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Functional Challenges in the Elderly

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1. Introduction

Aging reflects differences in geographic, culture, socio-economic, political and medical contexts, known as the increase in survival rates, with greater life expectancy. (Michel, 2004). Age itself is an independent morbidity and mortality risk factor for a long list of diseases, hospitalization, and length of hospitalization (Priebe, 2000).

The aging process combined with being sedentary enhances the loss of strength and muscular mass, decrease of balance, proprioception and mobility; all these symptoms combined predispose loss of independency and falls. Falls can evolve to fear of falling, to restriction of social activities and to impairment of daily activities performance. (Vreed, 2004)

Some diseases are frequently seen among the elderly. (Priebe, 2000) These include chronic heart failure (CHF), chronic obstructive pulmonary disease (COPD) arthritis and arthrosis, heart failure, (Okita, 1998)., hypertension, hypercholesterolaemia and diabetes mellitus (Ciolac and Guimaraes, 2002a).

The addition of those diseases to aging contributes to diminished functional development in elderly, (Okita, 1998) decreased life expectancy, greater risk of dementia (Richard, 2010), greater mortality risk and hospitalization length (Priebe, 2000).

2. Aging

Aging is a natural, intrinsic, detrimental, progressive and universal course of life which leads a subject to progressive functional aptitude loss (Papaléo, 2002) which corresponds to an independent morbidity and mortality risk factor for a long list of diseases, hospitalization, and length of hospitalization (Priebe, 2000).

Getting old represents physical, social, political and medical implications. Depending on the type and course of the developed morbidities, a subject can face physical suffering due to handicaps, which may increase government costs on social and health programs (Michel, 2004).

It's not totally clear how aging occurs. Flaw son automatic mistakes corrections, metabolic deviation, action of genes related to the protein synthesis and cells' programmed death (entitled apoptosis) implicate in structural and functional organs' alteration and they are responsible for their activity decline (Papaléo,2002; Alves, 2004).

3. Age related impairment in general

Changes in the elderly can be found in numerous interacting systems. Musculoskeletal, (Evans, 1993; Gill, 2004; Goldspink, 2005; Faulkner, 2007) cardiovascular, (Heath, 1981; Ciolac and Guimaraes, 2002b) pulmonary (Gill, 2004 ; Gardner, 2000) and neurological systems very often suffer impairment (Richard, 2010).

Decreases of 19 to 49% in muscle mass (sarcopenia (Ciolac and Guimaraes, 2002b) occur because of loss of myocytes (Goldspink, 2005) which leads to skeletal muscle atrophy. The gradual loss of 50% of muscle fibers happens in limb muscles (Faulkner, 2007).

There is also increase in bone porosity, cartilage degeneration, (Gardner, 2000), flexibility and proprioception loss (Gill, 2004; Gardner, 2000).

Elderly frequently have loss in coordination, balance (Gardner, 2000), a 2%-decrease in reflex velocity occurs each year (Gill, 2004) lower visual acuity, impaired central nervous system (CNS) function (Gill, 2004 ; Gardner, 2000).

Aging is associated with increased stiffness (reduced compliance) of large elastic arteries; impaired vascular endothelial function, including reductions in endothelium-dependent dilation (EDD), release of tissue-type plasminogen activator (fibrinolytic capacity) and endothelial progenitor cell number and function; increased intima-media wall thickness (IMT); and peripheral vasoconstriction (decreased basal leg blood flow); 40-50% differences in large elastic artery stiffness and compliance (Gates, 2003; Seals, 2008).

Advancing adult age is associated with profound changes in body composition. Declining basal metabolic rate (BMR) at a rate of 3% each ten years happens (Evans, 1993; Gardner, 2000; Gill, 2004) which may increase rates of cardiovascular and metabolic diseases (Fig. 1.) (Ciolac and Guimaraes, 2002a).

Of all the physiological changes that occur during the aging process, regarding quality of life and functional independence are declines in muscle strength and in aerobic capacity, (indexed as peak oxygen consumption-peak VO₂) (Heath, 1981; Fleg, 1988; Katznel, 2001; Fleg, 2005). As already known, peak VO₂ is known to be dependent on age, gender, activity status and disease state (Morris, 1993) and to be a significant predictor of death (Myers, 1998).

