Technology's Role on Physical Activity for Elderly People

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Abstract. The purpose of this study is to investigate the effectiveness of two physical exercise interventions in the elderly, one with the traditional way of exercising and the other with the use of new technologies and by comparing the two interventions and evaluating the most beneficial effects in their functioning ability and their quality of life. The exercise protocols included activities to improve aerobic capacity, muscle strength, mobility (flexibility) and coordination skills (balance). Forty-four elderly women aged 60–80 years old agreed to participate, grouped by twenty-two elderly in each intervention. They evaluated at baseline (pre assessment), as well as at the end of the intervention (post assessment). Both interventions took place at Day Care Centers and lasted 10–12 weeks (min 30 sessions, 2–3 times/week, 60'). The results of this study are in line with the reports of similar studies of the last decade pertaining to the positive role of the physical exercise and the exergames to the psychological well-being and quality of life in older adults. Both interventions revealed the improvement of body functions and balance associated with daily activities, improve their physical and mental health and therefore quality of their life.

Keywords: Physical training · Elderly and technologies
Active and healthy aging

1 Introduction

The worldwide phenomenon of aging is strongly affected by the limitation of the birth or the prolongation of life expectancy as well as immigration. During aging, some biological changes occur. The first signs are in appearance. Internally, the fat replaces lean body mass and many people are gain weight, there is loss of bone and muscle, the lungs lose their ability to take air and our respiratory efficiency decreases, the functions of the cardiovascular and renal systems reduce the number of strokes cells decreases, as is the total brain mass, and finally vision and hearing are impaired [1].

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According to the World Health Organization (WHO) it is estimated that the world population will be over two billion people aged over 60 by 2050, where 80% will live in developing countries [2]. These indications force many countries to follow new directions promoting active aging. The primary purpose is to raise awareness and to inform the responsible bodies and society about the problems that aging causes in the population. This fact leads to the need of developing methods and ways to address and meet needs existed in health and social security, promoting the autonomy of the elderly, ensuring the mutual obligations between the generations, even for the continuous improvement of a network of effective care and social support for the elderly.

The elderly people experience several changes, such as physical (kinetic, cardiovascular, respiratory, secretory, autonomous, reproductive system, reduced sensory stiffness), changes in cognitive functions (speed processing, memory, and intelligence), changes in the family's environment or feeling marginalization on the part of their family. When these changes appear, they can have positive or negative effects on their life, but also on the way they are getting old. These changes are a consequence of all these attributes acquired in their lives, such as health, education, employment, financial situation [3].

The major problem faced by the elderly is the social isolation and the blockade occurred by the modern socio-economic developments. According to the agency AGE Concern UK, the definition of social exclusion indicates the lack of accessibility to things of everyday life [4]. Physical impotence is the largest cause of social isolation. The participation of the elderly in a variety of social activities promotes their health and contributes to the greatest possible delay in aging. Aging is accompanied by a decrease in strength, energy and good physical condition and is therefore associated with poor quality of life. Improving elderly fitness capabilities (strength, balance, endurance and flexibility) through effective and comprehensive physical activity programs, enables them to maintain their functional abilities. Thus, elderly become able to adopt a more active lifestyle and improve their quality of life, delaying or reversing the decline in physical performance.

Marques et al. [5] and Mangani et al. [6] mentioned the effect of aerobic exercise against resistance in muscle strength and physical performance in the elderly. Their results presented that aerobic exercise improves the physical performance measures, as balance and gait speed enhances muscle strength improvement. Also, randomized controlled trials of combination of resistance and aerobic exercise have reported improvements in both the muscular strength and the physical performance [7].

Lack of balance in the elderly often leads them to fall where about 10% of falls leading to fracture or other serious injury [8]. Programs designed to improve balance and strength show significant reductions of falls in frail elderly. The component of all positive tests included the balance training [9, 10]. Several studies have shown that physical activity can contribute to the improvement of certain cognitive functions [11] and in particular when combined with cognitive exercise [12]. In a recent neuroscience study, presented data on how the preventive action affects cognitive and physical exercise on cognitive impairment and dementia [13, 14].

