Original Article

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Effect of Reaction Time Exercises on Physical Functionality and Quality of Life in Geriatrics: A Non-controlled Study

Geriatrik Bireylerde Reaksiyon Zaman Egzersizlerinin Fiziksel Fonksiyonellik ve Yaşam Kalitesi Üzerine Etkisi-kontrolsüz Bir Çalışma

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ABSTRACT

Objective: This study was conducted to investigate the effects of reaction time (RT) exercises on functional independence, static balance, fall risk, upper and lower extremity RT, and quality of life in older adults.

Methods: Forty participants aged 65-77 years were included in the study. Participants' functional independence was evaluated using the Functional Independence Scale, static balance using the Single-Leg-Squat Test, fall risks using the Morse Fall Scale, lower- and upper-extremity RT's using the Light Trainer Flash Light Exercise System (Model LTV2, Turkey, 2017), and their quality of life using the Short Form-36. RT exercises were performed using the Light Trainer Flash Light Exercise System for six weeks, three days a week. Measurements were repeated after the treatment.

Results: In the older adults examined, there was a significant difference between before and after the 6-week exercise protocol in functional independence, static balance, fall risk, upper- and lower-extremity RT, and quality of life ($p<0.05$).

Conclusion: The study showed that a 6-week RT exercise program had positive effects on functional independence, static balance, fall risk, upper- and lower-extremity RT, and quality of life in older adults. The results showed that reaction-time exercises can be added to rehabilitation protocols for older adults and can be used in clinical settings.

ÖZ

Amaç: Bu çalışma, geriatrik bireylerde reaksiyon zaman (RZ) egzersizlerinin fonksiyonel bağımsızlık, statik denge, düşme riski, üst ve alt ekstremite RZ ve yaşam kalitesi üzerindeki etkilerini araştırmak amacıyla yapılmıştır.

Yöntemler: Çalışmaya, 65-77 yaş aralığında 40 geriatrik birey dahil edildi. Geriatrik bireylerin sosyodemografik özellikleri kaydedildikten sonra fonksiyonel bağımsızlıkları, Fonksiyonel Bağımsızlık Ölçeği ile, statik dengeleri Tek Ayak Üzerinde Durma Testi ile, düşme riskleri Morse Düşme Ölçeği ile, alt ve üst ekstremite RZ'ler, Light Trainer Flash Light Exercise System (Model LTV2, Türkiye, 2017) ile yaşam kaliteleri Kısa Form-36 ile değerlendirildi. Bireylere altı hafta süreyle, haftada üç gün Light Trainer Flash Light Exercise System ile RZ egzersizleri yaptırıldı ve 6 hafta sound değerlendirme parametreleri bakımından ölçümler tekrarlandı.

Bulgular: Geriartrik bireylerde, altı haftalık RZ egzersiz ve sonrası sonuçları arasında fonksiyonel bağımsızlık, statik denge, düşme riski, bilişsel beceri, üst ve alt ekstremite RZ ve yaşam kalitesi bakımından anlamlı fark olduğu görüldü ($p<0,05$).

Sonuç: Çalışma, 6 haftalık RZ egzersiz programının yaşlı yetişkinlerde fonksiyonel bağımsızlık, statik denge, düşme riski, üst ve alt ekstremite RZ'si ve yaşam kalitesi üzerinde olumlu etkileri olduğunu gösterdi. Sonuçlar, RZ egzersizlerinin yaşlı yetişkinler için

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ABSTRACT

Keywords: Geriatrics, exercise, functional status

ÖZ

rehabilitasyon protokollerine eklenebileceğini ve klinik ortamlarda kullanılabileceğini gösterdi.

Anahtar Sözcükler: Geriatri, egzersiz, fonksiyonel durum

Introduction

The term aging refers to all the structural and functional changes that occur over time at the level of cells, tissues, organs, and systems in an organism with chronological, biological, social, and psychological dimensions (1). The population aged 65 years and over is increasing rapidly throughout the world and in Turkey. The number of people aged 65 and over, reported as 703 million in 2019, is expected to reach 1.5 billion by 2050 (1).

