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Assessment of functional mobility of persons in the 3rd age of life after programmed therapeutic exercises

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ABSTRACT

Introduction: Active aging is a process of optimizing of opportunities for health, participation, and safety to improve the quality of life as people age. Therapeutic exercises to strengthen muscles are especially important for the elderly, and the results of such exercises are positive in people with functional limitations. The aim of the study was to assess functional mobility of people in the 3rd age of life after programmed therapeutic exercises.

Methods: The prospective study included two groups of 130 respondents over the age of 65 who came to the "Centre for Healthy Aging" in Novo Sarajevo in the period from September 1, 2014, until March 1, 2015. Using the time up and go test (TUG), the basic functional mobility was assessed and it represents the minimum time the respondent needs to get up from the armchair, walk a distance of three meters, turn around, and sit back in the armchair. We tested the respondents at the beginning, in the middle, and at the end of the study, which lasted for 6 months.

Results: Analysis of the gender structure of the control and the test groups, using the Chi-square test, found a statistically significant difference, and in the test group, there were more female subjects than in the control group, $\chi^2 = 50.620$; $p = 0.001$. Analysis of the functional mobility of the respondents of the test groups using the TUG at the end of the study found that the respondents of the test group needed statistically significantly less time to perform the test (8.84 seconds) compared to the control group (9.59 seconds) and test Group B (9.41 seconds), F = 4.711; $p = 0.041$.

Conclusion: Programmed therapeutic exercise leads to a significant improvement in functional mobility of persons in the 3rd age of life.

Keywords: Third age of life; functional mobility; therapeutic exercises

INTRODUCTION

The number of people over the age of 60 is growing faster than any other age group all around the world (1). The number of this age group was estimated at 688 million in 2006 and is projected to increase to 2 billion by 2050 (2).

The World Health Organization has suggested the division of the elderly into three age groups: Group I includes people aged 65-75, Group II people aged 76-90, and Group III people over the age of 90. The division into age groups is not unique. Many authors have tried to separate the periods of development in adulthood from other phases and to present it as unique. However, research results show that late maturity (age) is not a unique period of development and should be divided into early (persons up to about 75 years of age) and late (persons aged 75 or more) (3).

Gerontology as a science that studies changes in the human body during the aging process and the biological, psychological, and social aspects of aging have difficulty in determining exactly when the old age begins. The prevailing opinion is that the moment of retirement, according to the criteria of long-term pension insurance in most countries, can be used as the beginning of the old age (60, 65, and 70 years), because it represents a long experience in the world as a dynamic measure that has been constantly shifted in the past five decades and at the same time follows the global trend of increasing life expectancy of the human population. Physical appearance, cognitive abilities, social functions, health, and mental changes are also important in this assessment. However, aging depends on changes that take place continuously throughout life (4).

Active aging is the process of optimizing opportunities for health, participation, and safety to improve the quality of life as people age (5). Active aging depends on various influences or determinants that surround individuals, families, and communities, including gender and culture, as well as six additional groups of complementary and interrelated determinants: (1) Access to health and social services, (2) behavioral determinant, (3) physical environment, (4) personal determinant, (5) social determinant, and (6) economic determinant. All of these determinants, and the

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interactions between them, play an important role in influencing how high or low the risk of falls is and how high or low the risk of serious injury is (6).

Balance and movement require a complex interplay of cognitive, neuromuscular, and cardiovascular functions, as well as the ability to quickly adapt to environmental requirements. As we age, the balance weakens and staggering intensifies (7).

It is well known that the decrease in functional mobility, and the lack of physical fitness of persons in the 3rd age of life is directly related to the onset of fall, which is a strong predictor of mortality. It has been found that slower walking speed in the elderly is associated with muscle weakness, and thus a reduction in the range of joints motion and biomechanical changes that are reflected in a safer way of walking (8).

Changes in gait that occurs in people in the 3rd age of life are subject of numerous studies with purpose to determine the potential risks of falling and to plan better rehabilitation programs to improve the life quality of this population. Almost all of the observed negative changes were associated with an overall decrease in muscle strength due to loss of motor neurons and decreased muscle fibers, muscle sensitivity, and aerobic capacity (9).

Avoiding physical activity is an important psychological variable in the development of fragility and the onset of falls in the elderly persons. Avoiding activities because of the fear of falling can negatively affect physical ability in the long run. Avoidance of activity has been found to be associated with a decrease in muscle strength in the lower extremities, trunk muscles, as well as flexor muscles of the hand and fingers, which should ensure a good grip. Therefore, fear occurs as a result of avoiding activities, which further leads to a reduction in quality of life, reduced mobility, reduced functionality, and the onset of falls (10).