Many researches' efforts are being made to support technology in order to find solutions about the elderly's physical exercise through games. The "exergaming" design, if properly implemented, significantly increases the motivation of the elderly

while training their body with the appropriate physical activity. The effects of exergaming are now well documented as the positive changes in mood, strengthening socialization and overall improvement in quality of life [15]. Serious games for the elderly, are mainly focused on physical or cognitive training, are considered as preventive/therapeutic interventions. In the composition of an important and promising part of serious games, the exergames are serious games that focus on engaging older people in physical activity through games. It has also been shown that serious games promote and enable the socialization of the elderly [9]. New technologies are a source of social support and general and an instrument for integration in society as citizens [16].

Therefore, there is a growing interest to investigate whether the negative effects of aging can be improved, or even delay their development, aiming at an autonomous and independent living for the elderly and at quality in their life. The aim of this study is to investigate the effectiveness of a traditional physical training intervention for elderly people with the presence of an expert and a computerized physical training intervention evaluating the most beneficial effects.

2 Materials and Methods

2.1 Participants

Forty-four (44) elderly women aged 60–80 years old participated in this study. One group of twenty two women with an average age of 67.09 (SD = 5.95) and an average span of education at 6.54 (SD = 2.17) (cf. Table 1) followed the intervention with traditional aerobic exercise while the other group of twenty two women participated in the computerized physical exercise intervention. A total of 44 women were invited to participate with the prerequisite of performing a medical examination in which good functional, psychological and emotional state were ensured. People with heart failure, hypertension and respiratory failure were excluded from the study. Additional criteria involved non participation in similar intervention programs. They were fully informed about the aims of the study and finally signed the informed consent form. The evaluation was conducted at baseline (pre assessment), as well as at the end of the intervention (post assessment).

Table 1. Demographic characteristics of participants across two different groups to test effects of two exercise-based intervention programs

	Web physical training *n = 22*		Physical training *n = 22*	
	Mean	SD	Mean	SD
Age (years)	*67.09*	*5.95*	*70.70*	*6.0*
Education (years)	*6.54*	*2.17*	*5.50*	*3.59*
Weight (kg)	*77.5*	*9.08*	*74.40*	*9.55*
Height (cm)	*156.7*	*5.93*	*154.9*	*5.23*
BMI	*31.42*	*3.37*	*31.13*	*4.75*
Smoker	*3 (13.6%)*		*0*	

2.2 Intervention

Two different training interventions were designed in compliance to the ACSM/AHA recommendations. The exercise protocols included activities to improve aerobic capacity, muscle strength, mobility (flexibility) and coordination skills (balance) (cf. Table 2). The intensity was 50%–60% of the maximum heart rate and 78–90 b/min [9, 17]. The first protocol consisted of computerized physical exercises using the personalized training program webFitForAll while the second protocol follows a traditional physical exercise intervention.

Table 2. Description of the content structure of two different training programs

Type of activity	Computerized physical training	Traditional physical training	Time (min)
Warm-up period	√	√	7
Stretching	√	√	8–10
Strength	√	√	10–15
Flexibility	√	√	8–10
Balance-strength	√	√	15
Cool down period	√	√	5
Use of technology	Yes	No	

Both interventions took place at the Day Care Centres (KAPI) of Municipality of Pella (cf. Fig. 1) and lasted 10–12 weeks (min 30 sessions, 2–3 times/week, 60').

Fig. 1. Day care centers of municipality of Pella

The webFitForAll exergaming platform, supports a large number of physical exercises suitable for the elderly and complies with the majority of design recommendations and practice suggestions. Adopts MS Kinect as the main gaming controller for delivering physical exercises blended with games (exergames) to the elderly. It enables the professional to create and edit the physical exercise protocols (e.g. type of exercises/games, game parameters, duration) and assign them to the elderly [9, 15]. The aerobic exercises navigate the elderly through a Google maps virtual environment (cf. Fig. 2) based on the walking on the spot or cycling on static bicycle speed. The balance

exercises delivered through games that require body balance alterations such as Fishing (balance alterations on the vertical axis), or the Arkanoid game (balance alterations on the horizontal axis) and Golf (balance alterations on both axis) (cf. Fig. 3).