The longitudinal rate of decline in peak VO₂ with age is not linear but accelerates at higher age decades in both sexes. A longitudinal decline in peak VO₂ was observed in each of the 6 age decades in both sexes; however, the rate of decline accelerated from 3% to 6% per 10 years in the 20s and 30s to 20% per 10 years in the 70s and beyond (Fleg, 2005).

By age 75 years, over half of the functional capacity of the cardiovascular system, (peak VO₂), has been lost (Tanaka, 1997; Hawkins, 2003).

Decline in peak VO₂ in individuals can be explained by the loss of muscle mass and changes in body weight and fat free mass (FFM), lifestyle habits, and development of subclinical and clinically apparent disease (Katznel, 2001) which occurs with advancing age (Fleg, 1988; Fleg, 2005).

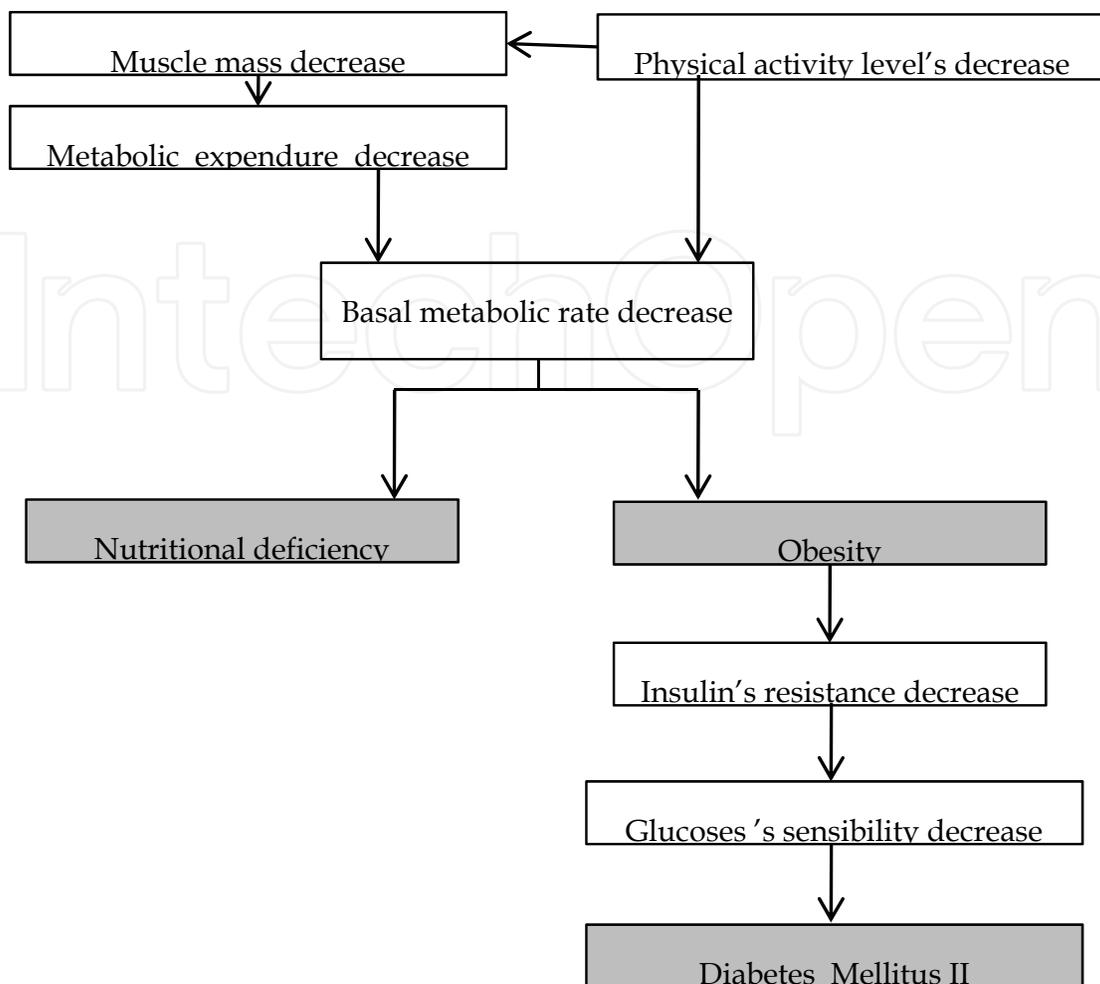


Fig. 1. Schematic representation of energetic metabolic reactions due to aging. Adapted from Ciolac and Guimaraes (2002a) with permission.

4. Age related functional decline

Functional ability decreases as people get old. Nonetheless, age is not the only contributing factor to function disability. Multiple factors influence functional decline in physiological systems, including aging, disuse and disease (Hawkins, 2003).

Thus, besides age (Morris, 1993), gender, weight, body surface area, thigh cross-sectional muscle area, peak VO_2 can also be correlated to functional capacity (Myers, 1998) (Heath, 1981).

