure may have a price and may involve more frequent and sustained experiences of loneliness [21]. Our society sees the stability and happiness of people subjected to uncontrolled stimulation, faced with uncertainty, anxiety and unrest in jeopardy. The individual increasingly lacks meaningful, affective and solid close bonds, constituting a "secure individuality". It is paradoxical to find so many human beings lonely and painfully alone in the age of communications. The old identities are not enough for the feelings of belonging in the face of the breakdown of the social body. Cuts of subjectivity that are threaded according to the needs of the market and produce an illusion of authentic individuality. Loneliness is a complex multidimensional, is a socio-cultural product [22].

Let's use a small example to point out how has been the evolution of recent years of technology consumption and how it relates to how personal relationships have evolved. In the 1970s, what was called "Teleclub" appeared in some towns in Spain. As it is defined in the statutes of the Teleclub "The Teleclub is a civic center of open and voluntary collaboration, created to promote the personal formation of its members, the community development of the society in which it resides, and the professional, social and economic progress of the human nucleus in which it carries out its activity". These Teleclubs appeared above all in very ruralized contexts, with difficulty in accessing modern televisions, generally for economic reasons. In some cases, these centres were able to become an important institution where they were located, revitalising social and cultural life. The installation of television in these Teleclubs was an important milestone for that society, generally very backward, because it was an open window to the outside world, which allowed rural communities to connect with the rest of humanity [23]. There is little doubt that the Franco regime was able to use these centres as a place to develop its propaganda programme and the extension of its ideas, but it is also true that, with the arrival of democracy, these centres were also able to become spaces where the changes that resulted in the democratic transition could take on a certain form in these communities. The consumption of television in these centers, therefore, not only served to get in touch with the outside world, but within, towards the community, helped to maintain ties with neighbors and energized the social life. In the news on Spanish public television [24], a resident of one of the towns where a Teleclub is still open points out: "If there is no Teleclub, there is no village". It refers to the village not as a political entity or circumscription delimited by a municipal term, but rather to social life in common.

At the present time, the development of Internet also has as a consequence a certain "social isolation". The lack of access to Internet and the central role it plays in our days, leaves many people out of conversations with their families. As an investigation into loneliness in the elderly points out, many people who do not have access to Internet are left out of conversations and social life even when they visit or are visited by their relatives: "they talked all the time about thing that I wasn't able to understand" [25]. Even a person can feel isolated when surrounded by others. This is called phubbing: ignoring another person during a conversation because they are using our smartphone. Technology now, at times, tends to lock us in, to confine us. This influences our daily lives, not only the way we relate to each other, but also our attention or our consumption model. The disappearance of small businesses, where people communicated, with the appearance of big electronic stores has changed the way we buy, for example. Just ten years ago, information and communication technology (ICT) companies promised that their products would help create meaningful communities and relationships. However, some of these social networks deepen existing divisions, both individually and in groups. We may have thousands of contacts on social networks, but they may never satisfy us as much as personal relationships. A recent article examines how feelings of loneliness are articulated and revealed on Twitter, pointing to a significant number of tweets where users claim to be alone or very alone [26].

But technology has also appeared as a solution to the problem of loneliness. For example, internet literacy in the elderly seems to have shown a decrease in feelings of loneliness. Already in 2007, a German experiment was developed through the use of e-mail that proved to be a good space for socialization and reduced feelings of loneliness in older people who had never used technology [27]. The use of videoconferencing seems to reduce feelings of depression and loneliness [28]. Playing with Nintendo Wii, for example, activates certain motor functions and is related to reducing feelings of loneliness in older people [29]. The use of animal robots in people living in a nursing home showed high levels of attachment to the robot, comparable to that of a live animal, which also helped reduce their feelings of loneliness [30]. Ultimately, there are a variety of technologies to help alleviate the loneliness of older people. We want to point out, however, a couple of notes that sometimes go unnoticed.

Technology often appears as palliative care. Although they demonstrate some effectiveness at individual levels, it would be necessary to consider how this diversity of technologies can be integrated into public plans and policies that, through effective strategies, combat loneliness in the elderly. For this, something important should be taken into account. Older people, especially in rural areas (like our context of the regions of Extremadura and Alentejo) are predominantly analogue. The incidence of Internet use among our elderly is quite low, most of them still move between analogue communication and information technologies. These also seem to demonstrate themselves as important means to combat loneliness. As Mary, one of our informants, said to us "(...) I have the radio there, in the kitchen, but I like television very much, because I am alone, I have nobody and I put on my television and it is my companion". Television can therefore appear as the technological medium through which we work to improve the quality of life of older people with the aim of reducing their loneliness.

4 Conclusions

Technology should be a way to transform a problem such as loneliness based on social structure and the social changes that have taken place in recent years. If we act individually, not taking into account the different contexts where older people are exposed to a life in loneliness, we will not change these problems. Technology must therefore act as a means to transform social dynamics that are at the basis of the massive production of loneliness.

Space is a physical reality. A territory is a space built by the action of human; it is a space that generates human ties and bonds. Rallph Keyes, already raised in the seventies, as when speaking of community we must differentiate the community as territory and the sense of community. The first one was related to the place, to the physical space where community life developed. The second, the sense of community, is what we find among the people who know us, with whom we feel safe. This traditionally appeared with those people who were physically close, close to the space, to the community where we were. Today, however, shows us how more and more the sense of community is displaced from a physical space. When we talk about recovering the sense of community it is the one in which the person who sells us bread knows our name, where "the butcher can comment on meat and life" [31]. Technologies to combat loneliness must take these contexts into account and serve as effective means to produce community.

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Psychometric Qualities of a Core Set to Ascertain the Functional Profile of Portuguese Elderly Citizens

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Abstract. **Objectives:** This paper describes the psychometric qualities of a core set composed initially of 31 codes and extracted from International Classification of Functioning, Disability and Health, to ascertain the Functional Profile of Portuguese Elderly Citizens, residing in their own home or at a family or friends' home. **Methods:** Cross-sectional, descriptive study, with a final sample totaled 351 elderlies. Data collected by health professionals in the participants' houses, using the Elderly Nursing Core Set questionnaire. **Results:** The recommendation of the construct to the EFA was "excellent". Regarding reliability, the construct revealed factorial reliability. In terms of validity, the construct presented factorial validity and convergent validity, although failing regarding discriminant validity. **Discussion:** Comparing psychometric qualities between the original Elderly Nursing Core Set previously applied to institutionalized citizens in relation to the one presented in this paper (citizens residing in their own home or at a family or friends' home), lead to five latent factors and differences between functional profiles. More than half of the citizens are married and almost half of the sample never went to school, thus revealing an important aspect characterizing a lower literacy level of the citizens involved in this research.

Conclusions: The work based on Core Sets extracted from the International Classification of Functioning, Disability and Health, delineated to assess the nursing care needs and/or the outcomes of nursing interventions of citizens aged 65 years old or older, will be an ongoing process that will lead to the promotion of an Healthy Ageing and functional ability, as stated by World Health Organization.

Keywords: Ageing · Elderly residing in the community · Functionality profile assessment · Confirmatory Factor Analysis

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1 Introduction

Demographic data have been shown that Portugal is one of the European countries presenting one of the highest ageing index (153.2 elderly per 100 young), with this ageing phenomena being an ongoing process that will probably last the next fifty or sixty years [1]. This change in the age profile in Portugal (like in other countries of the world) is mainly characterize by two simultaneously processes: (i) the reduction of people with age less than 15 years (a decrease in birth rate and an increase in the emigration of Portuguese young people [2]) along with; (ii) the raise of the average life expectancy that lead to the increase of people with 65 years and more. According to the Statistics Portugal Institute (Instituto Nacional de Estatística – INE) the life expectancy was 80.80 years at birth for the entire Portuguese population, between 2016 and 2018. On the other hand, life expectancy at age 65 attained 19.49 years, also for the entire population, but distributed between man and women as follows: (i) a man aged 65 years could expect to live another 17.58 years; (ii) and woman aged 65 another 20.88 years [3].

However, when introducing “Health” in the context of life expectancy, regarding citizens with aged 65 years, it comes up the concept of “Healthy life years at 65 years”. This concept introduces the number of remaining years that a person aged 65 is still expected to live in a healthy condition, i.e., citizens living with the absence of limitations in functioning/disability during a certain period of time. According to the most recent statistics data (year 2017), the healthy life years at 65 for the Portuguese population, by sex, is as follows: (i) 7.9 years for mean; (ii) 6.7 years for mean; whose data puts Portugal almost among with last group of European countries whose citizens that live with less number of Healthy life years [4]. However, despite the aforementioned healthy life years at 65 years, there are citizens who already live with the presence of disabilities after this age, or even earlier.

A recent international report was done, to assess the Portuguese health system in relation to its performance on key challenges and opportunities in the post-financial crisis recovery period, involving the European Observatory on Health Systems and Policies, and the Regional Office for Europe of the World Health Organization (WHO), as well as the Health Portuguese authority (Serviço Nacional de Saúde – SNS). One of the reviewed topics was “Multimorbidity”, and the authors of the report state that most adults attending primary health care have more than one chronic condition. Data provided on this report (referred to 2016 and designated by “Burden of Chronic Disease”) shows that 41% users of Portuguese Healthcare System presented multimorbidity (they have equal or more than two chronic diseases (who 53.7% of them presented four or more chronic diseases), with only 18% presented one, thus resulting on 41% of citizens free from any chronic disease [5]. Moreover, multimorbidity may cause serious implications when health personnel need to provide care delivery to citizens in this health condition, which may become a challenge task, because the treatment of one chronic disease will be in the context of other chronic conditions. Regarding age, the same report states that major percentage of citizens with chronic diseases occur between the following age groups: (i) ages between [60–70], 70% for man and 75% for women; (ii) and ages between [80–90], 81% for man and 83% for women; (iii) followed by a decrease regarding the next age group (ages between [90–150]), more pronounced in man when compared to women, with a medium percentage of 72% of citizens presenting chronic disease [5].

As citizens are getting older, they become increasingly fragile, presenting functional impairments, multimorbidity (already shown based on the aforementioned data), and a significant prevalence of chronic conditions that easily decompensate them, leading to progressive losses, as envisioned by the various biological, psychological and social theories, frequently originating acute health care situations [6–8]. Due to the complexity and heterogeneity of individual aging, the level of functionality may vary distinctly from person to person. Studying the individual aging by integrating a care model in continuity and proximity, allowing the elderlies and family caregivers to monitor and manage their health at home, always under the supervision of health professionals, may result in management of various chronic conditions (multimorbidity) and to provide an appropriated "safety net" before occurring an "health crisis". To achieve this goal, i.e., to promote the quality of life related to the elderly's health, by requalifying their potential and allowing them to live with more independence and autonomy, it is essential: (i) to evaluate his/her their functional capacity in order to identify their disabilities; (ii) identify his/her appropriate self-care behavior that allows diagnosing, planning and assessing the necessary preventive nursing care needs, assuming that the demands of nursing care are high among older adults [9, 10]. Additionally, according to other authors, citizens with multimorbidity have better health outcomes when they benefit from adequate health interventions, structured from previous assessments of their functional level [8, 11], allowing us to the get the "big picture" in regard to the presence of disabilities and the overall health state of a person, around several components of his/her life, such as physical, psychological, social and environmental.

To achieve this goal, i.e., to classify the degree of functioning, the WHO developed the International Classification of Functioning, Disability and Health (ICF), which is the framework for measuring health and disability at both individual and population levels [12]. However, the full ICF taxonomy encompasses an extremely large number of elements. To develop a more manageable means of assessing functioning, several core sets (sets of ICF codes) have being developed [13].

In Portugal, the authors César Fonseca et al. have being done a very important and pioneer work on studding indicators of disability, and more particularly regarding limitations in activities and limitations in the functional capacity, targeting people aged 65 years and older. This important work result on grouping sets of ICF codes (core set), namely the "Elderly Nursing Core Set", aiming to classify the degree of elderlies functioning, which is also capable of even establishing elderly "nursing care needs" [10]. However, as mentioned earlier, their target was people already institutionalized.

Therefore, differing from the work developed by César Fonseca et al., the goal of this research is to study the Psychometric Qualities of the ENCS to ascertain functional profiles of Portuguese elderly citizens living in a rural area at the main Portuguese territory (people residing in their own homes or at a family or friends' home, i.e., in the community, thus not institutionalized). Another aims of the proposed work are as follows: (i) extract (through an Exploratory Factor Analysis– EFA) a set of latent factors that explained the relational structure of items applied to elderly resident citizens; (ii) validate the model extracted from the EFA through a Confirmatory Factor Analysis (CFA), which is not provided in [10]; (iii) a comparison between average functional scores of the entire sample, based on ENCS strategy and the computations of those using the extracted (*factor score weights*) *fsw* resulting from CFA (also not provided in [10]).

Finally, this research will contributes to the lack of population-based studies on socioeconomic, demographic, and health characteristics of the adult population living in rural areas [14].

2 Methods

2.1 Subjects

This research work involved a sample of citizens with age of 65 and more (elderlies) residing in a rural area namely Baixo Alentejo – BA, located at middle southeast of Portugal main territory that makes border with Spanish region namely Extremadura. 468 participants were selected by stratified random sampling of all 32893 citizens registered in the database of the Health Local Unit of Baixo Alentejo Region (Unidade Local de Saúde do Baixo Alentejo – ULSBA [15]). The sample was stratified by sex (male and female) and by aged group (65–74, 75–84 and 85 and more years old). Data were collected by health professionals in the participants' houses, using the Elderly Nursing Core Set questionnaire developed in [10], between January 2016 and April 2017.

The inclusion criteria rules (only comprising citizens aged 65 or older) were, cumulatively: (i) individuals interested in participating in the study; (ii) residing at the BA region in their own homes or at a family or friends' home; and (iii) those who were able to make decisions, even if sick or hospitalized. The final sample totaled 351 elderlies, those who answered the ENCS questionnaire fully and correctly, and signed the respective informed consent, as well as fulfilled all the stages of the inclusion criteria (response rate of 75%). More details about the construction, the main characteristics and the scale used by the codes (items) included in the ENCS can easily be found in [10].

2.2 Statistical Methods

The list of 31 ICF codes identified by César Fonseca et al. is shown in Table 1 (extracted from [16]).

Table 1. ICF codes included in ENCS [16].

ICF descriptors [17]	ICF codes [18]
Body functions	b110, b114, b140, b144, b152, b164, b280, b420, b440, b525
Body structures	s810
Activities and participation	d230, d310, d330, d350, d410, d415, d445, d450, d465, d510, d520, d530, d540, d550, d560, d760
Environment	e310, e320, e340, e355

The first working stage started by an Exploratory Factor Analysis (EFA), including the 31 codes listed in Table 1, in order to find the number of latent factors that explained the relational structure of the items, using IBM SPSS Statistics version 24.0.0 (IBM, Armonk, NY), as described in Marôco [19]. After that, the resulting factorial structure was processed by a Confirmatory Factor Analysis using the software AMOS (v.24, SPSS, an IBM company, Chicago, IL), in order to obtain the respective factorial validity of the resulting factorial structure, as suggested in Marôco [20]. The third stage encompassed a CFA with a second order factor, in order to infer each *fsw* ICF codes, which can be used to compute the functional profiles scores, and compared them with those computed adopting an unitary weight for each item, as proposed by the authors in [10].

The final task comprised a short descriptive analysis, to describe the biological and sociodemographic variables of the sample data, using absolute and relative frequencies.

3 Results

3.1 Exploratory Factor Analysis

After checking some few deviations of normality assumption of the 31 items (codes ICF), based on the analysis of skewness (Sk) and kurtosis (Ku), notably using thresholds of $|Sk| < 3$ and $|Ku| < 10$ (as suggested by Marôco in [19]), the EFA analysis was based on the Spearman's correlation matrix. Results can be shown in Table 2.