The ability to maintain the center of gravity of the body within the surface of support during standing, sitting, and moving, that is, maintaining balance or equilibrium, and functional mobility, is integral parts of daily activities, which in addition to maintaining balance requires other factors that can be negatively affected by aging processes. These factors are muscle strength, proprioception, range of motion in the joints, reaction time of the organism, vision, hearing, etc. (11).

To promote and maintain health and physical independence, the elderly should engage in activities that maintain or increase muscle strength and endurance at least twice a week. It is recommended to perform at least 8-10 therapeutic strengthening exercises for the main muscle groups a day, 2 or more days a week. To strengthen the muscles, dosing the resistance should be programmed so that the person can perform each therapeutic exercise 10-15 times. The effort that a person puts in during muscle strengthening exercises should be moderate to high. On scale of 1-10, where a score of 0 represents no movement and a score of 10 represents maximum muscle effort, moderate intensity of therapeutic exercise is between grades 5 and 6, and high effort is between grades 7 and 8 (12).

Therapeutic exercises to strengthen muscles are especially important for the elderly because these exercises prevent the loss of muscle mass associated with aging, have a beneficial effect on bone mass, and the results of such exercises are positive in people with functional limitations. At present, only about 12% of the elderly perform muscle strengthening exercises twice a week (13).

With sufficient knowledge, experience, programmed therapeutic exercises, and training, the elderly can achieve high levels of physical activity and greater functional mobility (14).

The aim of this study was to assess functional mobility after programmed therapeutic exercises of persons in the 3rd age of life.

METHODS

The study was designed as an interventional (manipulative), open, randomized, prospective analytical research conducted in the "Centre for Healthy Aging" Novo Sarajevo in the period from September 1, 2014, until March 1, 2015.

A total of 260 people were included in the research. The sample was divided into a test group (130 persons) and a control group (130 persons). The test group was divided into subgroup A and subgroup B.

The test group consisted of 130 subjects who were randomly divided into subgroup A which had 65 subjects and subgroup B which also had 65 subjects.

The program of therapeutic exercises in the test subgroup A consisted of therapeutic exercises of moderate intensity strengthening with Theraband bands for 40 minutes (which should correspond to the grade of 11-14 according to the Borg scale of perceived effort). Each session included therapeutic 5-minute warming exercises and therapeutic strengthening exercises with Theraband resistance bands for 30 minutes, where respondents were instructed to perform the exercises with moderate intensity. To ensure the strengthening of the torso muscles, and the upper and lower extremities, we have prepared moderate intensity therapeutic exercises with the help of elastic bands. The respondents were instructed to gradually, every 2-4 weeks, increase the band resistance by switching to the following color of the band (from weakest to strongest: Yellow, red, green, blue, black, silver, and gold), or the band was used at a shorter distance, thus increasing the resistance of the elastic bands. In fact, the respondents increased the bands resistance when they were able to report 20 repetitions of a certain movement with little effort.

Strengthening exercises were followed by therapeutic relaxation exercises lasting 5 minutes. Therapeutic exercises were performed 3 times a week for 40 minutes a day.

In the test subgroup B, therapeutic antigravity exercises or therapeutic exercises without resistance were used: Therapeutic breathing exercises, therapeutic coordination exercises, therapeutic balance exercises, therapeutic exercises to increase the motion range of upper and lower extremities, therapeutic exercises to increase mobility of lumbar and cervical spine, and therapeutic exercises to tone the muscles of the extremities. Therapeutic exercises were performed 3 days a week, 40 minutes a day. Programmed therapeutic exercise for both groups lasted continuously for 6 months (15).

The control group consisted of 130 respondents who were older than 65 and who came to the "Centre for Healthy

Aging" Novo Sarajevo and did not participate in the programmed therapeutic exercise.

The study inclusion criteria were age range of 65 years and above, history of falling once or more in the past 6 months, not participating in sports during the past year, ability to walk without aids, and performing the desired exercise program.

The study exclusion criteria were existence of orthopedic and neurological problems that prevented participation in exercises, mental disorders, dizziness, severe deformity, especially in the lower extremities, severe cardiopulmonary disorders, and acute vision and hearing problems.

The research instrument was Timed Up and Go (TUG) test. It is a test of basic functional mobility and represented the minimum time that the respondent needed to get up from an armchair, walk a distance of three meters, turn around, and sit back in the armchair (16). This test was performed on each respondent at the beginning, in the middle, and the end of the study, which lasted for 6 months.