However, among all these changes, the decrease in muscle mass and balance are the greater responsible for physical dependency (Avlund, 2003; Gill, 2004) because strength and balance are both necessary in order to develop any kind of duties with expected stability and agility (Brawley, 2003). As a result walking is the first affected daily activity, and its pace and speed are mostly influenced by lower limb strength (Nied, 2002, Pansa, 2003).

As a consequence of performance decline, elderly frequently experience falls (Blank, 2011). Falls can be common older person and can cause notable decreases of quality of life due to

fear of falling, restricted mobility, loss of autonomy and bone fractures (Gill, 2004; Blank, 2011). Elderly people who have experienced bone fractures after falls have 45 to 60% of decline in their independency and around 80% of them become inactive due to psychosomatic aspects. (Marks, 2003)

5. Functional activity decline related inactivity

Inactivity itself (due to either fear of falling, loss in joint mobility or decreased balance) is also a contributing factor for sarcopenia, muscle strength, balance, and quality of life decline (Avlund, 2003; Vreed, 2004) Indeed dependency during activities of daily living increases from three to five times as inactivity rises. (Frank, 2003)

6. Functional activity improvement

Recent trials suggest healthy older women are capable of exercising and increasing the exercise intensity by exercise training (ET) similar to young women (Fig. 2.) (Ciolac and Brech, 2010).