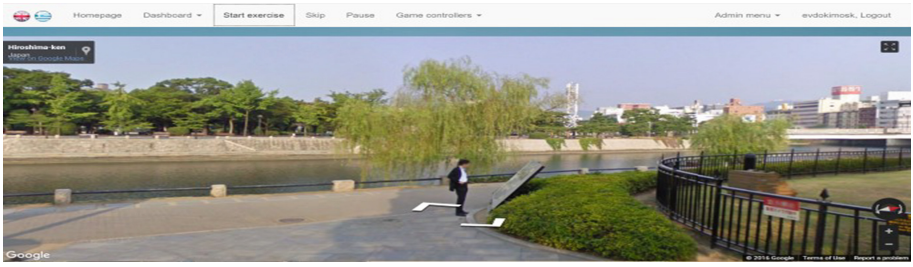

Fig. 2. Aerobic is represented through a Google Maps virtual environment

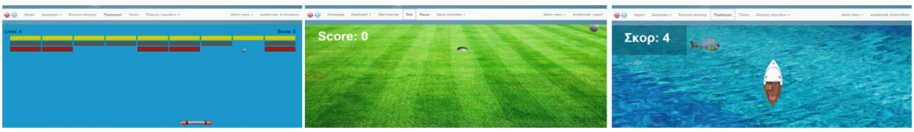

Fig. 3. During the fishing game the users control the boat's position with body movements on the vertical axis.

2.3 Physical Assessment

The tools selected for the assessment of their physical status and their functional capacity were: the Fullerton Senior Fitness Test (Chair stand, 8 Foot Up and Go, Back Scratch, Arm Curl, Chair Sit and Reach, Two Min Step) [18] to assess the overall physical status, the Berg Balance Scale [19] for the balance and risk of falls, the Tinetti Test [20] for walking and risk of falls and the Stork Balance Stand Test [21] for assessing the balance when standing on one leg.

2.4 Quality of Life and Neuropsychological Evaluation

The WHOQOL questionnaire was used, developed by the World Health Organization, which aims at promoting an intercultural Quality of Life assessment system and the use of the wider health sector. It includes 26 questions divided into four thematic sections (WHOQOL Group 2004) where the respective questions consider: (a) physical health, (b) mental health, (c) social relationships and (d) the environment [22]. It should be noted that there were many cases in which not only the aforementioned assessment tools were used, but also self-report questionnaires were collected. For the evaluation of some cognitive functions (depression, functional, physical and mental health, anxiety, sociability, risk of falls), the following were used: GDS, PHQ-9, IADL, SF-12, BECK, Risk of Falls, Friendship Scale.

3 Results

The statistical analysis was conducted via a 2 × 2 Mixed Model ANOVA. The groups of intervention (Web Physical Training and Physical Training) served as between-subjects factor whereas the time (pre-post) as within-subject factor. Results revealed a statistically significant interaction between time and intervention for the Chair Stand score difference [F(1,42) = 6.522, p = 0.014]. Furthermore, an interaction between time and intervention was also revealed for the Tinetti score [F(1,42) = 12.47, p = 0.001], the Berg Balance score [F(1,42) = 23.48, p = 0.000], the PHQ-9 score [F (1,42) = 6.54, p = 0.014] (cf. Table 3), (Fig. 4).

