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Equilibrium and muscle flexibility in elderly people subjected to physiotherapeutic intervention

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ABSTRACT. To evaluate the equilibrium and flexibility of elderly people submitted to a training program involving physical therapy exercises. Six elderly people were selected, average age 69.66 years. Wells's Bench and the Functional Reach Test (FRT) plus Timed Up and Go Test (TUG) were employed respectively to assess muscle flexibility and balance analysis. Tests were performed before and after the exercise program which consisted of thirty-five 50 min physical therapy group sessions, twice a week, with stretching exercises, gait training, active exercises, postural correction exercises and breathing exercises. Statistical analysis was done with Sigma-Stat® 3.5. Assessments occurred before and after sessions, and the final test was undertaken after 35 sessions. There was a statistically significant increase in the flexibility of the posterior muscle chain. In the TUG test, the group achieved a shorter time after treatment, with statistical significance between tests. There was a statistically significant increase in the average FRT after the sessions. Current study showed better results in the execution of tests evaluated after the program of physiotherapy activities, contributing towards the improvement of muscle flexibility and balance of elderly people.

Keywords: postural balance, muscle stretching exercises, aging, physiotherapy.

Análise do equilíbrio e flexibilidade muscular de idosos submetidos a intervenção fisioterapêutica

RESUMO. Avaliar o equilíbrio e a flexibilidade de idosos submetidos a um programa de treinamento físico fisioterapêutico. Foram selecionados 6 idosos, com idades média de 69,66 anos. A flexibilidade muscular foi avaliada com o banco de Wells, e para a análise do equilíbrio, o Teste de alcance funcional (TAF) e o teste de levantar e caminhar - *Timed Up and Go* (TUG). Os testes foram realizados antes e após o programa de exercícios físicos, que consistiu em 35 sessões de fisioterapia em grupo, de 50 min, duas vezes por semana, com exercícios de alongamentos, treino de marcha, exercícios ativos, exercícios de correção postural e exercícios respiratórios. Utilizou-se do software Sigma-Stat® 3.5 para a análise estatística. A análise foi feita antes e após as sessões, sendo que no teste final, após as 35 sessões, houve um aumento estatisticamente significante da flexibilidade da cadeia muscular posterior. No teste TUG, o grupo apresentou menor tempo após o tratamento, com significância estatística entre os testes realizados, bem como apresentou aumento estatisticamente significativo no valor médio do TAF após as sessões. Este trabalho demonstrou melhores resultados na execução dos testes avaliados após o programa de treinamento físico fisioterapêutico, colaborando para melhora da flexibilidade muscular e do equilíbrio dos idosos estudados.

Palavras-chaves: equilíbrio postural, exercício de alongamento muscular, envelhecimento, fisioterapia.

Introduction

In Gerontogeriatrics, functional capacity is the product of the interaction between physical and mental health, autonomy in daily and social integration, with the support of the family and economical resources (Mitre et al., 2008; Nakatani, Silva, Bachion, & Nunes, 2009). Brazilian population is aging fast, coupled to an increase in

longevity (Alves & Rodrigues, 2005). Forecasts show that there will be approximately 27 million elderly Brazilians in 2020, or rather, 12.9% of the entire population. In fact, it represents a considerable percentage, with increasing importance within Brazilian society. The south-eastern region of Brazil has the highest percentage of the load (Oliveira, 2013). General health problems and difficulties to undertake activities related to functional capacity

increase as aging takes its toll. In fact, age becomes a basic health factor during aging (Lima-Costa, Barreto, & Giatti, 2003). Therefore, the acknowledgement of the relevance in evaluating elderly people's functions and functionality has a main role within physiotherapy intervention.

Aging is a physiological process and the maintenance of the functional ability in the elderly may be influenced by several factors, namely, changes in equilibrium and in muscle flexibility (Overstall, 2003; Araújo, 2008) and loss of muscle mass and strength. Flexibility is related with 'elasticity' of tendons, ligaments and joint capsules, which decrease by age due to deficiency in collagen (Rebellato, Calvo, Orejuela, & Portillo, 2006). Therefore, the functional capacity may be impaired by physiological changes that affect elderly people's mobility (Dantas, Pereira, Aragão, & Ota, 2002; Penha, Piçarro, & Barros Neto, 2012). Lack of activities is the main factor that causes these modifications during old age. Since the level of physical activities is one of the factors that determine body composition from childhood to old age, proper flexibility helps people to have functional balance throughout their life and to participate wholly in numberless recreational and communitarian activities. Lack of reasonable flexibility favors high probability in acquiring lesions and functional problems, especially when the elderly or sedentary people are involved. Flexibility decreases with age, or rather, people have a 20 to 30% loss in flexibility between 30 and 70 years (Dantas et al., 2002).