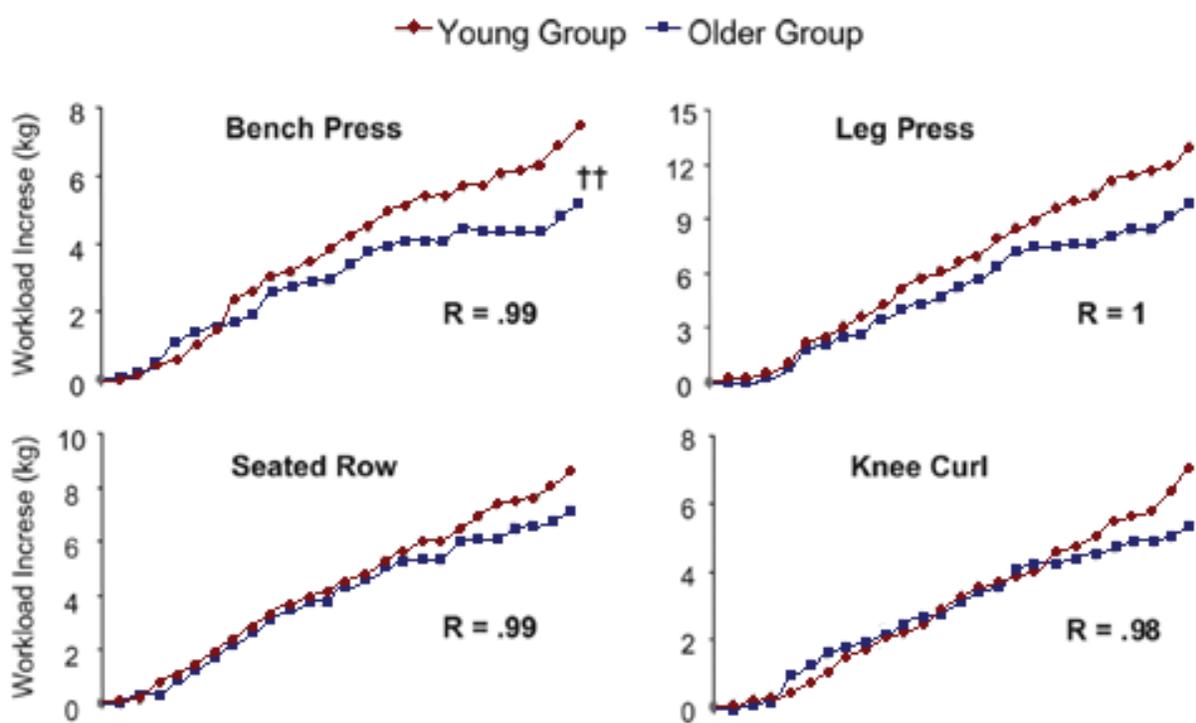


Fig. 2. Absolute workload increase curves for aerobic and resistance exercises. *Workload increase value in watts. †Tendency to be different from the younger group ($p = 0.06$). †† Significantly different from younger group ($p < 0.01$). Adapted from Ciolac and Brech (2010), with permission.

6.1 Selecting subjects

When selecting a population in which to introduce a physical activity program, the aims of the program need to be carefully considered. However, 65-year old people who have balance loss can be selected to a rehabilitation program (Vreede, 2004; Blank, 2011)

To evaluate the risk of falling older people need to have at least one of the following criteria: fall within the last 12 months; fear for falling; sitting to standing >10 sec; Timed-up-and-go-Test >10 sec (Blank, 2011)

However, the elderly in general would improve muscle strength and balance from exercise programs because it's known that they have progressive and declining loss of all organ functions over time. (Priebe, 2000; Papaléo, 2002).

6.2 Exercise in general

Strength training and weight-bearing exercises, functional power training, balance training, daily activity performance with motor coordination and proprioception, gait training with change of pace and direction while walking all contribute to functional activity improvement (Blank, 2011).

Strength training and weight-bearing exercises have perhaps greater adherence from the participants because they are more common to them. These exercises can fulfill their expectations and increase their self esteem (Vreede, 2004).

6.3 Muscle strength improvement

Limitation daily activities due to sarcopenia, loss in muscle strength can be partially or totally solved with the practice of strength training and weight-bearing exercise (Boulgarides, 2003; Seguin, 2003).

Weight-bearing exercise training is the most efficient intervention responsible for muscle mass and strength gain, besides it also guarantees increased functional reserve, cardiovascular conditioning, better sleep quality and lower fear of falling (Lord, 1995; Gardner, 2000; Borst 2004).