Results presented in Table 2 shows that the obtained factorial structure exhibit five latent factors (after iteratively removal of codes b280, b420, b440, b445, b525, and s810, which started with the initial number of eight latent factors), following the rule of "eigenvalue greater than 1". Almost 100% of the 25 factor loadings are equal or greater than 0.5, while four latent factors presented mean values of the respective factor loadings equal or greater than 0.7, expect for factor "F5" due to some lower factor loadings, but all greater than 05. Regarding the communalities, almost all were large (only 20% present values less than 0.5, but none of them are below than 0.3, which can be a threshold considered appropriate for this type of construct). The total variance explained by the model is higher than 60% (64.3%), with the "F1" latent factor explaining more than 50% of this variance. Finally, the recommendation to the EFA was considered as "Excellent", according to the Kaiser-Mayer-Olkin adequacy measure (KMO = 0.909). Moreover, regarding some adjustment indexes to evaluate the quality of the model adjustment, like the goodness-of-fit and the adjusted goodness-of-fit indices, they present relative poor, (GFI = 0.630 and AGFI = 0.350), which may be related to the relative low facto loadings o "F5", although a "very good" RMSR* of 0.05 was achieved

Regarding the contents of the ICF codes (items of EFA), we produced the following thematic classification of the five Latent factors, based on [17, 18]: (i) "F1" = "Self-care in activities of daily living"; (ii) "F2" = "Self-care in fundamental human needs"; (iii) "F3" = "Mental functions"; (iv) "F4" = "Communication"; (v) "F5" = "Support and relationships", with some similarity to the one proposed by Fonseca et al. [10].

Table 2. EFA results, leading to five retained latent factors, respective factor weights and communalities.

ICF codes (items)	Latent factors[a]					Communalities
	F1	F2	F3	F4	F5	
d450	.807	–	–	–	–	.716
d410	.804	–	–	–	–	.747
d465	.763	–	–	–	–	.666
d415	.761	–	–	–	–	.646
d230	.753	–	–	–	–	.703
d510	.651	–	–	–	–	.720
d520	.649	–	–	–	–	.714
d540	.568	–	–	–	–	.711
Mean value	*.720*	–	–	–	–	–
d550	–	.808	–	–	–	.791
d560	–	.781	–	–	–	.772
d530	–	.492	–	–	–	.508
Mean value	–	*.694*	–	–	–	–
b114	–	–	.816	–	–	.792
b110	–	–	.809	–	–	.795
b140	–	–	.795	–	–	.761
b152	–	–	.587	–	–	.489
b144	–	–	.570	–	–	.523
b164	–	–	.495	–	–	595
Mean value	–	–	*.679*	–	–	–
d350	–	–	–	.799	–	.821
d330	–	–	–	.741	–	.751
d310	–	–	–	.662	–	.713
Mean Value	–	–	–	*.734*	–	–
e310	–	–	–	–	.718	.548
e320	–	–	–	–	.644	.469
e355	–	–	–	–	.533	.336
e340	–	–	–	–	.515	.390
d760	–	–	–	–	.504	.403
Mean value	–	–	–	–	*.583*	***.643***
Eigenvalues	9.749	1.606	2.156	1.438	1.129	–
Variance explained	39.0%	6.4%	8.6%	5.8%	4.5%	–
Cronbach's alfa[b]	$\alpha = 0.924$ (Very good)	$\alpha = 0.779$ (Reasonable)	$\alpha = 0.848$ (Good)	$\alpha = 0.853$ (Good)	$\alpha = 0.580$ (Almost unallowable)	–

[a]Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization;
Rotation converged in 7 iterations.
[b]Qualitative classification adopted from [19].

3.2 Confirmatory Factor Analysis

The second stage of this researched consisted on a CFA, using the factorial structure obtained from EFA (see Table 2), as a testable model. The computation started based on a first order model as shown in Fig. 1. The names included in the symbols representing the five latent factors are abbreviations of the thematic names that were given in the above section, notably: (i) "Self-care in activities of daily living" – "SC-ADL"; (ii) "Mental Functions" – "MF"; (iii) "Self-care in fundamental human needs" – "SC-FHN"; (iv) "Communication" – "COM"; (v) "Support and relationships" – "SR". The goodness of fit of the adjusted model can be assessed by reading the respective adjustment indexes listed at the top of Fig. 1. All the thematic names given to each latent factor were done in respect to the contents of ICF codes description, the name of ICF groups of codes [17, 18], as well as including the recommendations described in [10].

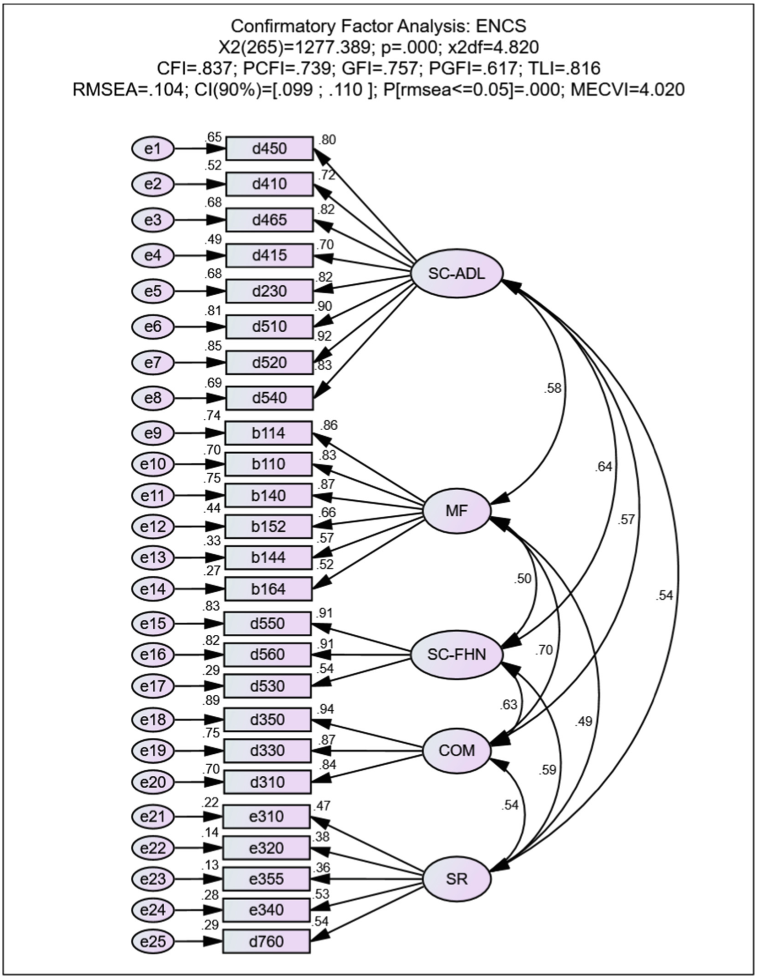

Fig. 1. Initial CFA model including the 25 items extracted from the EFA.

As can be seen, the model fit is poor: (i) Chi-squared statistics divided by the degrees of freedom $\left(\chi^2/df\right)$ is almost equal to 5; (ii) Comparative fit index (CFI) stays between [0.8; 0.9[; (iii) Goodness-of-fit index (GFI) is less than 0.8; (iv) Root Mean Square Error of Approximation (RMSEA) is greater than 0.1, among other issues (see Table 4.1 in [20] for the qualitative classification).

However, to achieve a better fit, the errors of observed variables (referred from "e1" until "e25"), were correlated, based on the modification indexes (MIs > 11) as suggested by Marôco in [20]. As can be seen, the Mean Expected Cross-Validation Index ($MECVI$) shown at the top of Fig. 2 ($MECVI = 2.897$) is lower than the previous model ($MECVI = 4.020$), which allows inferring that model in Fig. 2 presents a better global fit when compared to the model shown in Fig. 1.

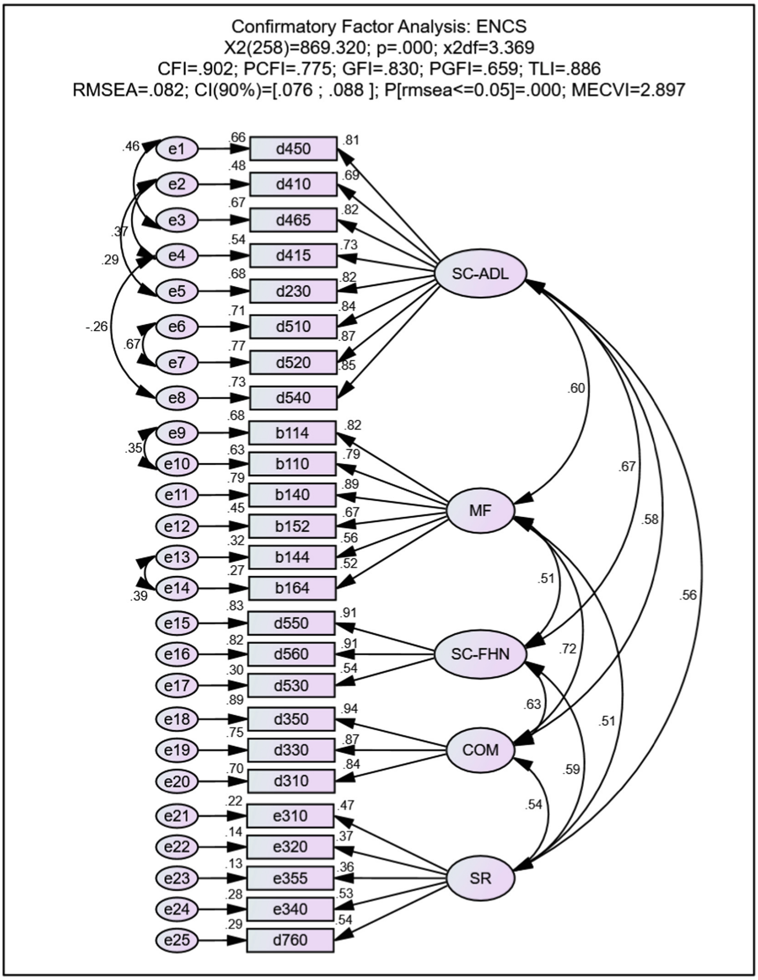

Fig. 2. Adjusted model based on the modification indexes (MI > 11, this threshold suggested by Marôco in [20])

The quality of the adjusted model can be now classified as reasonable: (i) Chi-squared statistics divided by the degrees of freedom $\left(\chi^2/df\right)$ is almost equal to 3; (ii) Comparative fit index (*CFI*) is "good", staying between [0.9; 0.95[; (iii) Goodness-of-fit index (*GFI*) is "favorable", staying between [0.8; 0.9[; (iv) Root Mean Square Error of Approximation (RMSEA) is "acceptable", staying between [0.05; 0.1[; Tucker-Lewis Index (*TLI*) is "favorable", staying between [0.8; 0.9[, (see Table 4.1 in [20] for the qualitative classifications used here). Regarding the model adjustment based on the MI values, it is important to refer that the process must be grounded on some theoretical aspects of the model, and not only correlate those errors because the involved MI values are high. For example, we assume that some of the items present some similarity in their formulation, and their contents are some way related, as an example: "d410 Changing basic body position" (brushing teeth, shaving, grooming, etc.) and "d415 Maintaining a body position" (bathing, drying, washing hands, etc.). As can be seen, these both codes refer the same body positions, like Squatting, Kneeling, Sitting, Standing, Bending, which may confuse respondents. The items individual reliability was measured by the respective standardized factor loadings (λ), with only two presenting values lower than 0.4 and a third almost equal to 0.5, which allows us to assume a "Favorable" factorial validity of the construct. The construct reliability (internal consistency) was evaluated through the Cronbach's Alfa (α_c) and composite reliability (CR), whose values are listed in Table 3 and almost greater than 0.7, as recommended in Marôco [20]. However, according to Hair et al. [21], values less than 0.7 may be accepted in case of exploratory research, which is the case here, thus we also assume a "favorable" reliability of the construct. Finally, regarding the construct validity (CV), we started by assuming a factorial validity of the construct, since it was checked that the items effectively conceive the "big picture" that is actually being measured by the specific latent factors. In relation to the convergent validity of the construct, this characteristic was evaluated by the average variance extracted of the CFA model (AVE) [20]. The results in Table 3 shows that only "SR" factor present a "fair" convergent validity (AVE values must be greater than 0.5, as suggested in Marôco [20]) which is due to the fact that this latent factor includes three standardized regression factor loadings lower than 0.5 (see Fig. 2). However, it is possible to foresee an almost overall "favorable" convergent validity of the adjusted CFA model.

Table 3. List of α_c, CR and AVE index values.

Latent factors	α_c	CR	AVE
SC-ADL	0.924	0.938	0.654
MF	0.848	0.863	0.521
SC-FHN	0.779	0.841	0.649
COM	0.853	0.914	0.780
SR	0.580	0.564	0.210

As an alternative solution to some high correlations between latent factors shown in model of Fig. 2 (all with $p < 0.001$), we suggest a hierarchical model positioning an

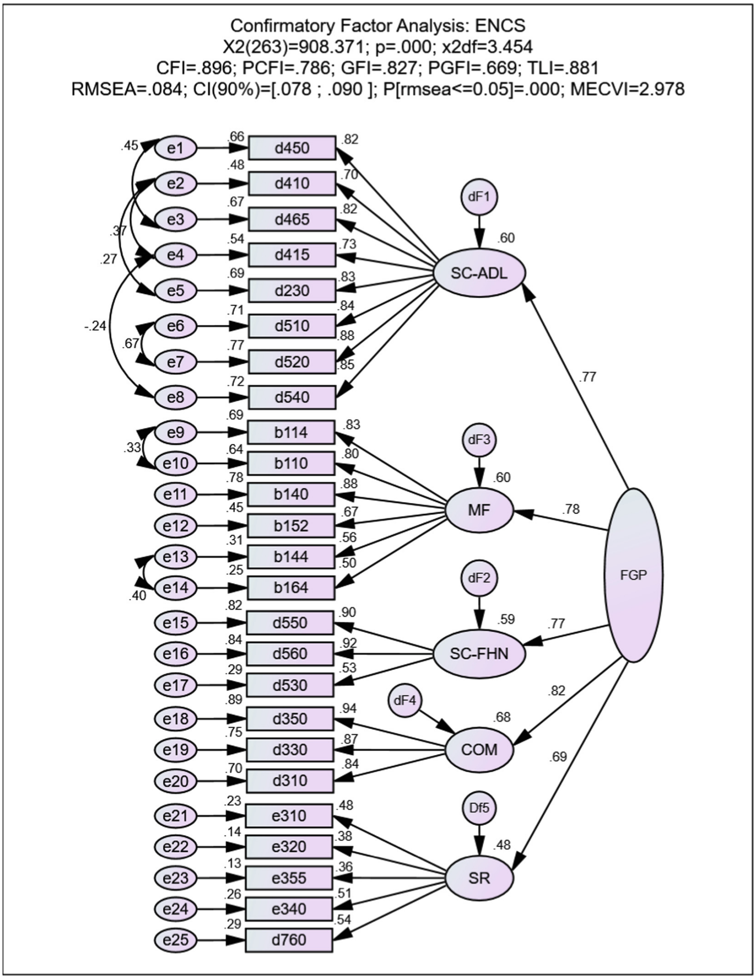

Fig. 3. Fitted second order factorial model adopting a FGP latent factor, after correlating the measurement errors of facets whose MI suggested their correlation (adopted MI > 11).

high order factor called Functioning General Profile - FGP (second order latent factor) as shown in Fig. 3, as recommended for this type of models in Marôco [20].

As can be seen by the values at the top of Fig. 3, this second order model shows a reasonable fit indexes (similar to the ones presented in top of Fig. 2), with the second factor order being the FGP measure, expressed through the various items (observed variables) and associated with each of the five latent factors. In respect to the correlations between FGP and the five latent factors, all were somehow high and all are statistical highly significant ($p < 0.001$): (i) $\rho_{SC-ADL} = .77$; (ii) $\rho_{MF} = .78$; (iii) $\rho_{SC-FHN} = .77$; (iv) $\rho_{COM} = .82$; (v) $\rho_{SR} = .69$. Regarding FC, α_c and AVE index values for FGP latent factor, respective very good values were obtained: 0.878, 0.921 and 0.591, respectively.

Based on the CFA results, a factor score weight (*fsw*) is extracted for each item (ICF code), which allows computing the scores of those six latent factors (SC-ADL, SC-FHN, MF, COM, SR and FGP), for each citizen individually. According to the authors of the original ENCS [10], the score of each latent factor is computed as the average value of the items (ICF codes) that are included in the respective latent factor, thus using a *fsw* value of "1" for each item. However, in this paper we propose the computation of individual's functional profile scores of each latent factor based on the *fsw* available for each item. Table 4 shows the adjusted *fsw* and how to compute the new scores of each latent factor (profiles).