Equilibrium is a complex process which depends on the integration of eyesight, vestibular and peripheral feeling, central commands, neuro-muscular responses and, especially, flexibility, muscle force and reaction time. An age-related decrease in functional capacity are evident in all parts of the systems and results in the fact that one third of over-65-year-old people experience falls (Overstall, 2003). So that a better balance could be obtained, people have to maintain their body mass center within the stability limits determined by the ability to control position without changing the supporting basis (Overstall, 2003). In Brazil, 30% of elderly people have a fall at least once a year. The higher one's age, the greater is the chance of having other falls: 32% of falls occur between 65 and 74 years; 35% between 75 and 84 years; and 51% when over 85 years old. Females experience falls more frequently than males within the same age bracket. Elderly people between 75 and 84 years old who require some sort of help for their daily activities (feeding, taking a shower, hygiene, putting on clothes, getting out of bed, urinary and fecal

incontinence) have a probability of falling 14 times more than people of the same age bracket but who are independent in daily activities. Further, 5% of falls cause bone fracture and 5 – 10% inflict injuries that require medical help (Bukzman, Vilela, Pereira, Lino, & Santos, 2008).

Although senescent changes are common to all elderly people, their increase is due to a sedentary lifestyle which, in its turn, increases the trend for cardiovascular diseases and other chronic and degenerative conditions (Zimmer & Amornsirisonboon, 2001) and an undesired life quality. The above justifies the need to assess and propose more specific exercises for the elderly due to the above mentioned senescent alterations.

Health assistance to the elderly is currently becoming highly important, due not only to the increasing numbers but also to an increase in chronic and disabling diseases (Veras, Lourenço, Martins, Sanches, & Chaves, 2002). As a rule, the elderly have more chronic disease problems than the general population (Mitre et al., 2008). Improvements in muscle force, bone density, dynamic equilibrium and overall functional status due to regular exercises may minimize or revert the syndrome of physical weakness (Penha et al., 2012).

Prevention and health-enhancing programs for the elderly are a must since this section of the general population is accountable for approximately 40% of the National Health System (SUS) expenditure, especially in hospitalizations. Regular physical activities prove to be an asset in attenuating most potentially deleterious physiological changes caused by aging (Jacob Filho, 2006; Nelson et al., 2007). Aerobic exercises and resisted training, performed separately, enhance immediate and long term physical and psychic benefits (Whelton, Chin, Xin, & He, 2002; Terra et al., 2008). Current research is scientifically relevant since it evaluates the efficiency of a physical training program that attends elderly people of a municipal health unit, focusing on two main changes which characterize aging, equilibrium and flexibility, and demonstrates whether the methodology of group activities is capable of minimizing the deleterious effects of aging. Current paper evaluates the equilibrium and flexibility of elderly people who undergo a physical-physiotherapeutic group training program.

Material and methods

Current analysis was approved by the Ethics and Research Committee of the Universidade Federal do Triângulo Mineiro (UFTM), protocol 1.144.645. The elderly people participating in current research

read or listened to the Terms of Consent, approved the aims of current study and its procedures and signed the document.

Characterization of the sample

Current study is characterized by a transversal and exploratory design in which the evaluated agents were their own control. They were evaluated before and after intervention and thus a control group was not required. Male and female elderly people, inserted in a preventive geriatric physiotherapeutic program of a health unit of the municipality of Uberaba (UMS) linked to the Universidade Federal do Triângulo Mineiro (UFTM), participated in current research. The inclusion criteria of current study comprised healthy elderly people who were not restrictions for the practice of physical activities, physically independent and not participants in any other structured physical exercises program. Elderly people with vestibular alterations or any other disorders that might affect equilibrium and those with neurological and physical restrictions for the practice of physical exercises were excluded. Data on inclusion and exclusion were retrieved by a pre-participation medical assessment which analyzed the participants' general health.

Procedures and instruments

Information on age, gender, ethnicity and medicines used were retrieved from the clinical charts of the elderly people attended at the UMS.

Wells Bench, 35 cm high and wide and 40 cm long, for the measurement of body flexibility, was used to analyze their flexibility. Assessment comprised sitting in front of the bench with feet placed on the support and knees extended; the arm is raised and one hand is placed on top of the other, both of which are placed in front till they reach the bench ruler. Three movements were undertaken and their mean was determined. The movement was undertaken passively: the evaluator conducted the movement till resistance to the movement was perceived. The greatest reach of the subject's movement was measured in cm, without any interference of the force capacity of the evaluated person. Flexibility assessment with Wells Bench was undertaken at the start and at the end of each physiotherapeutic session (Espindula et al., 2010).