For statistical analysis of the obtained data, the software package SPSS for Windows (version 20.0, SPSS Inc., Chicago, Illinois, USA) and Microsoft Excel (version 10. Microsoft Corporation, Redmond, WA, USA) were used.

We used the following statistical methods for analysis of the obtained results:

- For continuous variables in the study, we first analyzed the symmetry (normality) of their distribution using the Kolmogorov–Smirnov or Shapiro–Wilk test, to see if there was a statistically significant deviation from the normal (Gaussian) distribution, to show the average values and scattering measurements, we used median and interquartile range, and for their comparison, a non-parametric test (Mann–Whitney U-test)
- Nominal and ordinal variables in the study were analyzed by the χ^2 test, and in the presence of an expected frequency lack, we used Fisher's exact test. In the statistical analysis, we used Pearson χ^2 test for the difference between the distributions of nominal and ordinal data, and Fisher's exact test and Yates' correction in the absence of expected frequencies in comparison of variables
- For the relation and the direction of the relation between the variables, correlations were made (Spearman's rho).

RESULTS

The analysis of the gender structure of the control and test groups, using the Chi-square test, found a statistically significant difference, as in the test group, there were more female respondents than in the control group, $\chi^2 = 50{,}620$; $p = 0.001$. In the control group, there were 55% of male respondents and 45% of female respondents. In the test Group A, there were 12.3% of male and 87.8% of female respondents, while in the test Group B, the percentage of male respondents was 6.1% and female respondents 93.3%. By analyzing the average age of the respondents in the test groups, we found no statistically significant difference, F = 1.22; $p = 0.297$. The average age of the respondents in the control group was 73.25 ± 6.69 years (65-87), while in the respondents of the test Group A, it was 71.28 ± 5.21 years (65-84), and in the test Group B 72.56 ± 5.15 years (65-85).

In this study, by analyzing the functional mobility of respondents in the test groups using the TUG test, it was found that for the average minimum time required for this test, there was no statistically significant difference during the first measurement ($p = 0.810$) (Table 1).

By analyzing the functional mobility of the respondents of the examined groups using the TUG test, it was found that in the average minimum time required for this test, there was no statistically significant difference during the second measurement ($p = 0.694$) (Table 2).

By analyzing the functional mobility of the respondents of the examined groups using the TUG test at the end of the research, it was found that the respondents of the test Group A needed statistically significant less time to perform the test (8.84 seconds) compared to the control group (9.59 seconds) and the test Group B (9.41 seconds), F = 4,711; $p = 0.041$ (Table 3).

By analyzing the functional mobility of the respondents in the examined groups using the TUG test, it was found that in the average minimum time required for this test, there was no statistically significant difference between the first ($p = 0.810$) and second testing ($p = 0.694$). However, at the end of the study, during the third measurement, the respondents in the test Group A needed statistically significant less time to perform the test (8.84 seconds) compared to the respondents of the control group (9.59 seconds) and the test Group B (9.41 seconds), F = 4.711; $p = 0.041$.

DISCUSSION

By testing the functional mobility of the respondents of the examined groups using the TUG test, we found that for the average minimum time required for this test, there was no statistically significant difference during the first measurement ($p = 0.810$), with the time for the control

TABLE 1. The average minimum time required for performing the test Timed Up and Go during the first measurement

First test	N	X	SD	SEM	Minimum	Maximum
Control group	130	9.79	3.12	0.20	5.89	27.08
Test Group A	65	9.91	3.82	0.34	6.06	27.08
Test Group B	65	9.98	5.66	0.51	0.00	61.00
F=0.211; *p*=0.810						

TABLE 2. comparison of the average minimal time required for performing the test timed up and go during the first and the second measurement

Tests	n	X	SD	SEM	Minimum	Maximum
First test						
Control group	130	9.79	3.12	0.20	5.89	27.08
Test Group A	65	9.91	3.82	0.34	6.06	27.08
Test Group B	65	9.98	5.66	0.51	0.00	61.00
F=0.211; *p*=0.810						
Second test						
Control group	130	9.77	4.26	0.27	8.00	61.00
Test Group A	65	9.75	1.75	0.22	7.01	14.61
Test Group B	65	9.70	2.33	0.30	5.89	18.36
F=0.365; *p*=0.694						

TABLE 3. Comparison of the average minimal time required for performing the test Timed Up and Go during the first and the third measurement