Table 4. Proposed formulae used to compute the individual's functional profile scores based on the *fsw* extracted from the CFA second order model shown in Fig. 3.

Latent factor	Formulae (*fsw* $\times$ individual responses to the ICF codes)
SC-ADL	0.104 × d450 + 0.001 × d410 + 0.104 × d465 + 0.156 × d415 + 0.139 × d230 + 0.066 × d510 + 0.172 × d520 + 0.258 × d540
SC-FHN	0.406 × d550 + 0.557 × d560 + 0.037 × d530
MF	0.241 × b114 + 0.176 ×b110 + 0.416 × b140 + 0.104 × b152 + 0.041 × b144 + 0.022 × b164
COM	0.556 × d350 + 0.285 × d330 + 0.159 × d310
SR	0.159 × e310 + 0.093 × e320 + 0.125 × e355 + 0.289 × e340 + 0.334 × d760
FGP	0.016 × d450 + 0.000 × d410 + 0.016 × d465 + 0.024 × d415 + 0.022 × d230 + 0.010 × d510 + 0.027 × d520 + 0.040 × d540 + 0.113 × d550 + 0.154 × d560 + 0.010 × d530 + 0.047 × b114 + 0.034 ×b110 + 0.081 × b140 + 0.020 × b152 + 0.007 × b144 + 0.004 × b164 + 0.154 × d350 + 0.079 × d330 + 0.044 × d310 + 0.016 × e310 + 0.009 × e320 + 0.012 × e355 + 0.029 × e340 + 0.033 × d760

Based on the results listed in Table 4, it was possible to compute the average functional profiles for the entire sample, whose results are provided um Fig. 4. The "Mean*" values represent the scores computed based on the formulation proposed in [10], while "MeanFSW" values symbolize those scores computed using the formulae listed in Table 4. The remaining values in Fig. 4 represent: (i) "MaxDiff", the maximum positive differences at individual level (adopting "Mean*"-"MeanFSW"); (ii) "Min-Diff", the minimum negative difference for the same minus operation, also at individual level; (iii) "StdDiff", the standard deviation between all individual differences, notably "MaxDiff" and "MinDiff". All the items were in Likert scale (1–5) and scores (ranging from 0 to 100%) were computed based on the following equation:

$$Functional\ score = 25 \times itens\ response - 25. \tag{1}$$

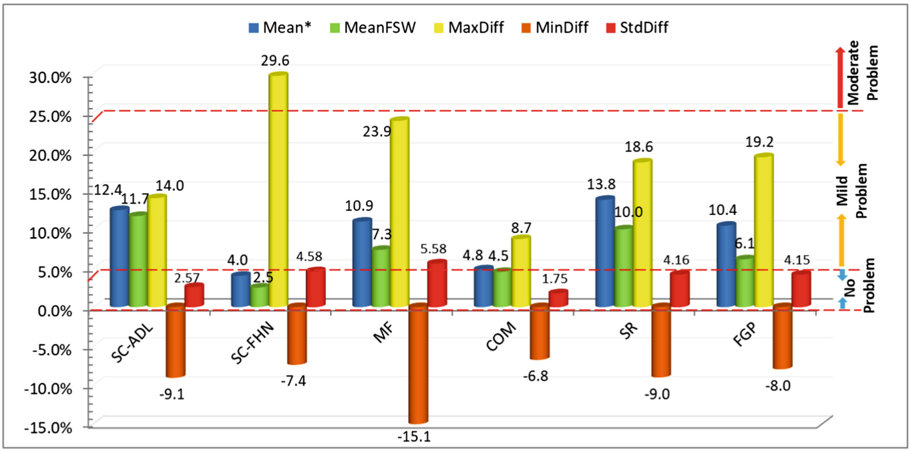

Fig. 4. Average functional profiles scores (for the entire sample for each of the six latent factors), computes using the *fsw* extracted from the adjusted second order CFA model.

3.3 Descriptive Statistics

A short descriptive statistics of the sample data, processed under the scope of this research, is also provided in Table 5. The table lists the biological and sociodemographic characteristics of the 351 respondents residing in the region of BA.

Table 5. Biological and sociodemographic characteristics of the sample data.

Biological and sociodemographic variables	*N*	%
Gender:	–	–
Male	163	46.4
Female	188	53.6
Age group:	–	–
65–74	132	37.6
75–84	135	38.5
85 and higher	84	23.9
Marital status:	–	–
Single	27	7.7
Married	206	58.7
Divorced	4	1.1
Widowed	114	32.5
Educational level:	–	–
Does not know how to read or write	104	29.6
Knows how to read and write	59	16.8
1st–4th grade	165	47.0
More education	23	6.6

4 Discussion

Comparing the work developed in [10] with the one delineated in this paper, both show an "Excellent" recommendation regarding to the EFA, since the Kaiser-Mayer-Olkin adequacy measures are between the range] 0.9; 1.0] [20]: 0.963 and 0.909, respectively. Moreover, the work in [10] was able to extract four latent factors, while the one presented here is composed of five latent factors, whose the major difference is related to self-care: (i) one latent factor designated by "Self-Care" in [10]; (ii) two latent factors in the present proposal, namely "Self-care in activities of daily living" (composed by eight ICF codes) and "Self-care in fundamental human needs" (composed by three ICF codes). In relation to this topic, the present proposal may provide a little more detail regarding the citizens Self-care needs. Given the results of Bartlett's test of sphericity ($p < 0.001$), we rejected the null hypothesis and concluded that the variables of both constructs were significantly correlated. In addition, we established that the 25 indicators included in this component exhibit excellent internal consistency as also in [10].

Regarding the CFA results, adjustment indexes shows a very favorable adjusted CFA model, with the "SR" latent factor exhibiting the lowest reliability, motivated by three lower loadings, ranging from 0.5 and 0.3, with this lower threshold (0.3) being considered appropriate for this type of construct. Important issues regarding the validation of the construct based on CFA, reveal that the items achieved a very favorable individual reliability, and the construct reliability as also reached, although the "SR" latent factor was the one that presented a lower contribution for this validation issue, although values below 0.7 and greater than 0.5 may be accepted in case of exploratory research, like the one developed here, according to Hair et al. [21]. In relation to the construct validity, the factorial validity of the construct was also reached, since we checked that the items effectively conceive the "big picture" that is actually being measured by the specific latent factors. Regarding the convergent validity, only the "SR" latent factor presented a value less than 0.5, which can be explained some of the lower loading factors of the respective items, whose mean values was 0.46 $((0.47 + 0.37 + 0.36 + 0.53 + 0.54)/5)$. Finally the construct fails in terms of discriminant validity, because correlations between first-order factors were higher, associated to lower AVE values. In this point, a comparison to the work developed by César et al. it was not possible, because no CFA is available in [10].

Regarding the functional profiles scores calculated based on the *fsw* extracted from CFA model shown in Fig. 3 and those computed according to the details provided in [10], the full scenario is depicted in Table 5. The analysis of the results shows that the global mean scores are almost similar for the "SC-ADL", "SC-FHN" and "COM" latent factors, and more pronounced for "MF", "SR" and "FGP", although always higher for "Mean*" than "MeanFSW". Almost all the global means reach a "Mild functional profile", except for "SC-FHN" (corresponding to "No Problem" functional profile). The most relevant aspect found is when making an individual analysis of the scores of each citizen, because there are differences in the results, which are higher positive differences for "SC-FHN", "MF", "SR" and "FGP", when compared to "SC-ADL" and "COM", and major negative differences in "MF". Those differences were the maximum found (either positive or negative), among all citizens composing the sample. We think that the differences between scores found must be carefully analyzed and it should be done by a group of health experts. Again, comparison at this level to the work developed by César et al. it was not possible, because no CFA is available in [10].

Finally, biological and sociodemographic characteristics of the sample show the presence of more females than males, the group of citizens presenting age a more advanced age as a relevant proportion in comparison to the other two. More than half of the citizens are married and almost half of the sample (29.6% + 16.8% = 46.4%) never went to school, thus revealing an important aspect characterizing a lower literacy level of the citizens involved in this research.

5 Conclusions

As promoted by WHO, years lived in old age must not to be years of suffering and anguish, incapacities and dependencies, but rather years of meaning and quality of life, triggering processes that practice the available resources (individual and collective) in the redefinition of priorities, compensation of disabilities, adaptation to new situations, enabling the elderly to qualify, even when they have serious health problems enabling older people to remain a resource to their families, communities and economies [22].

We believe that the innovative work developed by Fonseca et al. [10, 16], and evaluated in this proposal on a different population sample, corroborate the recommendations in [10], i.e., the use of this type of Core Sets delineated the assess to the nursing care needs and/or to the outcomes of nursing interventions of citizens aged 65 years old or older, which will be also an ongoing process that will lead to the promotion of an Healthy Ageing and functional ability, which is stated as one of the frameworks promoted by WHO.

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Conflict of Interest. The authors declare that they have no conflicts of interest.

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Aging and Health Literacy: Site of Proximity to the Community

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Abstract. The Observatory of the Dynamics of Aging in Alentejo of the Polytechnic Institute of Beja, created in 2013, is part of IPBeja's functioning as an "Open, Solidarity, Participatory and Coherent Community" and an understanding of the relevance of its Social Dimension. In 2019, the "ODEA-IPBeja Website of Proximity to the Community" was created, which is an instrument that has a number of perspectives: (1) A platform that gathers information, studies and research in the area of Aging at a local and global level; (2) Dissemination and sharing of initiatives, activities and projects on aging at local, regional, national and international levels; (3) Mobilization and articulation of the local and regional actors involved in this theme, through the sharing of information and knowledge; (4) A tool that provides the scientific production of IPBeja teachers, dissertations and master's projects of IPBeja, in particular the Master's degree in Social and Community Gerontology and Community Development and Entrepreneurship, and the activities and dynamics of Psychogerontology Short Cycle; and (5) Link to the ODEA-IPBeja Website. Close to the Community can be found on the IPBeja page or at https://odeaipbeja.wixsite.com/deaipbeja. This paper aims to show the functioning and value of the "ODEA-IPBeja Website Project" for the aging literacy, empower older persons and construction of health and well-being in the aging community.

Keywords: Older persons · Aging literacy · Empowerment · Active and healthy aging in the community · Aging website project

1 Introduction

The Observatory of the Dynamics of Aging in Alentejo of the Polytechnic Institute of Beja, from Portugal, named ODEA-IPBeja, is a center for research, consulting, development and intervention in the field of aging, in particular in the Alentejo. Consequently, it fulfills its function by evaluating and monitoring the state of the aging population in the Alentejo, conducting the production of research, knowledge and dissemination on aging in the Alentejo and intervening at the community level, in the promotion of human development and the protection of the poorest and disadvantaged of this age group from the age of 65. It therefore presents itself with an interdisciplinary look at aging and longevity and focuses its main concern on human solidarity, citizenship and the promotion of a successful aging, with health, quality of life and dignity.

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In health and illness, it is necessary to have knowledge and to know how to act accordingly. So, only information is not enough. It is necessary to present an ability to obtain, select, process and understand basic health information, that is, health literacy. Only in this way is it possible to understand reality, make conscious and salutogenic decisions, choose healthy lifestyles, and face a pathological condition to be willing to face adversity, change behavior and take on life. Carrying the literacy to the domain of aging we observed that more knowledge and education are linked to more health. Knowing how to grow old with awareness of your own human development process contributes to a healthy and successful aging.

Knowledge and information are universal sources of well-being and progress and must be accessible to all. Health literacy linked to aging conditions how each of us is able to make informed decisions about our health at this stage of life. Access to reliable and adequate information about the aging process and its circumstances is therefore crucial to coping with everyday problems. Access to new technologies can contribute to the proximity of information and knowledge to promote active and healthy aging.

Investing in universal access to technological means makes it possible to reduce info-exclusion. In particular, inequality of access to information and communication technologies is due to differences in the uses people give to information, the types of tools they use and the level of access intensity [1] Beyond these barriers you need to be able to select reliable and current information.

In our aging society many of the older people are aware of a loss of control over their personal and social lives. To cope with this situation they fit computers and connect to the internet. The individuals who go on the internet are empowering themselves because they are participating with others in a community and increasing personal control over their lives [2]. Analyzing the testimonies of people over fifty years old it was verified that emerging empowerment themes (the power of change, information, guilt, and how the Internet has enriched lives and expanded worldviews). Evidence shows that websites need to be developed that empower older people and empower them for more health and quality of life.

It is in this sense, that the project of the ODEA-IPBeja website appears, whose main objective is to provide information on aging that is useful for professionals in this area, scholars on the subject and the general population, in particular the oldest. In this work, we present the development of this project based on two pillars, the health literacy and the empowerment of older people in society.

2 Health Literacy in Aging

The World Health Organization (WHO) [3] understands the concept of health literacy highlighting the relevance of its dynamic and procedural character. In this sense, it defines health literacy as an articulation of "cognitive and social skills that determine individuals' motivation and ability to access, understand and use information in a way that promotes and maintains good health" [3]. Health literacy implies the achievement of a level of knowledge, personal skills and confidence to take measures to improve personal and community health through personal change.

In the scope of health literacy in Portugal, the data speaks for itself [4]. It was observed that 61% of the surveyed population has general health literacy level problematic or inadequate, reaching the average of the nine countries (Spain, Greece, the Netherlands, Ireland, Germany, Bulgaria, Poland, Austria and Portugal) in 49.2%. Regarding the Healthcare dimension, only 44.2% have a sufficient or excellent level of health literacy. In terms of disease prevention, about 45% of respondents reveal a sufficient or excellent level of health literacy, and the average stands at 54.5%. In Health Promotion dimension about 60.2% of the auscultated population has an health literacy level problematic or inappropriate, and the average stands at 52.1%. In view of these results, it is necessary to develop strategies for the promotion of health literacy in the Portuguese population.

Health literacy has been viewed as the ability of individuals to obtain, process, and understand basic health information and services available to make appropriate health decisions (seeking and choosing a physician's help, health care, treatment, healthy lifestyles, interest, and implication in health determinants). But how to get it? The development of competencies in health literacy can occur in formal and informal contexts of learning, so we must identify the environments and moments of learning in health throughout life. On the other hand, more health is also related to a set of emotional, cognitive and behavioral skills and ability to apply knowledge successfully.

Low health literacy is related to low perception of self-efficacy in the prevention and management of health problems (difficulties in understanding information leaflets and internet consultation in health services or eHealth, inappropriate use of medication, excessive use of health services, ineffectiveness in dealing with emergency situations [5], while the mediator construct for health gains plays a decisive role in the promotion of individual health promoters and older adult health education.

In the process of achieving more health we use communication strategies to inform and influence the decisions of individuals and communities to promote their health. Health communication includes messages for a variety of purposes, such as promoting health and educating for health (avoiding risks and helping to deal with health threats, preventing diseases, suggesting and recommending changes in behavior, recommend screening tests, health information and diseases, informing about medical examinations that need to be performed and their results, prescribing medications, recommending preventive measures and self-care activities in sick individuals) [6]. The patient-centered health systems expect the active role of individuals to involve them in decision-making processes in health areas [7]. Therefore, the patient should have competencies that allow him to know how to deal with the health system and with the management of his health and illness.

In recent times, the World Health Organization [8–10] has envisioned for Europe an improvement in the health status of populations, particularly the most vulnerable, seeking to outline viable strategies and to reduce inequalities. Actions developed around prevention, control of communicable diseases, promotion and protection of health have been beneficial for the health and well-being of populations throughout the life cycle. Therefore, it is necessary that people, families and communities develop their potential, participate consciously in improving health determinants and contribute to the increase in the number of years of healthy life of citizens [9]. This is only possible by investing in the health literacy of citizens and communities, whether in health and illness, in health communication training of health service providers and programs, and in health policies. The WHO [9] defines healthy aging as "The process of developing and maintaining the functional ability that enables wellbeing in old age". The investment in active and healthy aging reflected contemporary thinking and level of interest in the health and quality of life of older people. The first step is to focus on health literacy and empowerment of older persons.