The Functional Reach Test (FRT) and the Timed Up and Go Test (TUG) evaluated the elderly's equilibrium. The two tests were applied before and after the physical exercises program proposed in current study. FRT marks the position of the evaluated person close to a metric tape fixed on the wall. The subject has his feet placed in

parallel, in a comfortable position, with shoulders flexed at 90° and fingers flexed (fist closed). He is instructed to bend forward for maximum reach. The subject must not let the heel off the ground and cannot step forward or lose his balance. An average of three reach attempts was taken into account. Reach rate was normalized by height since it is the factor that affects functional reach (Silveira, Matas, & Perracini, 2006).

In the case of TUG test, the subject was evaluated by the time taken to raise himself from a chair (~ 46 cm high), walk, go round an adhesive tape at a distance of three meters, return to the chair and sit once again. The test started with an order and ended after the evaluated person returned to his initial position with shoulders touching the back of the chair. Best time was registered after two trials (Shumway-Cook & Woollacott, 2003). The sample's history of falls was assessed by informal questions, such as 'Do you fall often? How many times per day or per week do you fall?'

Thirty-five 50 min physiotherapy group sessions were performed twice a week. Physiotherapy tests and exercises occurred in a special place in the UMS. Elongation exercises for the muscle chains of the neck, upper limbs, trunk and lower members were employed within the preventive physiotherapeutic activity program, during 30 s, with 5 replications, totaling 10 min of elongation. Active aerobic exercises and postural correction of the neck, trunk, upper and lower limbs were executed for 20 min. Gait training was also done, or rather, walking along the street after active exercises for 15 min and respiratory exercises after the walk were performed in which the elderly lay on the ground, inspiring and expiring slowly and relaxingly for 5 min.

An electronic spread sheet was prepared for statistical analysis and data were analyzed with Sigma-Stat® 3.5. Variables were tested for normal distribution with Kolmogorov-Smirnov test, coupled to analysis of variance. Since distribution was non-normal and the groups were non-homogeneous, non-parametric tests, paired *t* test and Wilcoxon test were applied to compare the two groups and to evaluate the samples before and after treatment. Differences were statistically significant at 5% ($p < 0.05$).

Results and discussion

Six elderly peoples, 2 males and 4 females, aged between 63 and 81 years old (69.66 ± 7.84 years) were evaluated and recruited to participate in the physiotherapeutic intervention program. Results

showed that at the end of 35 physiotherapy sessions there was a significant statistical increase in the flexibility of the posterior muscle chain when compared to mean rates given by the test prior to sessions for the evaluated group ($p < 0.001$). When evaluation is given according to the participants' gender, a significant increase in flexibility was verified for females ($n = 4$; $p < 0.001$) and males ($n = 2$; $p < 0.001$) after the sessions. Muscle flexibility was statistically significant when rates in the initial test of the first session are compared to the initial test at the last session, with a higher rate prior to the last session ($p = 0.005$). Figure 1 shows data on the muscle flexibility of the assessed elderly people.

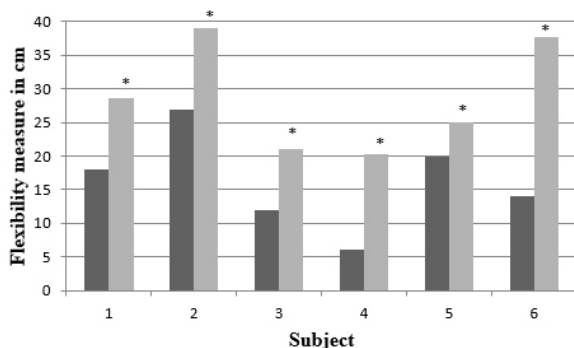


Figure 1. Flexibility rates for each subject ($n = 6$) in the initial test of the first session and in the initial test of the last session of the physiotherapeutic program. *Statistically significant difference ($p = 0.005$). Paired t test.

The evaluation of fall records of the sample by informal questions produced nil results.

Results of TUG test revealed that prior to exercises, mean time to complete the test amounted to 10.75 ± 2.56 s, with 4 participants scoring a period longer than or equal to 12 s. After undertaking 35 exercise sessions of TUG test, the group exhibited a mean time of 6.66 ± 1.96 s to perform the test, with a statistical significance between tests, or rather, a shorter time after intervention ($p = 0.003$) (Figure 1).