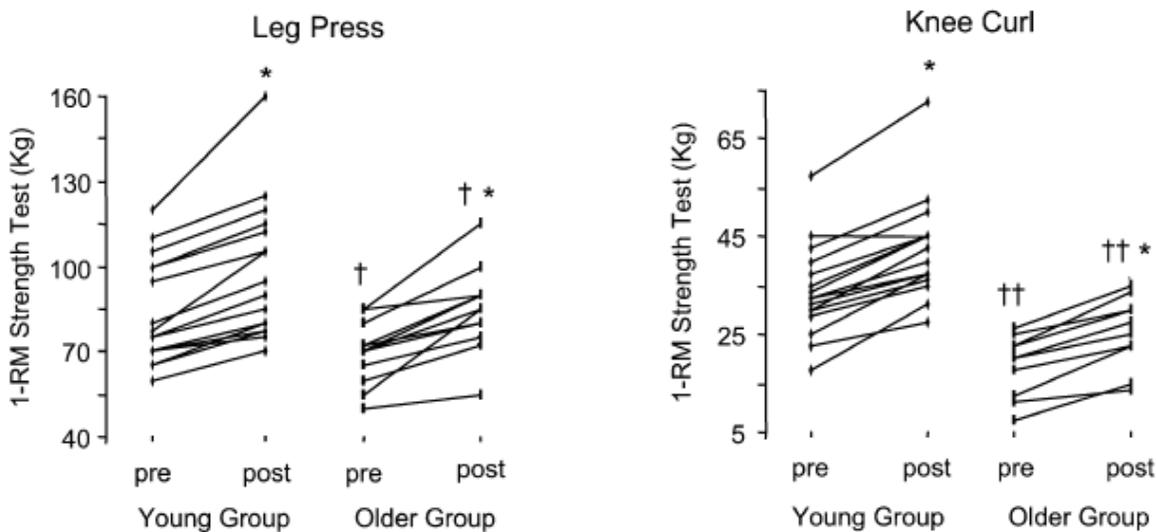


Fig. 3. Significantly difference between muscle strength († $p < 0.05$; †† $p < 0.001$). *Significantly different from before exercise training in the same group ($p < 0.001$). With permission of Ciolac and Greve (2011).

Generally strength training of antigravitational muscles is the most important measure to achieve better functional activity. Although these muscles are not considered essential for survival, they are extremely important for enabling people to carry out activities (Meuleman, 2000; Laughton, 2003). The most trained antigravitational muscles act on knee, hip and trunk extension (Judge, 1994; Meuleman, 2000; Marks, 2003; Skelton, 2003; Vreede, 2004; Faulkner, 2007; Ciolac and Greve, 2011).

The 1-RM workload, defined as the maximum weight that could be moved once through the full range of motion with proper form and without performing the Valsalva maneuver, is used in most populations, including the elderly (Ciolac and Greve, 2011).

Specificity is one of the fundamentals of muscle strength improvement, however similar gains can occur after resistance exercise, as seen in Fig. 3. (Ciolac and Garcez-Leme, 2010)

6.4 Balance improvement

Receptors in all musculoskeletal vestibular and visual ones systems are responsible for the body's entire balance control (Lorrd, 1993; VanSwearingen, 2001). Physical exercise may delay the synaptic function decline that is related to the aging process, thus increasing coordination and the performance of activities that require quick motor skills. (Lorrd, 1993; Fiatarone, 1994; Chiovatto, 2002; Ness, 2003).

Static and dynamic balance training can be improved by exercise and this leads to a decreased risk of falls as well as greater functional capacity. Figures 4 to 7 (Lorrd, 1993; Lord, 1995; Frank, 2003; Pansa, 2003).

Balance gain is effective when training different postural responses within functional activities. (Horak, 1997; Frank, 2003) but it is important to highlight that the key balancing point whenever in an upright position is in ankle mobility (Fig. 4.), thus, movement in this axis is essential (Chiovatto 2002; Brawley, 2003; Laughton, 2003; Marks, 2003).



Fig. 4. Training balance through ankle mobility.



Fig. 5. Training balance on instable surface combined to upper limbs movements.



Fig. 6. Training balance on instable surface combined to upper limbs movements.

Whithin each session, proprioception gain is fundamental in order to obtain a better impact on postural control (Gauchard, 1999; Perrin, 1999). This can be achieved by the use of unstable surfaces (Fig. 4 to 8), which lower the ankle proprioceptive input and emphasizes the vestibular and visual system (Lorrd, 1993). Sensory awareness and balance can be even more directed whenever unipodal support is performed during the exercise program. (Judge, 1994; Ringsberg, 1999; Nied, 2002).



Fig. 7. Training balance on instable surface combined to upper limbs movements.



Fig. 8. Training balance and proprioception on instable surface.

Associating exercise with eye closed also contributes to a more gain in balance (Frank, 2003). Having the eyes closed forces the subject to use proprioceptive and vestibular sensors with priority, to correct posture and to adopt a more appropriate balance strategy (Gauchard, 1999; Perrin, 1999; Ringsberg, 1999; Frank, 2003).