3 Competent Communities and ICT Older Adults Empowerment

3.1 Escaping Social Isolation

Social isolation is one of the situations of vulnerability in the senior population that can compromise active ageing. The works of Blazer [11] demonstrated that loneliness and isolation can lead to extreme situations. Social isolation is a phenomenon that can be measured by several indicators, namely the "income and living conditions in Europe" (Eurostat, 2010), in terms of personal happiness, social contacts are more relevant than income. The sociological analysis has shown that, from several angles, living in an isolated way influences the lack of support if necessary, never find relatives, never find friends, have no contact with relatives or friends. The networks of individuals isolated for long periods tend to be filled out by professionals, connected to the public system, or by acquaintances with a similar problem.

The "Berlin Declaration on the quality of life of the elderly" [12], reveals the preventive dimension of the disease and dependence, particularly in the ages between 60 and 80 years that "offer a late possibility for avoid or compensate for the normative loss of operation by the intervention" (2009:50). In this follow-up, the prevention of social isolation and the loneliness of the elderly is fundamental for the promotion of quality of life and wellbeing, and the continuity of full participation in society as an active citizen is relevant, which plays a role in society, feels useful, and that maintains connection to conviviality and family activity. In 2002, the process of optimizing the opportunities in health, participation and security becomes part of the concept of active ageing assumed by the UN, which highlights the relevance of personal, behavioural, economic, social and environmental, while advocating the determination of individuals, in autonomy, participation and human dignity, as well as social responsibility and social justice, which must be expressed in fair institutions, in the quality of life, in dignified life, safety and wellbeing.

The studies [13] reveals that social support has an impact on the degree of stress resistance and changes the situation of the individual context, being associated with a lower risk of psychological problems. Participation in social activities and the social network is fundamental to promote the quality of life of seniors, revealing also preventive effects on the mental and physical functioning. According to Carvalho [14] the intervention focused on promoting the participation of seniors has been more focused on activities of daily living than in social activities and social relations with family, friends and acquaintances. On the other hand, the creation of new contact spaces, such as associations of residents, neighbourhood clubs or mutual aid groups, have increased the degree of participation, responsibility and knowledge among the participants. The exchange of resources within networks in the community reinforces the active social context and stands out as a useful strategy that contributes to the sustainability of resources while facilitating interpersonal contact and access to social support.

3.2 ICT Tools and Older Adults Empowering

Through the globalization, ICT is reshaping societies, economies and governments worldview. ICT facilitate processing, transmission and display of information, ever faster and cheaper, they condense or elide spatial and temporal distances.

In September 2015, the 193 members of the General Assembly of United Nations adopts 2030 Agenda for Sustainable Development which guides national plans and the development of cooperation extending to 17 Sustainable Development Goals (SDGs), and 169 Measures that promote action in five areas: the 5 Ps: People (SDGs 1–6), Prosperity (SDGs 7–10), Planet (SDGs 11–15), Peace (SDG 16) and Partnership (SDG 17). ICT can help achieve the global goals and find direct and multiple applications across each SDG, can quicken upscaling, cut deployment costs, improve awareness, inclusiveness, and engagement; stimulate connectivity, productivity, efficiency and innovations.

It's should be crucial to government's and stakeholders' agendas both to enhance older adults's social inclusion and promote social and community connectiveness. We live in a changing society with many services and resources accessible only through digital means. Older adults confront the increasing challenges of a technology society, yet they may be unable to keep up with Web-based connectivity, either because of access or skills to participate effectively [15]. Although older adults represent a growing group of technology users [16], the ever evolving nature of ICT means also an ever increasing level of digital literacy to maintain their sense of inclusion [17].

Hill, Betts and Gardner [17] reveals that (i) the impacts of digital technology at the micro and macro levels are related to inclusion, (ii) the policy should account for barriers to digital technology use in older adults, (iii) Older adults use digital Technology to facilitate and include themselves and others, and (iv) digital technology empowers and protects older adults from the digital divide. In spite of the risk factors related to the digitalization of society, we can also highlight some benefits of technology use for older adults In fact, several studies [17] demonstrates that ICT may offer mechanisms to enhance social inclusion in older adults, namely those with limits mobility can use digital technology to maintain their social networks and facilitate their wellbeing; greater computer knowledge can empower older adults to be more independent, and enhance their knowledge of health issues; reducing feelings of loneliness by spent time constructively; and, prevents cognitive decline.

One of the applications of ICT to the care and monitoring of seniors is the model of teleassistance and telemedicine. In Portugal, teleassistance is more implemented in large urban centers, and the role of entities belonging to the Solidarity Network is significant, consisting of more than 280 Internet access points in non-governmental organizations to and from persons with disabilities, elderly or at risk of exclusion [18]. The teleassistance model has evolved from a base with first-generation telephone services and central social alarm devices for second-generation, ones that include sensors to control users in hygiene tasks, pill dispensers, sensors of falls and others with georeferation of seniors.

The European Commission funded several pan-European eHealth projects (e.g., PALANTE) aimed at empowering European patients/citizens. Those experiences reveals relevant evidence from heterogenous eHealth services for patient empowerment, by transforming the traditional patient/citizen role in the management of their health. In particular, several providers have pursued eHealth solutions for patient empowerment, such as the delivery or enhancement of health care services or health care information through the internet and relates technologies [19].

In sum, digital divide may persist if older adults realize digital technology with apprehension essentially due to its language and complexity or fear associated to security and vulnerability both themselves and the technology. Nonetheless, the use of the internet and ICT have impact in sense of social connectiveness and social inclusion and may allow older adults to balance for potential mobility loss and lifestyle changes associates with ageing and promote a sense of empowerment.

4 Website of Proximity to the Aging Community

Population aging is one of the most significant trends of the 21st century. It has important and far reaching implications for all aspects of society [20]. The aging of the population is the social and demographic phenomenon that has transformed society the most in the last century. This situation is changing the world we live in, significantly affecting the developed countries. The increase in the population over 65 is nowadays a determining factor in the European social panorama. This circumstance leads to new challenges: finding appropriate and quality answers to the new demands of a growing social group, and the new problems associated with aging. This leads us to rethink the methodologies and communication models that have been applied so far.

The project "ODEA-IPBeja Site of Proximity to the Community" was developed by the Observatory of the Dynamics of Aging of the Alentejo with the collaboration of the Higher School of Education and Higher School of Health of the Polytechnic Institute of Beja. It was designed as a meeting place for all those people and groups affected and interested in the knowledge, determinants, and actions associated with aging. It offers a global perspective, to obtain answers to the various opportunities and associated problems. It also allows access to relevant information and useful contacts and links. Therefore, on this website, you find information about aging, in particular, knowledge, experiences, coping problems, good practice on active and healthy aging and contributions of international cooperation networks. Is a fundamental tool in order to help all actors (family members, caregivers, health professionals, gerontology professionals).This website had based on the perspective of a model of aging support and care provision based on the quality of life using Information and Communication Technologies.

In the "ODEA-IPBeja Site of Proximity to the Community" we understand that aging is a collective reflexion and social construction, and it is not a matter of individuality, but also a society commitment [21], changing the social vision of aging, of a particular fact of the elderly and their families to a general perception, in which the whole society is implied and affected. Meantime, it offers to local community a source of quality information and reference in the field of aging, and all services and initiatives developed.

The homepage brings together publications and content of interest in the field of aging. The events show an offer of the meetings, seminars, symposia, congresses that are happening in gerontology. The Alentejo Aging Dynamics Observatory encourages cooperation between health professionals, research groups and other specialists, through collaboration and multidisciplinary work, promoting the exchange of knowledge and the creation of common projects. It also offers to the community the information and news about practices, therapies and most relevant initiatives that are being developed at local, regional, national and international level. The aging support webpage serves as a source of information on aging, its associated factors and pathologies. The population of the region Baixo Alentejo resides in territories of low population density and high dispersion, this tool facilitates obtaining information, training and an opportunity to understand aging, eliminating the physical barrier. The offer of training with the aim of training professionals committed to the community, to improve public and professional attitudes, to increase the understanding of aging, and early diagnosis of the pathologies associated with it (Fig. 1).

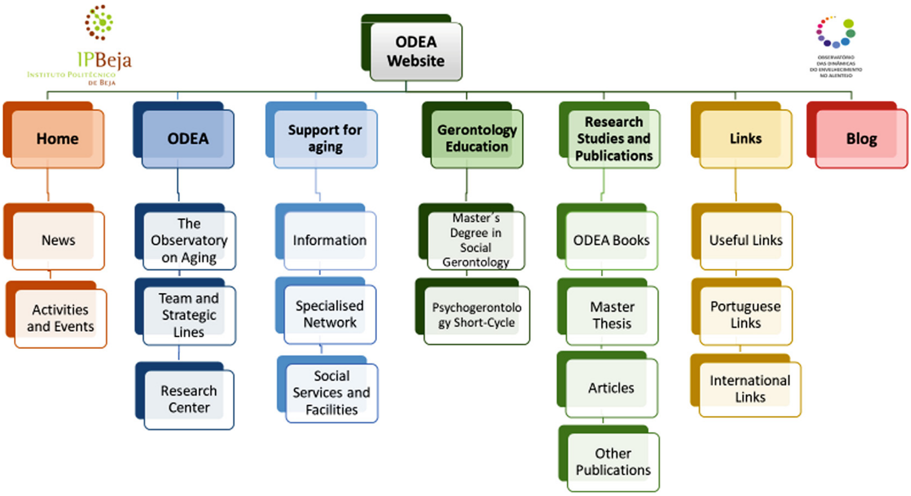

Fig. 1. ODEA/IPBeja Website map. https://odeaipbeja.wixsite.com/odeaipbeja (Authors).

Studies and publications provide free access to IPBeja research related to aging. It offers a bank of documentation, research, and proposals for intervention projects. Additionally, it offers a wide range of research articles developed by the ODEA-IPBeja researchers and relevant scientific production. The Blog builds a virtual community in which all those interested in aging take place: elderly people, caregivers, family members, professionals, students, researchers, and community. It mobilizes and articulates the local and regional stakeholders in accordance with this themata, promoting the sharing of information and could provide opportunities for considerable synergies through participation in a mediated technology platform.

5 Discussion

This paper emphasizes the ICT benefits in aging and healthy literacy operationalised through the construction of the ODEA/IPBeja site of proximity with the community, in a south Portugal (Alentejo) region that is frequently described as an elderly community with serious social isolation risks. In health and illness, it is necessary to have knowledge and to know how to act accordingly in order to promote successful aging, making conscious and salutogenic decisions, choose healthy lifestyles, and to know how to face and deal with a pathological condition.

Social isolation is one of the situations of vulnerability in the senior population that can compromise active ageing. The prevention of social isolation and the loneliness of the elderly is fundamental for the promotion of quality of life and wellbeing, and the continuity of full participation in society as an active citizen is relevant, which plays a role in society, feels useful, and that maintains connection to conviviality and family activity. The empowerment suggests an alternative and creative approach to the development of interventions and social change, focusing on health, in adaptation, competence, and social interaction systems. Participation in the community allows access to various resources, promotes interpersonal relationships, potentiates the ability to solve problems and reducing constraints, contributing to the construction of competent communities and has been enhanced using information and communication technologies (ICT). It is the population over 65 years of age that emerges as a group with greater vulnerability to loneliness and social isolation, so it is pertinent to explore the potential of ICT in the construction of tools and networks of proximity with the community, especially in health, safety, protection, citizenship, informational and recreational levels.

The use of the internet and ICT have impact in sense of social connectiveness and social inclusion and may allow older adults to balance for potential mobility loss and lifestyle changes associates with ageing and promote a sense of empowerment. Access to reliable and adequate information about the aging process and its circumstances is crucial to coping with everyday problems. Therefore, officially created in March 2019, the ODEA-IPBeja website project was designed as a meeting place for all those people and groups affected and interested in the knowledge, determinants, and actions associated with aging. In the current first stage the website aim to provide selected information, and maintain a constant flow of information, on aging that is useful for professionals in this area, scholars on the subject and the general population, in particular the older adults. The second stage will engage local agents, municipalities, stakeholders, local development associations, local community, to give their contributes to keep website up whilst at the sometime all agents participate, empowering an empowered, both virtual and real, competent aging community.

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How to Delineate the General Profiles of Functionality of Citizen's Aged 65 Years and Old as a Function of Its Age

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Abstract. Objectives: A core set of International Classification of Functioning, Disability and Health codes was used, to ascertain the general profile of functionality as a function of biological and sociodemographic characteristics, notably the age of the citizens.

Methods: Data were collected by health professionals in the participants' houses. The factorial validity of the construct was assessed by a confirmatory factor analysis. An ordinal regression model was built to identify the general profile of functionality as a function of age.

Results: It is expected that people under the age of 74 years will present no functional problems and that, after age 74, the most likely functionality problem will be a "MILD problem".

Discussion: The functional profile of each elderly is interrelated with his or her sociodemographic context as well as with the overarching biological, cultural, and environmental characteristics of society. A progressive decrease in GPF occurs with age.

Conclusions: The evaluation of each person (even those with no perceived or incipient levels of functional impairment who are at risk of progressing to a more severe disability) about what are the factors that are related with this functional decline as people get older, allows identify the respective nursing interventions to be developed.

Keywords: Ageing · Elderly residing in the community · Functionality profile assessment · Confirmatory factor analysis · Nursing care

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1 Introduction

At the population level, Portugal (a country at southwestern Europe) has one of the highest rates of aging index of the resident population among the European Union countries, (153.2 elderly per 100 young) [1], and national estimates indicate that this rate will more than double by 2080 (317 elderly for every 100 young) [2]. The Baixo Alentejo region (BAR), which covers an area of 8.544.6 km^2 (corresponding to 10.8% of the main territory), is an inland region located at middle south of the Portugal that borders Spain (Estremadura region). It was chosen for this study because it undergoes a delicate, worrying and heterogeneous socio-demographic scenario of population aging [3]: (i) since rural areas prevail to a larger extend (traveling average distances between villages range from 20 km to 120 km); (ii) the public transportation network in BAR is scarce and inefficient, thus causing some mobility inequalities along the territory, including some cases where people is unable to travel by their own means (e.g. due to their advanced age some elderly are no longer allowed to drive and presenting disabilities); (iii) it has the lowest population density of the country (14.8 individual per Km^2) [4]; (iv) it is identified as an aged region, presenting an important aging index of 189.2 elderly per 100 young [5]; and (v) most of these people they live alone or with other elderlies, often playing the role of caregivers.

As elderly get older, they become increasingly fragile, presenting functional impairments, multimorbidity and a significant prevalence of chronic conditions that easily decompensate them, most commonly seen in the only reference Emergency Department (ED) at BAR for medical problems such as cardiac, respiratory, and cerebrovascular related conditions (generally related to self-care problems), but also have a high rate of fall-related injuries [6, 7]. A report made by the Health General Directorate of the Portuguese Health Service, state that the burden of chronic disease in Portuguese population is estimated as follows: (i) 18% of the Portuguese health system users have one chronic disease; (ii) 11% has 2; (iii) 8% has 3; (iv) 22% has 4 or more. Therefore, at least 59% of people present one or more chronic disease (estimate) [8]. Due to the complexity and heterogeneity of individual aging, the level of functionality may vary distinctly from person to person. Studying the individual aging by integrating a care model in continuity and proximity that allows elderlies and family caregivers to monitor and manage their health at home, always under the supervision of health professionals, which may result in management of various chronic conditions (multimorbidity) as well as provide a "safety net" before a health crisis requiring ED care occurs [6, 7], was the main motivation that led the authors to develop the present study [3]. To achieve this goal, promoting the quality of life related to the elderly's health, by requalifying their potential and allowing them to live with more independence and autonomy, it is essential. According to Lesende et al., the health care of patients with multimorbidity and the appropriate strategies of interventions have a better outcome if structured based on a previous evaluation of the functional state of the person [9].

By providing multidisciplinary interoperability, the World Health Organization (WHO) has developed several tools in an attempt to devise a standardized international health information system. One example is the International Classification of Functioning, Disability, and Health (ICF) [10]. This classification encompasses "bio-psycho-socio-environmental" factors because it classifies (i) the functioning, disability, and health of people as an interrelationship among health states; (ii) bodily functions and structures (i.e., the presence or absence of disabilities); (iii) activity (i.e., the performance of a task or action by an individual); (iv) participation (i.e., the involvement of an individual in a real-life situation); and (v) contextual (i.e., environment and personal) factors that can act as "barriers" or "facilitators" [11–13].