The group exhibited mean FRT rate of 27.16 ± 3.06 cm prior to treatment, with a significant statistical difference of 35.66 ± 5.26 cm ($p = 0.008$) for mean FRT rate after the sessions (Table 1).

Table 1. Timed Up and Go test (TUG) and Functional Reach Test (FRT) before and after physiotherapy intervention.

Parameters	Before	After	Difference	p rate
TUG (s)	10.75 ± 2.56	6.66 ± 1.96	-4.08	0.003*
TAF (cm)	27.16 ± 3.06	35.66 ± 5.26	+8.50	0.008*

*Statistically significant difference ($p = 0.005$). Paired t test.

The study raised the hypothesis that group physical training undertaken by elderly people of a health unit interferes positively in the equilibrium and in muscle flexibility of the assessed population. It also assessed the functional mobility with regard to equilibrium by undertaking the Timed Up and Go test (TUG) and Functional Reach Test (FRT), coupled to muscle flexibility with Wells Bench. The hypothesis was confirmed and results were significant since they showed an improvement in flexibility and in the execution of the tests proposed.

Several authors underscore the establishing of special attendance places without the traditional hospital or clinical apparatuses. In other words, they focus on health promotion and prevention for the elderly by developing games and stimulating conviviality. It is highly important to enhance the elderly's health by maintaining or recovering autonomy and independence, and delay to the utmost the initial phases of diseases. In fact, at this stage most diseases are chronic and highly difficult to cure after their establishment (Veras & Caldas, 2004). Further, the aging of the population and increase in life expectancy require preventive action to reduce risk factors in falls and enhance measures that cause the participation of the elderly to practice some sort of physical activity (Guimarães et al., 2004). Although the consequences of aging are unavoidable, a physiological modification of the process is possible through exercises and health enhancement programs (Penha et al., 2012). Current study is relevant since it stimulates preventive attention and health promotion for the elderly supplied by an institution of higher education by enhancing conviviality and underscoring the practice of physical activities by the elderly of the community through a program of physiotherapeutic exercises undertaken with a group of elderly people in a health unit.

The aging subject's functional capacity and mobility gradually degenerate mainly by the loss of muscle mass and consequently of muscular force. Improvement in muscle force, flexibility, dynamic equilibrium and overall functional state by regular exercises may minimize or revert the elderly's physical weakness (Penha et al., 2012). Several studies suggest a progressive flexibility decrease according to age (Araújo, 2008; Lima, Aguiar, Paredes, & Gurgel, 2010). Consequently, interventions that are an asset for the elderly with regard to improvement in mobility, equilibrium and flexibility should be taken into account. This is due to the fact that they are patients with a constant loss of functional capacity related to age. In fact, people with a sedentary lifestyle may have even greater

losses. Even if the patients evaluated in current study did not have a significant deficit or a deficit above average, the mobility gains showed that regular physical activity has a very important role to enhance the mobility variables under analysis. This suggests an effect that prevents and retards mobility degradation of elderly people.

The muscular flexibility of the lower limbs and trunk was evaluated in a study by the sitting-and-reaching test. The lowest averages were detected for females when compared to males, even though there was no significant difference between the genders (Silva, Menezes, Melo, & Pedraza, 2013). Another study had positive results in an exercise program with elderly people: playful activities, gait training and elongation exercises of the quadriceps muscles were undertaken in 24 sessions causing a significant increase of muscle flexibility (Gallon et al., 2011). When the flexibility of the posterior muscular chain was assessed in current study, a significant flexibility increase of the elderly group, males and females, was detected, due to the physical training program and to the flexibility in males and females separately. The genders, however, were not compared. Current data corroborated analysis by Lima, Aguiar, Paredes, and Gurgel (2010) who also assessed flexibility by Wells Bench and verified a significant improvement of flexibility in elderly females, with individual gain reach in the test after a two-month period in an exercise program with local gymnastics and elongations.

Body equilibrium is attained when all internal and external forces acting on the body are under control and allow the body to remain in the desired position (static equilibrium) or to move in a controlled manner (dynamic equilibrium). Body balance is reached by coordinate actions of the several muscle groups which maintain the relationship established between the body segments and the relationship of the set of segments or of the body as a whole, with the milieu. Within this scenario, the aging process may provide a higher level of functional equilibrium commitment, with greater intensity as from the age of 62, when compared with that found in adolescents, young people and adults (Figueiredo, Pícoli, Borges, & Patrizzi, 2011). When the impact of a programed physical activity on the functional mobility related to the dynamic equilibrium of physically independent elderly people is verified, results indicate a significant decrease in the duration of TUG test. Although the assessed elderly people were independent and lacked a specific pathology that would affect their equilibrium, they revealed a weakness translated in the physiological changes of

aging. Therefore, gains are actually positive since they may prevent functional degradation. They also show an improvement in the physical performance, activity and agility of the elderly assessed. Current results agree with a study by Pagliosa and Renosto (2014) who, with TUG within the pre-intervention phase, pinpointed a mean rate of 14 s for the execution of the test. After a two-month intervention, a statistically significant decrease in duration was achieved, namely, an improvement in performance, fastness and equilibrium while gait training.