6.5 Combined therapy

Getting old contributes to poor functional activity, it seems reasonable working with combined groups of exercise to improve elderly functional capacity (VanSwearingen, 2001; Ciolac and Guimaraes, 2002b; Papaléo, 2002; Alves, 2004).

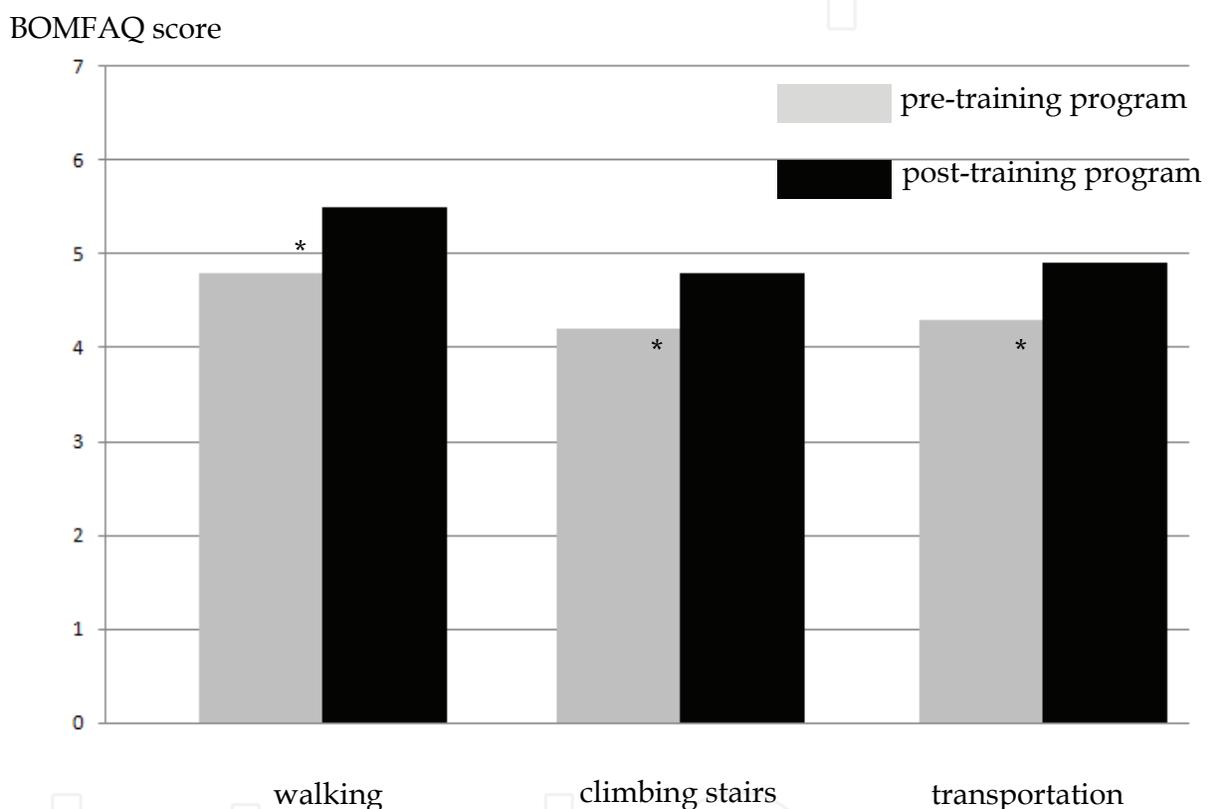


Fig. 9. Comparison of activities (walking, climbing stairs and getting off the transportation) after an exercise program. *Significantly different from before exercise training in the same group ($p < 0.05$). With permission of Tavares (2008).

Strength training, weight-bearing exercise and functional power training, plus balance training, daily activity performance with motor coordination and sensory awareness, gait training are all part of different elderly rehabilitation (Judge, 1994; Tavares, 2008; Ciolac and Brech, 2010; Blank, 2011).

Combined therapy with strength, balance and proprioception training, plus weight-bearing exercise improves functional performance (Fig. 9) according to the Brazilian multidimensional Functional Assessment questionnaire (BOMFAQ) (Tavares, 2008).