In Portugal, Lopes [14] and then Fonseca [15] developed a tool to evaluate the individual profile of functionality of people aged 65 and over, called the Elderly Nursing Core Set (ENCS), which resulted in a set of 31 ICF codes, hereon referred to as "ENCS31".

Since the previous research tool was only developed to institutionalized elderlies, the authors of the present research intend to proceed with the previous study [16], by applying the ENCS31 to people aged 65 or over residing in the community, aiming the following objectives: (i) validate an experimental factorial model through a confirmatory factor analysis (CFA); (ii) a descriptive statistics of biological and sociodemographic variables, as well as the respective proportion of general profiles of functionality (GPF); (iii) standardizing the GPF based on age.

2 Methods

2.1 Subjects

This study examined the population aged 65 years or older who were registered in the Portuguese Health System of BAR, namely the Local Health Unit of Baixo Alentejo (ULSBA, for its acronym in Portuguese) [17]. The sample size was calculated adopting the formulae proposed by Scheaffer et al. [18], stratified by gender (male and female) and age group (65 to 74, 75 to 84, 85 or more years), adopting the Neyman optimal allocation, based on the total of elderlies listed in the ULSBA's database (32893). The calculated sample size was 470 elderlies, which were randomly selected from the respective ULSBA's database. The inclusion criteria cumulatively adopted were: (i) age 65 years or older; (ii) desire to participate in the study; (iii) residing in the BAR in their own home or in the home of family members or friends; and (iv) able to make their own decisions, even if sick or hospitalized. The final (random) sample, stratified by gender (male and female) and by age range (65 to 74, 75 to 84, 85 or more years), included 351 people who, cumulatively, fulfilled all the inclusions criteria, signed an informed consent document and answered to all the ENCS31's questions.

Data were collected between January 2016 and April 2017 at the homes of participants by health teams from ULSBA using the ENCS31. Prior to each interview, each health professional presented the informed consent document (which was especially developed for this study and previously approved by the ethics committee of ULSBA) to each individual and his or her family. During this period, the informed consent document was fully read by the individual in the presence of the health professional or it was read by the health professional if the individual was unable to read it. Information about the study objectives were fully provided to the individuals and their families, stating that their confidentiality and anonymity would be guaranteed. The interviews took at least 30 to 45 min, depending on the elderly's age and their level of literacy, and they started only after the elderly had agreed to participate in the study and had freely signed the informed consent. However, at any time each individual was allowed to cancel the interview based on his own initiative.

2.2 Statistical Procedures

After validating all collected data, a database was prepared using the IBM SPSS for Windows, Version 23.0 (IBM, Armonk, NY).

A previous Principal Component Analysis allows us to extract five latent factor based on Kaiser criteria, selecting a possible factorial structure, which in our case result in 5 latent factors composed of a total of 25 ICF codes. After that, descriptive analysis was used to describe the biological and sociodemographic variables of the sample data, as well as the GPF scores of the 25 ICF codes.

The factorial validity of this new subset of ENCS31 was assessed through a CFA using SPSS AMOS version 23.0.0 (IBM, Armonk, NY) and according to Marôco [19]. The CFA applied the following steps: (i) construct reliability was evaluated using Cronbach's alpha (α) and composite reliability (CR) as an alternative measure, and both measures were obtained for each of the five latent factors; and (ii) construct validity was evaluated using an analysis of the factor weights of the model (factorial validity), the average variance extracted (AVE) for each latent factor (convergent validity), and the comparison with the squared correlation coefficients between the latent factors (discriminant validity). Because the maximum likelihood method was used to estimate the CFA model parameters, the assumption of normality was tested by analyzing the skewness and kurtosis values. The overall goodness-of-fit of the model was assessed based on the indexes suggested by Marôco [19]. The codes with the highest weight in the estimation of the scores of the latent factors were identified through an analysis of factor score weights (FSWs). Finally, the 25 extracted ICF codes are hereon designated as "ENCS25". In sum, six codes (b280, b420, b440, b445, b525, and s810) were removed.

An ordinal regression model was then performed to evaluate whether the age and gender of the respondents showed a significant effect on the GPF (which included the 25 validated codes). That analysis sought to answer the following research questions: "Is the GPF identical between men and women?" "What is the effect of Age?"

3 Results

3.1 Confirmatory Factor Analysis

The five latent factors were thematically characterized by the authors, based on content of WHO ICF practical manual an WHO ICF checklist documents [20, 21], as follows: (i) "Self-care in activities of daily living" – SC-ADL; (ii) "Self-care in fundamental human needs" – SC-FHN; (iii) "Mental functions" – MF; (iv) "Communication" – COM; (V) "Support and relationships" – SR. The reliability of each latent factor was evaluated based on Cronbach's α, whose values ranged from "very good" to "reasonable", except for the latent factor SR (<0.60 but very close to the threshold for "Weak") (Table 1).

The ENCS25 was subjected to a CFA (see Fig. 1). The initial model showed a "fair" quality (performed without correlating the measurement error of any codes belonging to

Table 1. List of five retained latent factors with the respective reliability results, eigenvalues and percentages of variance explained.

ICF codes	Latent factors				
	SF-ADL	SF-FHN	MF	COM	SR
Eigenvalue	9.749	1.606	2.156	1.438	1.129
Variance explained	39.0%	6.4%	8.6%	5.8%	4.5%
Cronbach's alpha	$\alpha = 0.924$ (Very Good)	$\alpha = 0.779$ (Reasonable)	$\alpha = 0.848$ (Good)	$\alpha = 0.853$ (Good)	$\alpha = 0.580$ (Almost Unallowable)

ENCS31): (i) $\chi^2/df = 4.820$ (Chi-squared statistics divided by the degrees of freedom); (ii) $CFI = 0.837$ (Comparative fit index); (iii) $PCFI = 0.739$ (Parsimony comparative fit index); (iv) $GFI = 0.757$ (Goodness-of-fit index); (v) $PGFI = 0.617$ (Parsimony

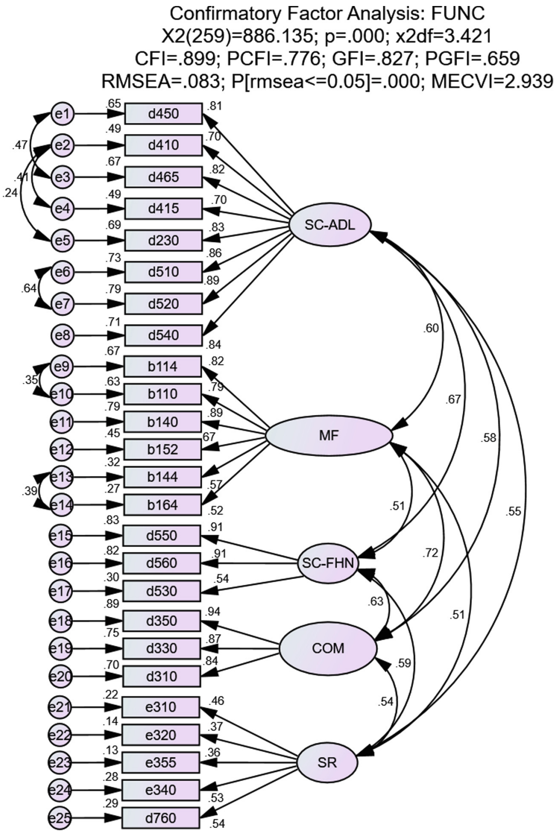

Fig. 1. The fitted factorial model of the ENCS25, after correlating the measurement errors of codes whose MIs suggested a correlation (empirically adopted MI > 15).

goodness-of-fit index) (vi) $RMSEA = 0.104$ (Root mean square error of approximation); (vii) $PCLOSE < 0.001$ ("p value" for testing the null hypothesis that RMSEA is less than .05 in the population); and (viii) $MECVI = 4.020$ (Mean expected cross-validation index). However, after correlating the measurement errors of codes d450 with d465, d410 with d415 and d230, d510 with d520, b114 with b110 and finally between b144 and 164, as suggested by the modification indices (MIs > 15), the overall model goodness-of-fit was classified as "fair to good" (see the qualitative classification of Table 4.1 in Marôco) [19]. Figure 1 shows the adjusted model with the new CFA indexes at the top.

Of the 25 standardized factor weights, only two (12%) presented values lower than 0.5, which suggested that the factorial validity of the construct is considered as "Favorable". The convergent validity was evaluated using the composite reliability measure (CR) (an alternative to Cronbach's alpha as suggested by Marôco [19]), based on the results from the CFA and the convergent validity (CV), this last characteristics being evaluated by the average variance extracted of the CFA model (AVE) [19]. Regarding CR, all values were greater that 0.8 (considered an appropriated reliability of the construct, since the value is higher than 0.7, as suggested by Marôco [19]), except for the SR latent factor (CR = 0.564), although values less than 0.7 may be accepted in case of exploratory research [22], which was the case of the present paper. In relation to CV, the AVE values were always greater than 0.5, representing an adequate convergence validity as suggested by Marôco [19], although a "weak" (AVE = 0.210) value was achieved, again for the SR latent factor (an expected result since this latent factor includes three standardized regression weights lower than 0.5, as can be seen in the bottom of Fig. 1).

3.2 Biological and Sociodemographic Variables and GPF

The sample data exhibited a higher proportion of women than men (Table 2). Most respondents were married and a considerable proportion was widowers (32.5%: 76.3% of women and 23.7% of men). Regarding education level, the eight categories listed were reduced to four because of the small absolute frequency observed in the higher education levels, where approximately half of the respondents (46.4% = 29.6% + 16.8%) did not had formal education, and 29.6% of the sample (57.8% of women and 42.2% of men) were illiterate. A quick review of the general profiles of functionality showed that the largest proportion of the "no problem (0–4%)" profile corresponded to individuals in the younger group and those with a higher education level. The most common profile observed was "mild problem (5–24%)" for almost all other variables (numbers typed in bold in Table 2).

3.3 Standardizing the GPF Based on Age and Sex

To evaluate whether the age and gender of respondents had a significant effect on the GPF, an ordinal regression model was done. The results showed that gender was not significant in the model: (i) $b_{Gender} = 0.045$, with $p = 0.750$ and the 95% confidence interval (CI) equal to CI = [−.234, .325]; and (ii) $b_{Age} = 0.074$, with $p < 0.001$ and CI = [.055, .093]; thus, no statistical evidence supports the hypothesis that the GPF differs between men and women. The model was reproduced again only for age. The final model was considered as highly significant ($-2LL = 193.832$, $\chi^2(1) = 64{,}347$,

Table 2. This table lists the biological and sociodemographic characteristics of the 351 respondents residing in the BAR as well as the respective proportion of general profiles of functionality taken from the ENCS25.

Variables	*n*	%	General Profile of Functionality				
			No 0–4%	Mild 5–24%	Moderate 25–49%	Severe 50–95%	Complete 96–100%
Gender:	–	–	–	–	–	–	–
Male	163	46.4	34.6%	**56.4%**	6.4%	2.7%	0.0%
Female	188	53.6	37.4%	**50.9%**	11.0%	0.6%	0.0%
Age group:	–	–	–	–	–	–	–
65-74	132	37.6	**58.3%**	37.9%	2.3%	1.5%	0.0%
75-84	135	38.5	27.4%	**62.2%**	8.9%	1.5%	0.0%
85 and higher	84	23.9	14.3%	**65.5%**	17.9%	2.4%	0.0%
Marital status:	–	–	–	–	–	–	–
Single	27	7.7	25.9%	**59.3%**	14.8%	0.0%	0.0%
Married	206	58.7	42.2%	**49.5%**	6.3%	1.9%	0.0%
Divorced	4	1.1	0.0%	**100.0%**	0.0%	0.0%	0.0%
Widowed	114	32.5	28.1%	**58.8%**	11.4%	1.8%	0.0%
Educational level:	–	–	–	–	–	–	–
Does not know how to read or write	104	29.6	12.5%	**65.4%**	18.3%	3.8%	0.0%
Knows how to read and write	59	16.8	28.8%	**62.7%**	6.8%	1.7%	0.0%
1^{st}-4^{th} grade	165	47.0	46.1%	**49.7%**	3.6%	0.6%	0.0%
More education	23	6.6	**87.0%**	8.7%	4.3%	0.0%	0.0%

$p < 0.001$), although the effect size was somewhat small ($R^2_{CS} = 0.168$; $R^2_N = 0.195$; $R^2_{MF} = 0.093$). In the ordinal regression model, the link function "Log-negative log" $P(Y < K) = exp\big(-\exp\big(-\big(b_K - b_{Age} \times Age\big)\big)\big)$ was adopted because it is recommended when the classes of the lowest-order dependent variable (functional profiles indicating a less severe problem) have a higher frequency when compared to the classes of severe and complete problems (presenting low frequencies) [19]. b_K is the coefficient associated with each of the three thresholds obtained because no respondent showed a "complete problem" GPF ($b_{K=1} = 5.718$, $p < 0.001$; $b_{K=2} = 8.138$, $p < 0.001$ and $b_{K=3} = 9.994$, $p < 0.001$). As age increases, the probability of observing response items that corresponded to a greater problem/severity functional profiles increased because the parameter estimate for age was positive ($b_{Age} = 0.074, p < 0.001$; see the curves in Fig. 2). With regard to the GFI of the model, Pearson's chi-square and deviance tests revealed that the null hypothesis regarding the model fit was not rejected ($\chi^2_{\text{Pearson}}(98) = 90.232, p = 0.699$ and $\chi^2_{\text{Deviance}}(98) = 79.202, p = 0.918$). The assumption of slope homogeneity was validated ($-2\text{LL} = 191.031$, $\chi^2(2) = 2.801, p = 0.246$).

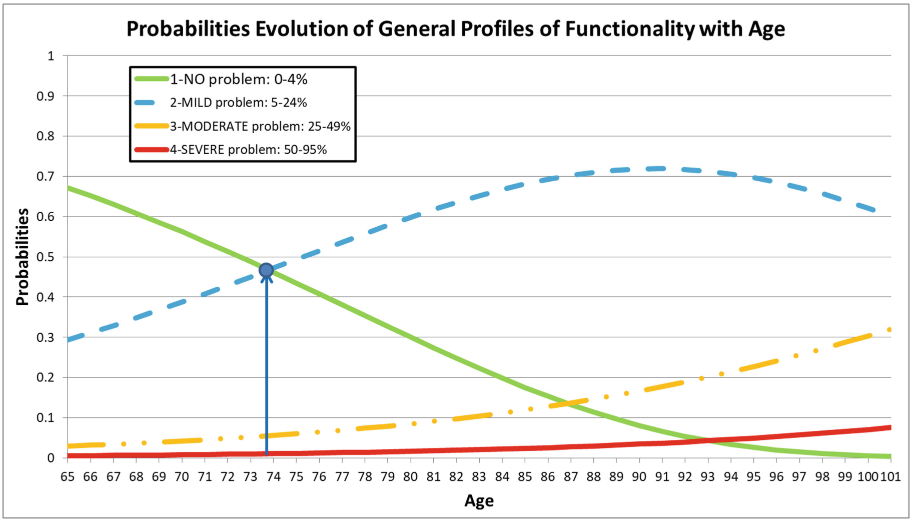

Fig. 2. Probabilities evolution regarding the general profiles of functionality, as a function of the age of the respondents.

4 Discussion

4.1 Characterization of Biological and Sociodemographic Factors and GPF

The functional profile of each elderly is interrelated with his or her sociodemographic context as well as with the overarching biological, cultural, and environmental characteristics of society; this aspect was there generally observed in the present study, which corroborates the reports of other authors [23, 24]. The current sample followed the trend observed in the scientific literature; was a predominance of women, particularly in the older population group, a phenomenon known as the "feminization of old age" [25]. Table 2 shows that the functional profile "No problem (0–4%)" had a greater proportion of the youngest participants, which has been observed by other studies [4]. The same is true of the people with the highest education levels because literacy helps people better and more effectively cope with their health/disease process (c.f., Kimberly Parr [26] and Abalo et al. [24]).

4.2 Standardization of the GPF Based on Age

Figure 2 suggests that the most likely GPF up to 74 years of age should be "no problem" and that "mild problem" should be the most likely profile after this threshold, with a progressive decrease in GPF with age. This result aligns with that found by Lopes et al. [13], Abalo et al. [24] and Lesende et al. [9]. These results answer the research question: "What is the effect of age on the GPF of people aged 65 and over who reside in the BAR?" Note that this question was reformulated because gender was not significant in the model.