Specific literature reveals that the duration of TUG test predicts the risks of falls in the elderly. Ten s is the period classified for the elderly without changes in equilibrium and with low fall risks, considered normal for healthy and independent adults; 11 and 20 s is the period for elderly people without any important equilibrium changes, partially independent but with some weaknesses and average fall risks; a period higher than 20 s is a significant deficit in physical mobility and fall risks (Podsiadlo & Richardson, 1991; Gonçalves, Ricci, & Coimbra, 2009; Pagliosa & Renosto, 2014). Most elderly people in current study revealed duration higher than or equal to 12 s for the TUG test, indicative of average risk in falls. However, the record of falls, by which the elderly people's independence was not affected, was not evaluated. Although they were below the limiting point prior to intervention, it should be underscored that an improvement occurred in the test after the exercises and contributed so that the elderly people would reach a low score in fall risks, with special reference to the preventive measure in the study and in the type of therapeutic intervention. However, several authors state that TUG performance in less than 20 s indicates a patient with low risk in falls; between 20 and 30 s reveals a moderate risk; more than 30 s demonstrates high risk (Aikawa et al., 2009). Although the elderly participating in current investigation did not practice any physical activities and had a sedentary lifestyle, they did not complain of any relevant ailments nor were they pathologically compromised in their independence. Perhaps this is the reason why they did not present any significant risk in falls.

The regular practice of physical exercises was not merely a counterpoint to the sedentary lifestyle, keeping physical capacity within satisfactory levels, but also contributed towards the adhesion of healthy habits and a life full of activities (Freitas, Rogério, Yamacita, Vareschi, & Silva, 2013). Another study demonstrated a decrease in mobility, equilibrium and gait training capacity in a group of elderly people

with a sedentary lifestyle when compared to the qualities of a physically active group. When they evaluated the TUG test, the elderly with the shortest time were those who practiced regular physical exercises made up of a mixed training involving aerobic exercises and specific exercises for the strengthening of the muscles (Padoin, Gonçalves, Comaru, & Silva, 2010). Although current study did not compare results with control (no physical exercises), the evaluation of variables of the elderly before and after the proposed physiotherapeutic exercises underscored the positive effects of physical activity for the group. Since they comprised a shorter time for the performance of the TUG test, literature data were confirmed.

A study with 297 elderly people, aged 60-90 years, underscored that functional decline revealed a co-relationship between TUG and age and that aging is associated to decreasing FRT rates and increased TUG rates (Almeida, Chavessoldera, Carli, Gomes, & Resende, 2012). Specific literature insists that elderly people that achieve between 15.2 and 25.4 cm of displacement have a double risk in falling than elderly who reach more than 25.4 cm. On the other hand, elderly people who reach less than 15.2 cm have four times the chance of falling than those with more than 25.4 cm displacement. Consequently, falls have a multidimensional feature, or rather, when an elderly person falls, it is not a mere isolated fact but a set of physical, environmental and emotional determinants are involved. With regard to the prevention of falls, interdisciplinarity should be underscored. Health professionals engaged in primary care and family health programs should also include guidelines on risks and consequences of falls, coupled to the identification of accident-prone elderly people (Teixeira et al., 2011). Current data indicate significant results in FRT comprising increase in reach distance after the activities proposed. Although initial rates failed to indicate greater fall risks, it was evident that therapeutic exercises provided an improvement on the previous assessment and elucidated TUG results. In fact, the practice of regular physical activities is a way to avoid falls by elderly people. On the other hand, elderly people with a sedentary lifestyle has less mobility and a higher trend in falling when compared to elderly people who practice regularly physical activities (Guimarães et al., 2004).

Current study may be an important guideline for health professionals on the relevance of preventive attention in elderly people's equilibrium and flexibility. It also demonstrates the need for the practice of physical activities for the improvement or

maintenance of functional abilities of the elderly population.

Conclusion

Physiotherapeutic activity program collaborates for the improvement of muscle flexibility and equilibrium in elderly people since it provides good results in the execution of assessment tests. It is an important strategy for the prevention of the deleterious effects of aging. Further research may be endeavored to compare other variables that may affect falling risks.

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