Tests	N	X	SD	SEM	Minimum	Maximum
First test						
Control group	130	9.79	3.12	0.20	5.89	27.08
Test Group A	65	9.91	3.82	0.34	6.06	27.08
Test Group B	65	9.98	5.66	0.51	0.00	61.00
F=0.211; *p*=0.810						
Third test						
Control group	130	9.59	2.60	0.33	5.89	18.68
Test Group A	65	8.84	1.83	0.29	6.00	17.01
Test Group B	65	9.41	1.81	0.23	6.48	14.61
F=4.711; *p*=0.041						

group 9.79 seconds, for the test Group A 9.91 seconds, and for the test Group B 9.98 seconds (F = 0.211; p = 0.810). After the second test, the average minimum time to perform this test did not show statistically significant difference. In the control group, it was 9.77, in the test Group A 9.75, and in test Group B 9.70 seconds (F = 0.365; p = 0.694). However, by analyzing the functional mobility of the respondents of the examined groups using the TUG test at the end of the study, it was found that the respondents from the test Group A needed statistically significant less time to perform the test (8.84 seconds), compared to the respondents from the control group (9.59 seconds) and the test Group B (9.41 seconds) (F = 4.711; p = 0.041).

Hess and Woollacott in their study conducted in Oregon on 74 people with mild balance disorders, aged 74-96 years, examined the effect of high-intensity strengthening exercises on balance and mobility. The research lasted 10 weeks. The respondents were divided into two groups: The test group, in which high-intensity strengthening exercises were performed on fitness equipment, and the control group, in which the respondents were not included in the therapeutic exercise. The results indicated that at the beginning of the study, there was no significant difference in the average value of the time required to perform TUG test, but at the end of the study, there was a significant reduction in time required in the test group compared to the control group, in which the required time even slightly increased (17).

In their research, Kim and Kim investigated the influence of therapeutic exercises for strengthening the muscles of the lower extremities with the help of elastic bands on balance and mobility of persons in their 3rd age of life. Respondents were divided into two groups: The experimental group that performed therapeutic strengthening exercises for the lower extremities with elastic bands and the control group that did not do any exercises. The results showed that in the experimental group, after 3 months of exercise, the average time required to perform the TUG test decreased statistically significant by 2.67 seconds, while in the control group, this required time slightly increased by 0.19 seconds (18).

Thirty elderly subjects participated in a 2-month clinical trial by Hassan et al. in 2020 (IRAN). Subjects were divided into an experimental group (n15) and a control group (n15). Subjects of the experimental group performed torso strengthening exercises for 8 weeks, 3 times a week, while subjects of the control group were not included in the programmed exercising. The results of the study showed that there was a statistically significant improvement in the results of the TUG test in the experimental group, which is in correlation with our study (19).

Yamauchi *et al.*, on the one hand, and Hasegawa et al., on the other hand, in separate studies conducted in Japan, proved that in the persons of 3rd age of life, after 3 months of exercise with elastic bands, 3 times a week, there was a decrease of the time required to perform the TUG test by 6% in the first study (16) and 9.7% in the second study (20,21).

The results of our study suggest that moderate-intensity strengthening exercises had a significant positive effect on gait of the elderly people with mild cognitive problems and with a history of falls. Aging and weakening of the muscle strength of the lower extremities and trunk lead to changes in body posture, changes in the gravity center of the body during movement, and frequent falls of the elderly. In fact, during lower extremity movements such as walking and rotation, multifidus muscles, and transverse abdominal muscles help maintain dynamic balance during walking, providing support to the spine and improving the transmission of upper extremity force to the lower extremities, and reducing postural insufficiency (22).

There is an obvious advantage in the application of therapeutic strengthening exercises of moderate intensity with Theraband bands over therapeutic exercises without resistance because they strengthen the muscles of the lower extremities as well as the torso muscles which are the center of force transmission between the lower and upper extremities. Because by strengthening the muscles of the torso, the oscillations of the torso are reduced, and the disturbed balance during gait is corrected.

CONCLUSION

At the end of the study, by analyzing the functional mobility of the respondents in the observed groups using the TUG test, we obtained results that indicate a significant reduction in the average test time in the test Group A who exercised with Theraband resistance bands, when we compare them to the respondents from the test Group B and the control group.

As a recommendation, we suggested that it is necessary to try to emphasize the importance of therapeutic exercise for persons in the 3rd age of life through media, to introduce the therapeutic exercises to the elderly and eventually involve them in some kind of therapeutic exercises. Information should also be directed through professional medical workers who have contact with the elderly in family medicine health-care centers and centers for physical therapy on a daily basis.

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