Recent trials recommend a safe exercise training program (safe because no injuries or major muscle pain was observed) on cycle ergometry (CE, 65–75% of reserve heart rate), whole-

body resistance exercise (RE, 60% of 1 repetition maximum [1RM]) and stretching during rehabilitation program. An increase of 5% is possible to be made in the exercise intensity, and one of 5–10% (1-5Kg) in the RE whenever adaptation occurs, without compromising this safety (Ciolac and Brech, 2010).

6.6 Hydrotherapy

Exercise in water may be a viable alternative for people whenever weight-bearing exercise are not be suitable for individuals with orthopaedic or musculoskeletal limitations, excess adiposity or other medical conditions (Meredith-Jones, 2011).

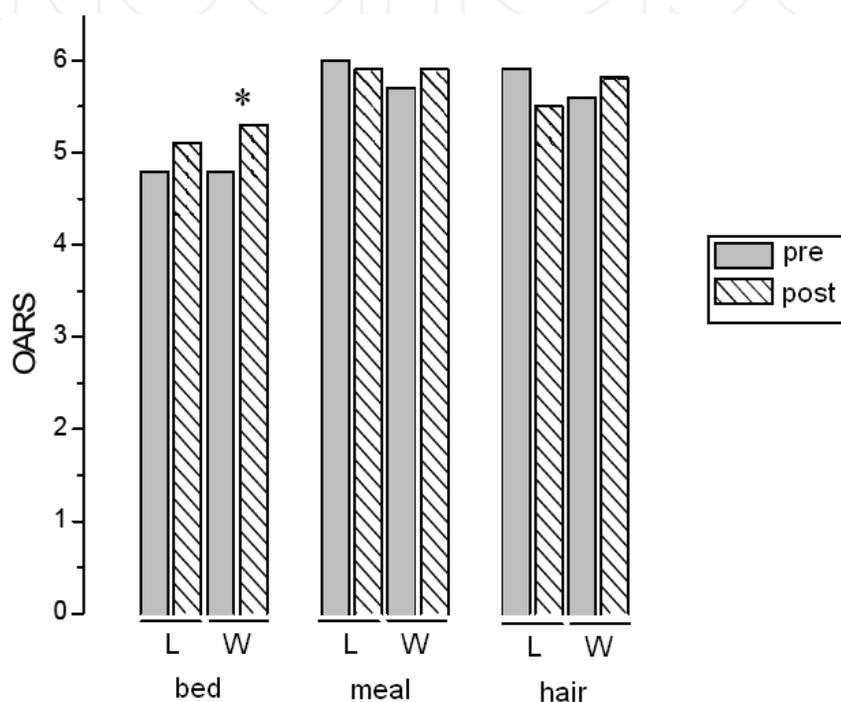


Fig. 10. Comparison of activities (lying and getting up the bed, having a meal; combing the hair) after an exercise program in land (L) and in water (W) *Significantly different from before exercise training in the same group ($p < 0.05$). With permission of Tavares (2009).

Water's properties help participants to detect errors, correct them with more length of time, and experience a wider range of movement without an increase in the risk of injury due to a fall (Teffaha, 2011).

It is suggested that in water, people are allowed to have a larger band width of movement in exercise in which the participants could make mistakes, receive a feedback and, then, correct that error without an increase in their fear of injury through the use of these movement errors in water (Meredith-Jones, 2011; Teffaha, 2011).

The emphasis of an intervention in water has similarities to exercise in land. They all include warm-up, stretching, weight-bearing exercise on antigravitational muscles and balance training (Simmons, 1996; Vreed, 2004; Teffaha, 2011).

A program based on exercises in the water improves the capacity of walking on the plane and of lying and getting out of bed after a 12-week, randomized, single-blind study in elderly as seen on Fig. 10 (Tavares, 2009).

Water exercise induces significant improvement in aerobic capacity, neuromuscular fitness and quality of life score (Simmons, 1996; Bocalini, 2010). Training needs to be constantly because a short length period of detraining (6 weeks) is responsible for returning to untrained levels the upper and lower body strength, agility, flexibility, and body balance (Bocalini, 2010).