5 Conclusions

It is known that as people get older, they present functional decline due to the progressive increase of impairments and disabilities. The authors think that the evaluation of each person (even those with no perceived or incipient levels of functional impairment who are at risk of progressing to a more severe disability) about what are the factors that are related with this functional decline as people get older and identify the respective nursing interventions to be developed, based on the results shown in Fig. 2, will avoid the worsening in the patients' health status and the upward spiral in their care needs, which is potentially modifiable, predictable and manageable, leading them to achieve gains in autonomy and independence for self-care.

Limitations
This study presents the following limitations. The most important was the lower number of respondents (351 although expected 470), especially due the lower level of participation of some health professionals. Since this study has been focalized in a region of Portugal main territory that presents special demographic and geographic characteristics, results may not be necessarily generalized for other regions or even for the entire country.

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Representations of Aging in Nursing and Social Work Students

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Abstract. The professionals involved in supporting the aging process of older people play a decisive role in the psychological, social and health support of this age group. It is intended that these actors understand the aging process and know how to act with competence, enabling an adequate response to the needs of older adults. Therefore, it is important to invest in personal training and gerontology early on. This study had as main objective to know the visions of future professionals of social service and nursing on older people in order to identify their representations and perceptions about old age. The study participants were thirteen students (Women = 7; Males = 6), from the 1st to the 4th year, single, aged between 18 and 34 years. Participants have contact with older people aged 80 to 105 years. The sampling was non-probabilistic of the snowball type. The Focus Group technique was used for data collection. A script was created in seven strands: Positive and negative images of older people; Contact/conviviality with older people; Elderly Aging gains and losses; Work of the professional with the Elders of society; and Training needs on gerontology. The analysis of the results evidenced that future professionals reveal a differentiated understanding about the well and unsuccessful aging. They suggested formative orientations along with the respective courses that allow future professionals a more qualified practice to promote the quality of life of the elderly.

Keywords: Higher education students · Nursing · Social work · Aging · Social representations · Social perceptions · Aged society · Gerontology

1 Introduction

The answer to the question "Who are the Elderly?" is too simple: "People who are Living and Ageing in Society". The same can not be said about the questioning of how humans view and accept ageing. Most people like to live and grow old, provided it is with health, quality of life and well-being. What humans most fear in ageing or the onset of old age is the fact that it may arise associated with certain physical, mental, and social frailties. People are afraid to be sick, to stop being able to think, to be alone and helpless, to lose autonomy and power, to suffer and to die). Anxious feelings arise throughout human life and knowing how to deal with them makes the difference between a more peaceful life or not. Many people, when they become aware of the ageing process they are subjected to, deny, forget, or seek to slow down the evolution of events through

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strategies that minimize or hide signs of ageing (hair painting, hair implantation, plastic surgery and esthetics, anti-ageing creams, special makeup, procurement of material goods and services, involvement in too much tasks, ingestion of anti-ageing foods and taking anti-ageing medication) [1].

The social representations about the phenomenon of ageing have arisen in the context of scientific research, associated, in many cases, to a more negative dimension, relating this stage of life with a series of stereotypes and effects based on occurrence of diseases, or of social problems, such as physical and relational isolation. However, it is possible to verify an attempt to distance this perspective, notably through investigations carried out from the year 2000, in which the center also focuses on the discussion itself on these stereotypes and on the representation of older people in society [2]. Thus, the study of social representations, in its multiple dimensions, becomes essential for the enlargement of the various prims that constitute, currently, the universe of ideas of what means for each of us "aging". Thus, it is important to emphasize the heterogeneity present in this population category, which is often characterized by scenarios of unequal experiences, which can contribute to the construction of very differentiated social representations of aging. These are, therefore, positions on the role of ageing itself in the process of human development: the traditional paradigm, which tends to associate it with loss, and physical and cognitive decline, and the contemporary paradigm that seeks to focus on positive aspects of this stage, emphasizing concepts such as active, productive or well-succeeded ageing.

In this line of thought, it is important to emphasize the impact that the social representations themselves can have on the self-perception of elderly people. These representations, more or less negative, are acquired in childhood, and therefore long before acquiring the status of elderly. It was found that the more positive the representations were revealed, the better the self-perception of the older people was revealed, associating themselves with the desire to live and survival of the elderly [2].

When considering the professionals involved in the aging process, we observe that they play a decisive role in the good conduct of problem solving, so it is important to know their view of the elderly in these circumstances. In this sense, it is necessary to understand the representations and formative needs of those who embrace a profession that by contemporary circumstances will be implicated in intervention plans and practices with older people. This study had as main objective to know the perspectives of future professionals of social service and nursing on older people and consequently identify their social representations about old age and formative needs to work with this target group. Thus, we intend, in the second moment, to present formative orientations that allow students to better understand the ageing and the performance of this growing age group, allowing a practice that is a vehicle for promoting the quality of Life of the elderly in the community.

2 Aging in an Aged Society

The World Health Organization [3] draws attention to the contemporary reality of the population ageing process and how it can meet global, national and local challenges. In particular, it relates seven challenges are highlighted in the following order: (1) disease double load (change in the pattern of non-communicable diseases to non-communicable, and is expected in 2020 an increase of 78% of the global burden of disease in non-communicable diseases, chronic diseases (heart disease, cancer and depression) causes death and disability, mental illness and injury; (2) higher risk of disability; (3) provision of care for aging populations process; (4) feminization of aging; (5) ethics and iniquities; (6) economy of a population aging process; and (7) creation of a new paradigm that perceives the elderly as active participants in a society with integration of age, active contributors and beneficiaries of development.

In today's society people can expect to live beyond the 60 years, which implies organizing and reinventing social and health policies, health systems and services, budgets and training of all professionals who are somehow connected to P Problematic Ageing. According to the WHO Director-General, Margaret Chan [4], many of the evidences found in the World Health Organization [4]. Worldwide report on aging and health refer to the fact that common perceptions and assumptions about older people are based on outdated stereotypes. The loss of skills or capacities arises in the common sense associated with aging, but, in fact, it is only and in some way related to chronological age. The Director-General of WHO [4] adds that there is no "typical" elderly person and that one needs to look at the life cycle to understand each aging process. Therefore, advanced age and some health problems do not necessarily imply dependence. Although older adults consider maintaining functional aptitude as a determinant, healthy aging goes beyond the absence of disease.

Advanced age involves a set of changes to which the individual has to adapt. At the biological level, aging is related to the accumulation of molecular and cellular damage that with time decreases physiological reserves increasing the risk of contracting a disease or several, contributing to the general decline of the person. However, it is necessary to understand that these changes are vaguely associated with chronological age [4]. At the social level, there are changes related to the social roles and positions, implicated in a certain way by the reform, and the losses of close relations. Progressively older adults select and seek to reduce the goals and activities to be carried out, which on the other hand gain in their meaning. Optimizing existing capacities becomes the motto, through practices and new technologies, we compensate for the loss of skills that can be experienced through the reinvention of the accomplishment of tasks of everyday life. On the other hand, in this advanced age, it is also observed that the objectives, motivational priorities and preferences arise as a target of change. Thus, we can see that the changes guide to an adaptation to the loss and evidence the continuous psychological development at this age, providing the exercise of new roles, viewpoints and social environments.

We can distinguish three aspects of subjective well-being: evaluative well-being (or life satisfaction), hedonic well-being (feelings of happiness, sadness, anger, stress and pain) and eudemonic well-being (sense of purpose and meaning in life) [5]. According to the authors, there is a link between health and well-being and age, that is, old age can be a period of greater subjective well-being. This fact can be explained through psychosocial changes. Studies have shown that there is an association between well-being and survival at more advanced ages evidencing the protective role of high welfare in maintaining health, and therefore the well-being of the elderly is an important goal for policy economic and health [5]. These findings lead us to an approach to old age beyond age, enabling a systemic view of aging and the elderly.

3 Social Representations of Aging

In the approach of social representations, we observed the articulation of the cognitive plan with the evaluative, motivational, emotional and social plans. Thus, according to Jodelet [6] the social representation can be defined as "a modality of knowledge, socially elaborated and shared, with a practical goal and contributing to the construction of a common reality to a social set".

The understanding of the world and the way the groups construct, communicate and share their knowledge, concepts, information and explanations about the facts of everyday life refers to the theory of social representations proposed by Moscovici [6]. The study on social representations refers to the difficulty of defining this construct. Therefore, a variety of definitions and plurality of study perspectives on this psychosocial phenomenon arise, according to the focus on the process or the product. According to Moscovici [7] the social representation is "a form of knowledge that aims to transform what is strange in family, through the aggregation of novelty to existing knowledge structures and endowed with certain Stability". We can highlight other definitions of social representation that have been emerging until our day [7] that explain it as:

- A form of knowledge, socially elaborated and shared, which presents a practical objective, and thus contributes to the construction of a common reality to a social set;
- One content and one process simultaneously: (1) A structured mental content (cognitive, evaluative, affective and symbolic) about a significant social phenomenon, which takes the form of images or metaphors, and which is consciously shared with other members of the Social group; and (2) a public process of creation, elaboration, dissemination and change of shared knowledge.
- A set of principles that are generators of positions linked to specific insertions that are within a set of social relations, and that organize the symbolic processes that intervene in these relations.
- A process of representation that results from the theories of common sense, elaborated and socially shared, linked to specific insertions within a set of social relations, to social groups, which have the functions explain relevant aspects of reality, define the group identity, guide social practices and justify actions and positions taken after they are performed.

In the course of life of human development we can observe an adaptive change and the search for a balance between gains and losses, usually associating to aging an increase of losses. In studies that aim to understand people about ancianity, we can find two approaches to this period of life [8–10], for sure, one more positive than the other: (1) Aging is a phase of decline associated with physical and social losses and is sometimes related to the binomial "health-disease" (negative experiences); and (2) old age is understood as a function of longevity, experience gained, experiencing old age with health and autonomy (positive experiences).

According to Baltes [10] we cannot ignore the issues associated with the final part of life (finitude, distancing and death), however, in addition to the limitations we have to consider in parallel the potential of ageing. Studies on the social representation of old age showed that the younger people represented old age with negative characteristics, even afraid of old age, realizing it as a moment of affective and social losses and an inusefulness to society, marked by the approximation of death. On the other hand, older people considered that reaching old age is a triumph, that bodily transformations can be lived without revolt, insofar as they are fruits of their history, in which reform is defined as a reward for the many years of work, thus referring to a group of older elderly people in relation to these the negative characteristics of old age.

4 Methods

The study is based on the definition of a qualitative and quantitative exploratory study based on the case study procedure.

4.1 Participants

Given that it was intended to obtain information and to know a certain situation, which implies specific facts and not a representativeness of the universe of the population, the sample was collected by convenience with the use of non-probabilistic methods Snowball types. The total number of participants was thirteen students of higher Education of Undergraduate Nursing (N) and degree in Social Work (SW). The undergraduate Nursing participants were seven students (Women = 3; Men = 4), january 2º, 2nd and 3rd year respectively, and one student of the 4th year, single, aged between 19 and 23 years (mean = 24, 14 years; sd = 5, 53), have contact with the elderly between 80 and 105 years. The participants of a bachelor's degree in Social Work were six students (women = 4; Men = 2) january 2º, 2nd and 3rd year respectively, five singles and one married, aged between 18 and 34 years (mean = 21, 33 years; sd = 2, 49) who have contact with the elderly between 60 and 104 years, most of them between 70–77 years.

4.2 Material

In order to collect information, it was considered that a proximity approach to (N) and (SW) students would be appropriate in order to know their reality and thus be able to subsequently create other more quantitative penchant research instruments, in particular, a questionnaire on social representations of aging that could be applied to social service students and thus encompass a greater number of participants. In general, the authors emphasize that the application of the focus group (discussion groups) can be combined with other methods, which may occur at different stages of the research project, in particular: initial phase (generate questions for a questionnaire); Intermediate phase (Help interpret the results obtained in a questionnaire); Final phase (discussing with participants the results obtained which could lead to new insights) [11].

Thus, the Focus Group technique was used for data collection, respecting the sequence of its application: planning, preparation, conduction, analysis. For this purpose was created a script that had as main objective to carry out the survey of social representations, older people and aging, in students of the undergraduate course in Social work of IPBeja. The script was divided into nine parts, evidencing the specific objectives considered: (I) characterizing the participants; (II) Identify the representations of the positive and negative images of older people; (III) Identify contact/conviviality with older people; (IV) to know the social representations of the elderly; (V) to know the social representations of aging; (VI) Identify the representations of the gains and losses of aging; (VII) to know the social representations of the work of the social service professional among the elders of society; (VIII) Identify training needs on gerontology; and (IX) identify suggestions and/or observations.

Thus, nine dimensions were taken into consideration among the inloved ones: (1) characterisation of the participants; (2) representations of positive and negative images of older people; (3) Contact/conviviality with older people; (4) Social representations of the elderly; (5) social representations of aging; (6) Representations of the gains and losses of aging; (7) Social representations of the work of the social service professional with the elders of the society; (8) training needs on gerontology; and (9) observations/suggestions.

4.3 Procedure

In this study, the necessary provisions were taken to protect the rights and freedom of the people who participated. The sampling was non-probabilistic of the snowball type, and two students were chosen from each year of graduation, preferably one of each genus. The participants were informed about the objectives of the research, clarifying that the information provided would be kept confidential and that would only be used for research purposes.

Two Focus Group were applied separately in two groups, students of nursing and Social work, in the Office of the Observatory of the Ageing Dynamics of Alentejo (ODEA-IPBeja) with two specialized moderators and was held during the Period of 2 h, after which a moment of balance was made of the information and reflections presented. The Focus Group was recorded and subsequently subject to transcription, respecting the discourse of the interveners. According to what is customary to be performed [11]. The analysis took place over three stages: Coding/Indexing; Storage/Recovery, and Interpretation.

For all data obtained, we used the SPSS 15 software for descriptive analysis with the analysis of means and frequencies (M, DP) and content analysis.

5 Results

We present below the results obtained through the analysis of descriptive statistics.

5.1 Evocations of the Image of the Older Person in (N) and (SW) Students

Regarding the results related to the images that appear on older people, it is verified that we found two groups of images, the positive and the negative. Nursing Students evidencing more positive evocations (51, 73%) and Social Work students more negative evocations (55.6%).

5.2 Social Representations of Older People in (N) and (SW) Students

We analyzed the evocations related to the social representations of older people also evidenced two groups (the positive and the negative ones) and observing, in this case. the predominance of positive evocations (59.47%) in Nursing students and positive evocations (56.24%) in Social Work students.

5.3 Designation of "Older People" in Society in (N) and (SW) Students

The percentage of the evocations about the way older people are assigned to the "name", "Old age for elderly" and "meaning of the old word". Nursing students find mostly that the most correct word to designate the oldest in society is "elderly" (77.77%), which despite "depends on person to person" (65.45%), should be considered elderly from 65 years (27.27%). In his view, the meaning of the elderly refers to the experience (19.51%) and "Affection and affectivity" (14.63%).

The social service students consider mostly that the most correct word to designate the Elders of society should be linked to affectivity (47.05%), which should be considered elderly from 80 years (57.14%) And that the meaning of the elderly refers to individuality (13.79%), wisdom (13.79%), life experience (13.79%) and, in particular, for someone who has many stories to tell (20.70%).

5.4 Representations About "Ageing" in Students of (N) and (SW)

Nursing students present a positive representation of "ageing" (73.91%). They understanding that it is the natural life-cycle process (30.43%) and the maturity process (21.74%). They also highlight risk behaviors as accelerators of ageing (8.70%).

We analyzed the evocations about the representation of "aging" for the students of Social Work, and it was found that they were predominantly negative (73.48%). Outstanding representations related to loss of capacities (22.45%) and loss of activity (12.25). Regarding positive evocations, we observed that aging was linked to a phase of tranquility and peace (10.20%) and a phase of changing the pace of life and preferences (10.20%).

5.5 Early Ageing in (N) and (SW) Students

From the perspective of the Nursing students, aging arises from the "onset of weakness/decline" milestone (42.86%), however, they consider that everything "depends on how the person faces aging not having the right age" (28.57%). For Social Work students, aging begins with "progressive loss of functionality" (41.67%) and "loss of health" (33.33%).

