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

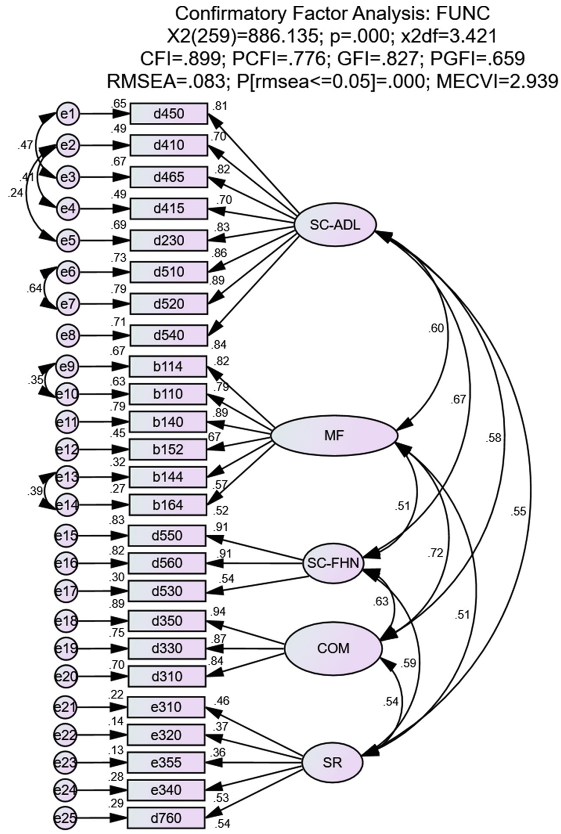

Fig. 1. The fitted factorial model of the ENCS25, after correlating the measurement errors of codes whose MIs suggested a correlation (empirically adopted MI > 15).

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 ($-2LL = 191.031$, $\chi^2(2) = 2.801, p = 0.246$).

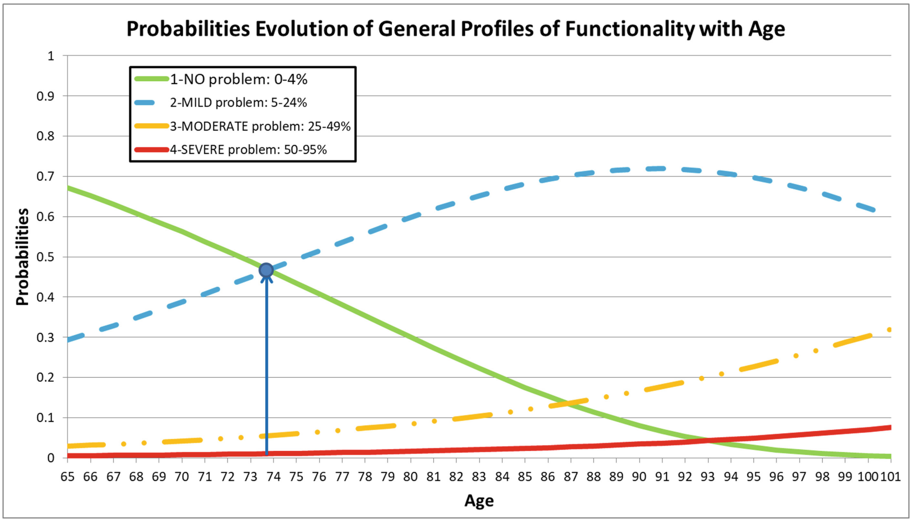

Fig. 2. Probabilities evolution regarding the general profiles of functionality, as a function of the age of the respondents.

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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