Table 3. 2 × 2 ANOVA results

Test	Subdomain	F(1,42)	Time/Interv.
Fullerton	Chair stand	6.522	0.014
Tinetti		12.472	0.001
Berg		23.488	0.000
PHQ-9		6.542	0.014

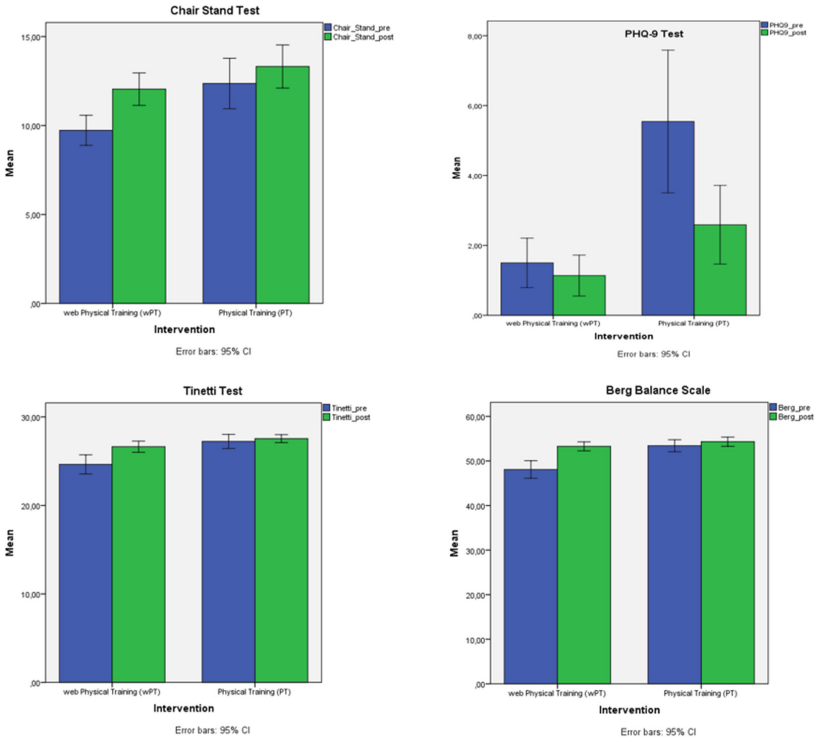

Fig. 4. Results from the 2 × 2 Mixed Model ANOVA

Table 4. Efficacy results in terms of Fullerton, Berg, Stork, Tinetti, GDS, IADL, PHQ-9, SF12, Beck, Friendship Scale, Risk of Falls and WHOQOL. Bold p values denote

Test	Subdomain	Web physical training *n* = 22		Physical training *n* = 22	
		t (21)	p value	t (21)	p value
Fullerton	Chair stand	−6.098	**.000**	−2.546	**.019**
	Arm curl	−5.116	**.000**	−4.134	**.000**
	2-min walk in place	−3.794	**.001**	−4.348	**.000**
	Sit and reach	−1.262	.221	0.596	.558
	Back scratch	−3.223	**.004**	−1.064	.299
	8-Foot-Up-And-Go	4.569	**.000**	3.281	**.004**
Berg balance scale		−6.689	**.000**	−2.160	**.042**
Stork test		−2.863	**.009**	−3.476	**.002**
Tinetti test		−6.079	**.000**	−.924	.366
GDS		3.648	**.002**	0.539	.595
IADL		1.368	.186	1.449	.162
PHQ-9		1.219	.236	3.052	**.006**
SF12pcs		−2.046	.054	−2.064	.052
SF12mcs		−0.340	.737	−2.208	**.038**
Beck anxiety inventory		−1.611	.122	1.694	.105
Friendship scale		−1.071	.296	−0.995	.331
Risk of falls		1.000	.329	−1.308	.205
WHO QOL		−2.162	**.042**	−3.049	**.006**
	Physical health	−1.328	.198	−1.548	.136
	Psychological	−0.957	.350	−1.566	.132
	Social relationships	−1.779	.090	−2.082	**.050**
	Environment	−2.220	**.038**	−3.819	**.001**

A paired-samples t-test was conducted to investigate the effectiveness of each physical training protocol. Table 4 presents the results (post–pre intervention differences and p-value) concerning the cognitive and physical assessment tests. On the physical assessment front, the results indicate that the Web Physical Training intervention evoked statistically significant improvement in the Chair Stand (lower body strength), Arm Curl (upper body strength), 2-min Walk in place (aerobic endurance), Back Scratch (upper body flexibility) and 8-Foot-Up-And-Go (complex coordination, agility and dynamic balance). In contrast to that finding, the Physical Training intervention showed statistically significant improvement in Chair Stand (lower body strength), Arm Curl (upper body strength), 2-min Walk in place (aerobic endurance) and 8-Foot-Up-And-Go (complex coordination, agility and dynamic balance).