7. Clinical improvement after rehabilitation

The elderly cluster that underwent clinical trials based on exercise found improved strength in more than 40% (Ciolac and Brech, 2010; Ciolac and Greve, 2011) improved neuromuscular fitness and quality of life score (Bocalini, 2010).

An activity program contribute to a positive cardiovascular risk reduction (Ortiz, 2010; Ciolac and Greve, 2011) because it decreases significantly systolic, diastolic blood pressure and pulse pressure (Ortiz, 2010; Pitsavo, 2011), it decreases significantly the left ventricular mass index (Pitsavo, 2011) and decreased atherogenic index and increased high-density lipoprotein cholesterol level (Ortiz, 2010). Besides, exercise shows significant improvement in aerobic capacity (Bocalini, 2010; Ciolac and Greve, 2011), and heart rate response (Ciolac and Greve, 2011)

8. Program specification for elderly, in general

Frequency trials have shown that functional capacity improvements often occur with 60 min training sessions (Perrin, 1999; Tavares, 2008; Tavares, 2009) with sessions ranging from twice a week (Perrin, 1999; Boulgarides, 2003; Gardner, 2000; Ciolac and Garcez-Leme, 2010) three times-per-week exercise-training programs. (Ciolac and Greve, 2011; Pitsavo, 2011) This short variance of frequency is able to reveal beneficial effects of regular exercise training in the elderly (Pitsavo, 2011).

Some trials point out the muscle and balance improvement after both, 12-week exercise program (Bocalini, 2010; Boulgarides, 2003; Ciolac and Garcez-Leme, 2010) and a 16 one (Blank, 2011; Pitsavo, 2011).

Usually the duration of the activity program in elderly lasts up to 12 (Rydwik, 2005; Tavares, 2008; Tavares, 2009; Ortiz, 2010; Ciolac and Greve, 2011) to 16 months (Pitsavo, 2011) in order to reproduce clinical benefits. However exercise followed by 6 weeks without training induced significant improvement in aerobic capacity, neuromuscular fitness and quality of life score (Bocalini, 2010).

According to exercise intensity in elderly, most trials which have improved results have worked with large muscles and moderate to high intensity (Ciolac and Guimaraes, 2002b). A 60–80% of reserve heart rate with an increase of 5% whenever adaptation occurs (Ciolac and Brech, 2010; Pitsavo, 2011) combined to a score between 11 and 14 on the perceived exertion scale can be used in a safe way whenever prescribing exercise (Guimarães, 2008).

9. Conclusion

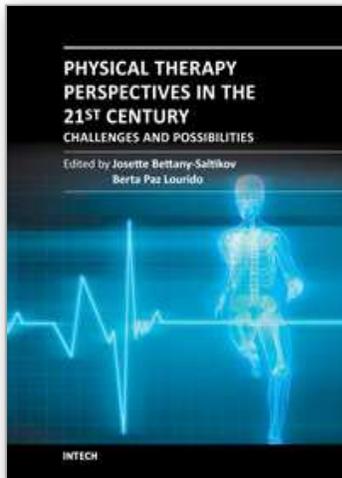
Decline in functional capacity with age is expected due to the aging process itself combined with being sedentary. Careful measurement of quality of life and fear of falling needs to be included within the management program of elderly peoples` rehabilitation. Exercise addressing balance, body weight bearing, as well as motor coordination needs to be specifically addressed within elderly rehabilitation.

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This book contains new information on physical therapy research and clinical approaches that are being undertaken into numerous medical conditions; biomechanical and musculoskeletal conditions as well as the effects of psychological factors, body awareness and relaxation techniques; specific and specialist exercises for the treatment of scoliosis and spinal deformities in infants and adolescents; new thermal agents are being introduced and different types of physical therapy interventions are being introduced for the elderly both in the home and clinical setting. Additionally research into physical therapy interventions for patients with respiratory, cardiovascular disorders and stroke is being undertaken and new concepts of wheelchair design are being implemented.

How to reference

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