5.6 Projection of Aging in (N) and (SW) Students

Indeed, Nursing students project their own ageing in a positive way, with emphasis on "happiness" (22.22%) and the "realization of life with a large family" (18.52%). Since the main representation they have of this is essentially positive (74.07%).

Really, Social Work students have difficulty in projecting their own ageing since the main representation they have of this is essentially negative (75%).

5.7 Aging Gains and Losses in (N) and (SW) Students

As regards the gains and losses of aging, Nursing students present a balance between the two dimensions and report that the main gain is the "lived Experience" (10.0%). And the "memories of experiences lived throughout life" (10.0%). The greater loss is the "loss of relatives and loved ones older" (13.33%).

With regard to the gains and losses of aging, Social Work students report that the main gain is the "lived experience" (20.83%). And that the greater loss is the "loss of family and loved ones older" (41.68%). It also demarks its refusal to think about the subject of "losses" referring to the future this thought (delayed representation of loss in aging) (12.50%). Indeed, social service students have difficulty in projecting their own ageing since the main representation they have of this is essentially negative (75%).

The opinions of social service students regarding the representation of unsuccessful ageing say in respect to "dependence" (16.67%) and a successful "enjoying life with the absence of serious illness, that is not impetive" (16,67%) and also to an "aging with happiness and personal fulfillment" (20.83%).

6 Conclusion

From the analysis of descriptive statistics on the data obtained we can highlight the following: (1) The visions about aging of future professionals who will work in proximity with this generation reveal comprehension in the area; (2) Two types of "images associated with older people" are highlighted, positive and negative, with predominance of negative images in the two groups of future professionals; (3) The "Social representations of older people" evidenced two groups (the positive and the negative), observing in this case the predominance of positive evocations in the two groups of students; (4) for the designation of "older people" in society, the technical word "elderly" is indicated for nursing students and Social Work students should be connected to the affectivity in the treatment of each person; (5) on the "representation of aging" there was a positive understanding of the process by the students of the Nursing, (understood as being part of the vital life cycle). But, the students of the Social Work have a different view, of negative nature associated with loss of capacities, referring to a professional differentiation of the problem approach; (6) on the "Age to be old" students are unanimous in saying that it depends on person to person, but, future nurses consider elderly from 65 years old, while for future social workers the marking of two periods of the aging, from 65 years and their designation: "Pre-elderly" is between 65 and 80, and "elderly" is "After 80"; (7) The "onset of aging" is understood by students as the onset of weakness/decline, the emergence of disease/loss of health and progressive loss of functionality; (8) it is observed a difference of vision in the projection of the aging itself, presented the future health professionals a positive approach linked to happiness and personal realization in the future in the construction of the family, that fills the future loss of the ones loved ones (grandparents, fathers, uncles), while future social workers reveal a difficulty and refusal to imagine their own ageing, in particular, linked to institutionalization, wishing to grow old with autonomy at home. The limited understanding about the effective work of the social service professional with the Elders of society and its areas evidencing the stereotypes of the aging of institutionalization; (9) in the aging gains the students agree on the main gain of the "lived experience" and the greater loss of "the older relatives and loved ones". It was interesting to have been referred to the role of family influence in the projection of aging. It is as if there were family models of aging (good and bad) that guided and led the new generations to learn to lead their lives towards a well or unsuccessful ageing, where the profile of their older elements can make the difference in the aging process in the family.

The study is in conformity with the reference research, given that the results exhibited also have a polarization in the comprehension of aging (positive and negative, gain and loss, acceptance and rejection, knowledge and Ignorance) exposing the contemporary social influence and evidenced that there seems to be a differentiation in the visions about aging and the older person according to the professional group. The formation and reality of the field of activity in the area of aging seem to format for a vision about older people and the process of aging. As we agree that there is no "typical" elderly person and that we need to look at the life cycle to understand each aging process, it is necessary to raise awareness of the needs of lifelong training in the area of gerontology that allow better preparation of professionals for the performance of quality proximity with the older generation.

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A Nursing Care Intervention Model for Elderly People Adopting Self-care as a Central Concept

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Abstract. Objectives: A core set of International Classification of Functioning, Disability and Health codes was used, to ascertain the general profile of functionality as a function of biological and sociodemographic characteristics and to determine systematized nursing interventions in accordance with self-care needs identified with the study of self-care behavior, in elderly living in extensive and sparsely populated rural areas. **Methods:** Data were collected by health professionals in the participants' houses. An exploratory factor analysis allowed reducing data dimensions. A bar graph was set as a measurement tool of nursing care needs as a function of self-care behavior and the functional profile level. **Results:** Regarding the nursing care needs, the produced model allowed inferring that "Support and Relationships" is the functional concept that presents higher levels of functional problems and, consequently, more need for self-care interventions, as well as people with age 85 and more always present therapeutic self-care deficits. **Conclusions:** The developed nursing care model might contribute to the development of health programs and a multidisciplinary/home support network that is more specific and effective at promoting functionality, preventing and compensating for disabilities, and enabling people to remain in their homes, with the quality of life that they deserve. This is a model a model of nursing care centered on the person and their caregiver, based on self-care.

Keywords: Ageing · Self-care · Functionality · Home nursing care

1 Introduction

At the population level, Portugal (a country at southwestern Europe) has one of the highest rates of aging index of the resident population among the European Union

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countries, (153.2 elderly per 100 young) [1], and national estimates indicate that this rate will more than double by 2080 (317 elderly for every 100 young) [2]. The Baixo Alentejo region (BAR), which covers an area of 8.544.6 km^2 (corresponding to 10.8% of the main territory), is an inland region located at middle south of the Portuguese main territory that borders Spain (Estremadura region). It was chosen for this study because it undergoes a delicate, worrying and heterogeneous socio-demographic scenario of population aging [3]: (i) since rural areas prevail to a larger extent (traveling average distances between villages range from 20 km to 120 km); (ii) the public transportation network in BAR is scarce and inefficient, thus causing some mobility inequalities along the territory, in addition to the cases where elderly are unable to travel by their own means (e.g. elderly with advanced age and presenting some disabilities, they are no longer allowed to drive), also associating to the lack of mobility policies taken by the civil authorities; (iii) it has the lowest population density of the country (14.8 individual per Km^2) [4]; (iv) it is identified as an aged region, presenting an important aging index of 189.2 elderly per 100 young [5]; and (v) most of these people they live alone or with other elderlies that often play the role of caregivers.

As elderly get older, they become increasingly fragile, presenting functional impairments, multimorbidity and a significant prevalence of chronic conditions that easily decompensate them, which frequently originates an acute health care situation, resulting in a recurrent visit at the reference Emergency Department (ED) at BAR, with medical problems such as cardiac, respiratory, and cerebrovascular-related conditions (generally associated to self-care problems), but also with fall-related injuries, as observed in several international studies [6–8]. A report made by the Health General Directorate of the Portuguese Health Service, state that the burden of chronic disease in European Portuguese population is estimated as follows: (i) 18% of the Portuguese health system users have one chronic disease; (ii) 11% has 2; (iii) 8% has 3; (iv) 22% has 4 or more. Therefore, at least 59% of people present one or more chronic disease (estimate) [9]. Due to the complexity and heterogeneity of individual aging, the level of functionality may vary distinctly from person to person. Studying the individual aging by integrating a care model in continuity and proximity that allows elderlies and family caregivers to monitor and manage their health at home, always under the supervision of health professionals, which may result in management of various chronic conditions (multimorbidity) as well as provide a "safety net" before a health crisis requiring ED care occurs [6], was the main motivation that led the authors to develop the present study [3]. To achieve this goal, promoting the quality of life related to the elderly's health, by requalifying their potential and allowing them to live with more independence and autonomy, it is essential: (i) to evaluate their functional capacity in order to identify their disabilities; (ii) identify the appropriate self-care behavior that allows diagnosing, planning and assessing the necessary preventive Nursing care needs [10]. According to Lesende et al., the health care of patients with multimorbidity and the appropriate strategies of interventions have a better outcome if structured based on a previous evaluation of the functional state of the person [11].

By providing multidisciplinary interoperability, the World Health Organization (WHO) has developed several tools in an attempt to devise a standardized international health information system. One example is the International Classification of

Functioning, Disability, and Health (ICF) [12]. This classification encompasses "bio-psycho-socio-environmental" factors because it classifies (i) the functioning, disability, and health of people as an interrelationship among health states; (ii) bodily functions and structures (i.e., the presence or absence of disabilities); (iii) activity (i.e., the performance of a task or action by an individual); (iv) participation (i.e., the involvement of an individual in a real-life situation); and (v) contextual (i.e., environment and personal) factors that can act as "barriers" or "facilitators" [13–15].

In Portugal, Lopes [16] and then Fonseca [17] developed a tool to evaluate the individual profile of functionality of people aged 65 and over called the Elderly Nursing Core Set (ENCS), which resulted in a set of 31 items (ICF codes), hereon referred to as the European Portuguese "ENCS31" (see 1st top block symbol in green in Fig. 1, i.e. a data block), making the evaluation of functionality more feasible [18].

The conceptual framework of the self-care nursing model for people aged 65 and over proposed in this article is based on: (i) the medium-range theory proposed by Lopes [16]; (ii) on the self-care deficit theories proposed by Orem [19]; (iii) and in the functionality/disability continuum proposed by Fonseca [17]. Lopes [16] described two crucial phases in relation to the context of a health care system, namely (see Fig. 1): the diagnostic phase and the intervention phase. However, Fonseca [17] established a theoretical association between the self-care needs (using an ordinal scale ranging from 1 to 3) and the functional profiles of the ICF (using an ordinal scale ranging from 1 to 5 – Likert scale), see Fig. 1, i.e.,: (i) "self-care in the activity" associated to the "no problem (0–4%)" and "mild problem (5–24%)" functional profiles; (ii) the "therapeutic self-care deficit (moderate)" associated to the functional profile "moderate problem (25–49%)"; and (iii) the "therapeutic self-care deficit (severe/complete)" associated to both "severe problem (50–95%)" and "complete problem (96–100%)" functional profiles. Therefore, in the first phase, the diagnostic phase, the nurse evaluates the situation of the person, what capacity he/she has, what he/she knows, what worries him/her. Before a functional evaluation is done, the nurse can expect people with different self-care needs, namely: (i) self-care in the activity; (ii) with moderate therapeutic self-care deficit and; (iii) complete or severe therapeutic self-care deficit. After evaluating the elderly person we get the intervention phase, where a nursing intervention is taken regarding the respective diagnosed self-care need. Examples of nursing interventions based on the Orem's self-care theory [19] can be read in the right three rounded boxes for each respective diagnose of self-care need in Fig. 1.

Since the previous research tool of functionality was only developed to institutionalized elderlies, the authors of the present research intend to proceed with the previous study [18], by applying the European Portuguese ENCS31 to people aged 65 or over residing in the community, aiming to define an elderly nursing care model that enables the implementation of systematic nursing interventions based on the nursing care needs identified by the study of self-care behavior after evaluating the functional profile of each latent factor, stratified by age group. Therefore, the disability level can be assessed through the functionality assessment, making it possible to subsequently determine the health care needs required in all dimensions of disability including body functions and structures, activities and participation, together with associated impairments, limitations, restrictions, and environmental factors.

2 Methods

2.1 Subjects

This study examined the population aged 65 years or older who were registered in the Portuguese Health System of BAR, namely the Local Health Unit of Baixo Alentejo (ULSBA, for its acronym in Portuguese) [20]. The sample size was calculated adopting the formulae proposed by Scheaffer et al. [21], stratified by gender (male and female) and age group (65 to 74, 75 to 84, 85 or more years), adopting the Neyman optimal allocation, based on the total of elderlies listed in the ULSBA's database (32893). The calculated sample size was 470 elderlies, which were randomly selected from the respective ULSBA's database. The inclusion criteria cumulatively adopted were: (i) age 65 years or older; (ii) desire to participate in the study; (iii) residing in the BAR in their own home or in the home of family members or friends; and (iv) able to make their own decisions, even if sick or hospitalized. The final (random) sample, stratified by gender (male and female) and by age range (65 to 74, 75 to 84, 85 or more years), included 351 people who, cumulatively, fulfilled all the inclusions criteria, signed an informed consent document and answered to all the ENCS31's questions.

Data were collected between January 2016 and April 2017 at the homes of participants by health teams from ULSBA using the ENCS31. Prior to each interview, each health professional presented the informed consent document (which was specially developed for this study and previously approved by the ethics committee of ULSBA) to each individual and his or her family. During this period, the informed consent document was fully read by the individual in the presence of the health professional or it was read by the health professional if the individual was unable to read it. Information about the study objectives was fully provided to the individuals and their families, stating that their confidentiality and anonymity would be guaranteed. The interviews took at least 30 to 45 min, depending on the elderly's age and their level of literacy, and they started only after the elderly had agreed to participate in the study and had freely signed the informed consent. However, at any time each individual was allowed to cancel the interview based on his own initiative.

2.2 Statistical Procedures

Figure 1 details the synthesis of the conceptual framework of the proposed nursing model. To identify the number of latent factors that explained the relational structure of the 31 items included in the ENCS31, an EFA (see 2nd top block symbol in green, i.e. a processing block, in Fig. 1) based on the correlation matrix was conducted. Factors were extracted via a principal component analysis using a varimax rotation. Subsequently, factors with an eigenvalue greater than 1 were retained in the model. The validity of the EFA was assessed using the Kaiser-Mayer-Olkin (KMO) criterion, and the quality of the fitted model was assessed using the goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), and modified root mean square residual (RMSR*) as suggested by Marôco [22].

A descriptive analysis was used to describe the biological and sociodemographic variables of the sample data, as well as the GPF scores of the 25 items extracted from the EFA, herein designated as “ENCS25” (see 3rd top block symbol in green, i.e. a data block, in Fig. 1) using absolute and relative frequencies.

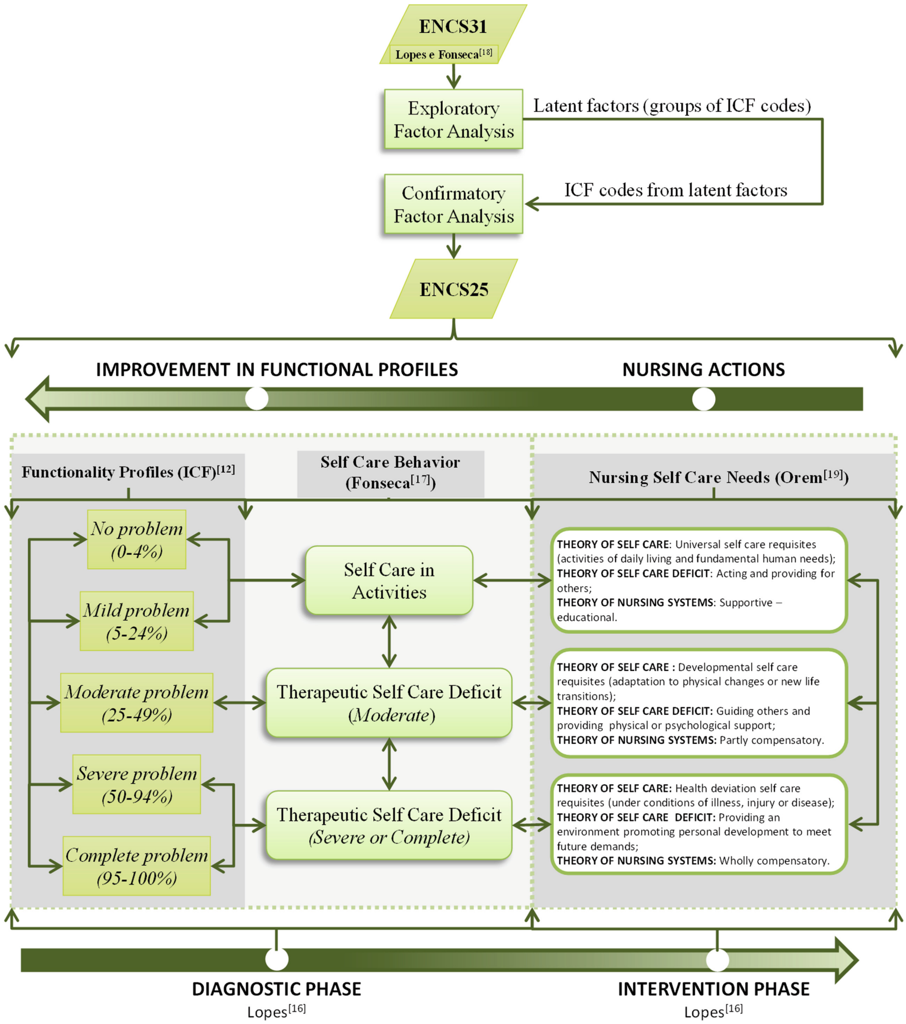

Fig. 1. Synthesis of the conceptual framework of ENCS25 nursing model and the correspondence between functional profiles [12] and Nursing self-care needs [19] according to self-care behavior [17, 18] of a person aged 65 or over, in the context where they are residing, namely: at their homes or at a family or friends’ homes.