In the same notion, Web Physical Training intervention evoked statistically significant improvements reflected in the rest physical assessment tests Berg Balance Scale (balance and risk of falls), Stork (balance on one leg), Tinetti Test (walking and risk of falls) as well as the non-physical assessment test GDS (geriatric depression) and WHO QOL (quality of life).

The participants of the Physical Training intervention showed statistically significant improvements in the Berg Balance Scale (balance and risk of falls), Stork (balance on one leg), PHQ-9 (Patient Health), SF12mcs (Physical and Mental Health) and WHO QOL (quality of life).

4 Discussion

The present study describes the design of two interventions and the conductance of a pilot test with elderly. The overall aim is to investigate whether physical training with or without the use of technology can evoke significant effects in both physical and physiological health, as well as the quality of life of the participants.

In Chair Stand test, which assesses the lower limbs strength and the dynamic balance, statistically significant differences post-pre assessments were revealed in both interventions. Also, statistically significant results were found in the Arm Curl test, evaluated the upper body strength, in the 8-Foot Up and Go test, as well as in the Two Minute Step test, which values the aerobic capacity in both interventions. The upper body flexibility was significantly improved in the Web Physical Training intervention according to the Back Scratch test.

Furthermore, significant results were presented in Berg Balance Scale test, which evaluates the balance and the risk of falling, in the Stork test, assessing the static balance capacity, as well as in WHO QOL (quality of life) in both interventions. The Tinetti test, which evaluates balance in different postures (sitting, standing and lying on one leg, seating and standing), as well as GDS test (geriatric depression) showed statistically significant results only for the participants of the Web Physical Training intervention. On the contrary, significant improvements showed to the participants of the Physical Training intervention as measured by PHQ-9 (Patient Health) and SF12mcs (Mental Health).

The American College of Sports Medicine (ACSM) [23], states that exercise is important for improving and maintaining the health of older people. Aerobic, balance, strength and flexibility are suitable for this population. However, there is no consensus on the frequency, intensity and type of balance exercises for them. Previous studies, showed that the combination of physical activity and brain training with computerized means significantly improved verbal memory after 16 weeks [24]. Moreover, our results are in line with the reports of similar studies of the last decade pertaining to the positive role of the physical exercise and the exergames to the psychological well-being and quality of life in older adults [25, 26]. Both interventions revealed the improvement of body functionalities and balance that are connected to daily activities like carrying luggage or shopping, as well as, more confidence and independence in general [27].

Significant improvements were indicated especially in the Web Physical intervention regarding the depression and quality of life assessment tests before and after intervention. This fact is considered to occur as the aerobic exercises, such as hiking and cycling, were presented through the environment of Google maps. Thus, the participants were able to visit and explore cities or natural places that visited before or heard of in their real life. This fact could provoke the feeling of nostalgia or the challenge to visit and explore new places [9].

The findings showed that there was a consistent positive and simultaneously strong relationship between many of the health indicators, physical state and functional capacity with a total volume of activity and at least moderate activity. In comparison of the results between the two interventions, we observed that the web Physical Training intervention showed statistically significant results in the testing of the strength of the lower limbs, in the balance in different postures and in monitoring and calculating the severity of depression. Physical activity is enjoyable but many older people tend to suffer from loneliness and lack of this. We believe that the use of technology through exergames can offer fun and physical and mental health.

5 Conclusion

The present study investigated the role of technology in physical training programs specialized for the elderly people which is considered to provide benefits to their physical and functional condition in order to deliver autonomous and independent living. Both interventions revealed the improvement of body functions and balance associated with daily activities, improve their physical and mental health and therefore quality of their life. The serious games, which used in the protocol, in addition to the fun, also offered an improvement in their balance and gait, strength of the lower body as they improve their attitude.

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