The means of the functional profiles of each latent factor and the GPF, separated by age group, were calculated. Based on these results and on the association between the functional profiles (measured using an ordinal scale ranging from 1 to 5) and Orem’s “nursing self-care needs” [19] in accordance with self-care behavior [17] (measured using an ordinal scale ranging from 1 to 3), a bar plot was constructed to visualize the answer to the following research question: “What are the predicted average nursing care needs of the elderly residing in the BAR by age group and latent factor?”

3 Results

3.1 Exploratory Factor Analysis

Table 1 lists the final values of the EFA results (only factor weights above 0.49 are shown). Because of the high skewness and kurtosis values of some items, the analysis was based on the Spearman's correlation matrix and not in the original variables. Using the "eigenvalue greater than 1" rule, the relational structure of the items was explained by five latent factors ("Self-care in activities of daily living" – SC-ADL; "Self-care in fundamental human needs" – SC-AFN; "Mental functions" – MF; "Communication" – COM; "Support and relationships" – SR), with only two factor weights at a threshold of 0.5 (d530 and b164). Six items (b280, b420, b440, b445, b525, and s810) were iteratively removed, thereby reducing the number of latent factors from eight to five. The final model (referred to as "ENCS25") was "excellent" based on the recommendation derived from the EFA (KMO = 0.909). The total variance explained by the model was 64.3%, and the first latent factor explained more than half of the total variance. In general, almost all communalities were high (only 20% present values less than 0.5, but none of them are below than 0.3, which can be a threshold considered appropriate for this type of construct), although the average of factor weights belonging to SR latent factor was somehow low (an average of factor weights within each latent factor 0.7 or higher is preferable, but only 0.583 was obtained for SR), which may compromise the correlational structure between the items of this latent factor. This finding was somewhat reflected by the obtained values of the goodness-of-fit indices (GFI = 0.630 and AGFI = 0.350), although a "very good" RMSR* of 0.05 was achieved. The reliability of each latent factor was evaluated based on Cronbach's α, whose values ranged from "very good" to "reasonable", except for the latent factor SR (< 0.60 but somehow very close to the threshold for "Weak").

3.2 Biological and Sociodemographic Variables and GPF

The sample data exhibited a higher proportion of women than men (Table 2). Most respondents were married and a considerable proportion was widowers (32.5%: 76.3% of women and 23.7% of men). Regarding education level, the eight categories listed were reduced to four because of the small absolute frequency observed in the higher education levels, where approximately half of the respondents (46.4% = 29.6% + 16.8%) did not have formal education, and 29.6% of the sample (57.8% of women and 42.2% of men) were illiterate. A quick review of the general profiles of functionality showed that the largest proportion of the "no problem (0–4%)" profile corresponded to individuals in the younger group and those with a higher education level. The most common profile observed was "mild problem (5–24%)" for almost all other variables (numbers typed in bold in Table 2).

3.3 Elderly Nursing Care Needs

As mentioned in the introduction section, the goal of this study was to develop a model that would enable the practical implementation of systematic nursing interventions based

Table 1. List of EFA results: (i) list of five retained latent factors and respective factor weights, eigenvalues and percentages of variance explained. Groups of vertical cells painted gray represent one retained latent factor; (ii) the average of the answers in terms of the Likert (LK) scale, with the corresponding profile of functionality.

ICF Codes (items)	Latent factors*					Com.	Mean (LK scale)	Functional profile**
	SF-ADL	SF-FHN	MF	COM	SR			
d450	.807	-	-	-	-	.716	1.55	Mild
d410	.804	-	-	-	-	.747	1.56	Mild
d465	.763	-	-	-	-	.666	1.47	Mild
d415	.761	-	-	-	-	.646	1.43	Mild
d230	.753	-	-	-	-	.703	1.76	Mild
d510	.651	-	-	-	-	.720	1.45	Mild
d520	.649	-	-	-	-	.714	1.44	Mild
d540	.568	.555	-	-	-	.711	1.31	Mild
d550	-	.808	-	-	-	.791	1.11	No
d560	-	.781	-	-	-	.772	1.08	No
d530	-	.492	-	-	-	.508	1.29	Mild
b114	-	-	.816	-	-	.792	1.23	Mild
b110	-	-	.809	-	-	.795	1.23	Mild
b140	-	-	.795	-	-	.761	1.26	Mild
b152	-	-	.587	-	-	.489	1.41	Mild
b144	-	-	.570	-	-	.523	1.79	Mild
b164	-	-	.495	-	-	.595	1.71	Mild
d350	-	-	-	.799	-	.821	1.18	Mild
d330	-	-	-	.741	-	.751	1.13	No
d310	-	-	-	.662	-	.713	1.27	Mild
e310	-	-	-	-	.718	.548	1.58	Mild
e320	-	-	-	-	.644	.469	2.21	Moderate
e355	-	-	-	-	.533	.336	1.57	Mild
e340	-	-	-	-	.514	.390	1.20	Mild
d760	-	-	-	-	.504	.403	1.19	Mild
Mean	***.720***	***.694***	***.679***	***.734***	***.583***	***.643***	***1.416***	
Eigenvalue	9.749	1.606	2.156	1.438	1.130	-	-	
Variance explained	39.0%	6.4%	8.6%	5.8%	4.5%	-	-	
Cronbach's alpha	α=0.942	α=0.731	α=0.824	α=0.898	α=0.545	-	-	

* Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization;
Rotation converged in 7 iterations.

**Labeled according to the mean LK scale for each code, after a correspondence with the ICF scale of profiles [12].

Table 2. This table lists the biological and sociodemographic characteristics of the 351 respondents residing in the BAR as well as the respective proportion of general profiles of functionality taken from the ENCS25.

Variables	*n*	%	General profile of functionality				
			NO 0–4%	Mild 5–24%	Moderate 25–49%	Severe 50–95%	Complete 96–100%
Gender:	-	-	-	-	-	-	-
Male	163	46.4	34.6%	**56.4%**	6.4%	2.7%	0.0%
Female	188	53.6	37.4%	**50.9%**	11.0%	0.6%	0.0%
Age group:	-	-	-	-	-	-	-
65–74	132	37.6	**58.3%**	37.9%	2.3%	1.5%	0.0%
75–84	135	38.5	27.4%	**62.2%**	8.9%	1.5%	0.0%
85 and higher	84	23.9	14.3%	**65.5%**	17.9%	2.4%	0.0%
Marital status:	-	-	-	-	-	-	-
Single	27	7.7	25.9%	**59.3%**	14.8%	0.0%	0.0%
Married	206	58.7	42.2%	**49.5%**	6.3%	1.9%	0.0%
Divorced	4	1.1	0.0%	**100.0%**	0.0%	0.0%	0.0%
Widowed	114	32.5	28.1%	**58.8%**	11.4%	1.8%	0.0%
Educational level:	-	-	-	-	-	-	-
Does not know how to read or write	104	29.6	12.5%	**65.4%**	18.3%	3.8%	0.0%
Knows how to read and write	59	16.8	28.8%	**62.7%**	6.8%	1.7%	0.0%
1st–4th grade	165	47.0	46.1%	**49.7%**	3.6%	0.6%	0.0%
More education	23	6.6	**87.0%**	8.7%	4.3%	0.0%	0.0%

on the elderly nursing care needs identified by a study of self-care behavior, after an evaluation of the average functional profile of each of the five latent factors, separated by age group (latent factor is hereafter referred to as "functional concept"). This model is depicted in Fig. 2 and can be used to answer the research question: "What is the predicted average nursing care need of an elderly people residing in the BAR by age group and functional concept?" The mean reference scores of the functional profiles for each functional concept are on the left lateral axis of the Figure, whereas the indicator of the predicted average nursing care needs of the elderly is on the right lateral axis of the Figure. The yellow and magenta dashed lines represent the reference values between the Likert scale (1 to 5) and the percentage values of 4–5% (yellow) and 24–25% (magenta), notably the thresholds between the three types of functionality profiles (the group composed of the first two profiles of functionality "no problem" and "mild problem", and isolated "moderate problem"). The red vertical lines in each bar represent the 95% CIs for the means. As an example, a person with a mental function score of 2.2 and who is 85 years old has a functional profile of "moderate problem", which is at the level of Therapeutic Self-Care Deficit (Moderate). Thus, nursing interventions become a requirement of people's needs when they are incapacitated or limited with regard to performing self-care. These interventions are listed in the Therapeutic Self-Care Deficit (Moderate) area of the Figure. In sum, the final goal of this model is to improve the person's profiles of functionality by applying the necessary nursing interventions and after that measuring the nursing-sensitive outcomes by comparing the profiles of functionality "before" and "after" the mentioned nursing interventions. This intervention should lead to the notion of "independence", which may regarded as "Self-care" focusing on the ability elderlies have to be self-determining [23].

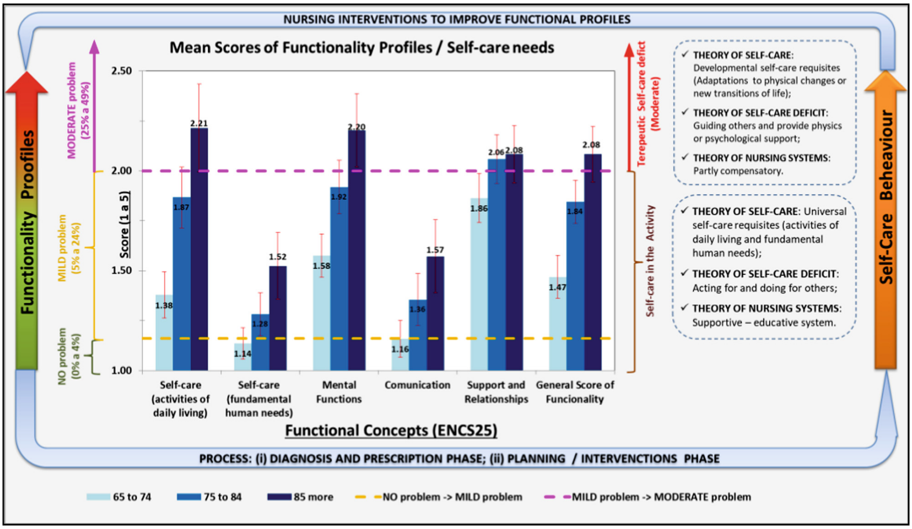

Fig. 2. Mean scores of functional concepts of the respondents and the correspondence in terms of the respective nursing interventions, stratified by age group, representing the elderly nursing care mode based on ENCS25. (Color figure online)

4 Discussion

4.1 Model Validation *EFA*

Five functional concepts (i.e., "latent factors" in Table 1) were extracted from the EFA. The first concept, "SC-ADL", was generally associated with the elements that encompass aspects related to personal care. The second concept, "SC-FHN", consisted of activities such as eating, drinking, and toileting, which are essential for human survival. The third concept, "Mental functions", encompassed elements that refer to orientation, attention, memory, and human consciousness. The fourth concept was called "Communication" because it encompassed related elements such as dialogue (i.e., talking, conversing, and communicating by sending and receiving messages). Finally, the fifth concept, "Support and relationships", was associated with aspects related to health professionals, personal care providers/personal assistants, and friends. These results suggest that the aspects related to the first concept stand out from the others because they explain the largest variance compared with the four remaining concepts. Importantly, in this context, problems that prevent the performance of activities of daily living can lead to loneliness and more pronounced physical aging [24, 25].

4.2 Characterization of Biological and Sociodemographic Factors and GPF

The functional profile of each person is interrelated with his or her sociodemographic context as well as with the overarching biological, cultural, and environmental characteristics of society; this aspect was generally observed in the present study, which corroborates the reports of other authors [26, 27]. The current sample followed the trend observed in the scientific literature; there was a predominance of women, particularly in the older population group, a phenomenon known as the "feminization of old age" [28]. Table 2 shows that the functional profile "No problem (0–4%)" had a greater proportion of the youngest participants, which has been observed by other studies [4]. The same is true of the people with the highest education levels because literacy helps people better and more effectively cope with their health/disease process (c.f., Kimberly Parr [29], and Abalo et al. [27]).

4.3 Elderly Nursing Care Model Based on the ENCS2

Regarding the predictions of elderly nursing care needs based on self-care behaviors, the responses can be obtained through an analysis of Fig. 2. Thus, the mean functional score obtained regarding the concepts "Self-care (fundamental human needs)" and "Communication" (left axis of Fig. 2) falls in the "Self-care in the activity" level of nursing care needs (right axis of Fig. 2). For example, a person who present signs of inadequate water intake or some difficulty to understand written or spoken directives reveal a slight difficulty in the universal self-care requisites, requiring nursing interventions at the supportive-educative level. Therefore a nurse will help him or her to teach and supervise the activities, even if the person is able to perform self-care. For the concepts "Self-care (activities of daily living)", "Mental functions" and "General Score of Functionality", the mean observed for the oldest age group reached the "Moderate Therapeutic Self-Care Deficit" level of nursing care needs (i.e., when the individual needs nursing care to help him or her with what he or she is unable to accomplish by him or herself and will compensate him or her through the nursing system). These effects can take the form of wholly compensatory support, partly compensatory, and educative. The other two age groups fall on average at the "self-care in the activity" level. Regarding the "Support and Relationships" concept (which refers to family, friends, neighbors, and health professionals), the two older groups reached the "Moderate Therapeutic Self-Care Deficit", level of nursing care needs. However, the group of 65- to 74-year-olds was also close to this threshold, showing that of the five functional concepts identified by the article, this concept is the most relevant for defining which nursing interventions to adopt in the self-care of the studied population. As such, the context in which people live might be a barrier rather than a facilitator of functionality [12], preventing the various aspects of people's lives to come together as a whole [30]. In this situation, the therapeutic requirement of self-care consists of a set of nursing interventions, like guiding others and providing physics or psychological support, conducted over time, because the person already has needs beyond his capacity.

In this study, no elderly nursing care needs at the "severe/complete self-care deficit" level were identified. In summary, the model ENCS25 described in Fig. 2 (i) assesses functional capacity to identify problems (care requirements); (ii) identifies the appropriate self-care behavior to diagnose, plan, and control nursing care needs; and (iii) implements the nursing process based on Orem's work across different operationalization phases [19]. On the other hand, the monitoring of the effectiveness of nursing interventions aimed at quantifying health gains is highlighted from the perspective of improving the quality of the nursing care provided, and this monitoring is essential to measure the results of these interventions [31].

5 Conclusions

The developed nursing care model might contribute to the development of health programs and a multidisciplinary/home support network that is more specific and effective at promoting functionality, preventing and compensating for disabilities, and enabling people to remain in their homes, with the quality of life that they deserve. This is a model a model of nursing care centered on the person and their caregiver, based on self-care.

It is known that as people get older, they present functional decline due to the progressive increase of impairments and disabilities. The authors think that the evaluation of each person (even those with no perceived or incipient levels of functional impairment who are at risk of progressing to a more severe disability) about what are the factors (the latent factors extracted from EFA) that are related with this functional decline and identify the respective nursing interventions to be developed, using the proposed elderly nursing care model based on ENCS25, will avoid the worsening in the patients' health status and the upward spiral in their care needs, which is potentially modifiable, predictable and manageable (improving the functional profiles).

Limitations

This study presents the following limitations. The most important was the lower number of respondents (351 although expected 470), especially due the lower level of participation of some health professionals. Since this study has been focalized in a region of Portugal main territory that presents special demographic and geographic characteristics, results may not be necessarily generalized for other regions or even for the entire country.

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In the originally published version of chapters 31, 33, and 35 the affiliation of the Author "Margarida Santos" was incorrect. The affiliation information has been corrected as "Escola de Medicina Tradicional Chinesa, Lisbon, Portugal".

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Author Index