Functional deficiencies can often develop in older adults because of age-related physiological changes, social factors, or diseases (2). The presence of functional deficiencies in these individuals may have negative effects on activities of daily living (3). A decline in physical performance and cognitive abilities with aging causes progressive deterioration in muscle strength, coordination, and balance (3).

Balance is fundamental to the ability to stand and move (4). Deterioration in body functions due to aging causes a decrease in the ability to maintain the center of gravity on the support base and an increase in the swing area in response to postural changes (5). This deterioration in balance functions may cause a decline in the activities of daily living and an increase in the frequency of falling (5). Falling emerges as a major health issue in older adults, in terms of its medical and economic consequences, and is among the factors that cause the highest rates of mortality and disability (6).

Falls are the primary cause of injury in older adults and can lead to reduced quality of life and high personal, social, and health costs (7). A person who falls may experience pain, hospitalization, surgery, decreased activities of daily living, lower quality of life, or fear of falling (7). Factors such as loss of muscle mass, prolongation of reaction time (RT), decrease in balance ability, and decline in muscle strength and endurance that occur with aging increase the risk of falling (7).

RT is the time between the stimulus reaching the central nervous system, its evaluation, and the appropriate response after the relevant arrangements are made. There are many factors affecting this parameter (8). Ageing is one of these factors, and with aging, the capacity of the nervous system to process information and activate a response decreases (9).

These factors affect the quality of life of older adults, a term that includes well-being rather than only health, and reduce their active participation in life (7). Increasing the level of physical activity helps minimize these negative factors, and it is known to be an important intervention to protect and maintain health in older adults (7). Therefore, these factors pave the way for both the preservation of quality of life and functional independence of the older population.

Exercise training for people aged 65 years has a positive effect on muscle strength and balance, increases bone mineral density, improves cognitive functions, and is an effective method for preventing falls, reducing risk factors for falls, and increasing quality of life (10). Resistance exercise programs, programs aiming to increase flexibility, balance, and endurance, tai-chi, ai-chi, and aqua therapy are among the most effective exercise methods for older adults (10). While there are numerous studies in the literature that examine the effects of physical activity on individuals aged 65 years and older, no study has investigated RT exercises aimed at activating cognitive functions during physical activity and enhancing engagement in exercise. Therefore, this study aimed to determine the effects of RT exercises on functional independence, balance, risk of falling, RT, and quality of life in the elderly population.

Methods

Study Design: Prospective Cohort Study

Participants

This study was conducted with 43 adults (26 female, 14 male) over 65 years of age who could walk independently and applied to the Üsküdar University Physical Therapy and Rehabilitation Center. The exclusion criteria were as follows: being diagnosed with Alzheimer's or dementia, having a history of cerebrovascular accident, a physical disability such as amputation, visual impairment, active cancer, advanced joint contracture, acute inflammatory problems, or having undergone any musculoskeletal surgery.

Ethics committee approval was obtained from the Non-Invasive Ethics Committee of Üsküdar University (no: 61351342/2020-231). Participants were informed about the purpose and procedures of the study. The "Informed voluntary consent" form was signed. This study was conducted according to the principles of the Declaration of Helsinki.

Assessment Tools

After recording the participants' sociodemographic and medical data, such as gender, age, height, weight, allergy status, chronic diseases, and drug use, the following parameters were evaluated.

Physical Functionality

Functional Independence Level

The functional independence levels of the participants were evaluated using the Functional Independence Measure (FIM). FIM is a scale used to evaluate individuals' daily life activities and independence levels. Küçükdeveci et al. (11) conducted a

Turkish validity and reliability study of the scale. The higher the score an individual receives because of the evaluation, the higher the level of independence. The scale was filled by the face-to-face interview method.

Static Balance Assessment

The static balance of individuals was evaluated using the Single-Leg-Squat Test (SLST). The validity and reliability study of the SLST test was performed by DiMattia et al. (12). In the test, participants were asked to lift one foot with their eyes open so that it would not touch the supporting leg and maintain this position. The test was terminated in those who stood on one leg independently for 30 s. Touching the supported leg, foot touching the floor, jumping or bouncing on the supporting leg, or the participant touching any object in the environment for support were determined as the termination criteria of the test. Three measurements were made, and the average of the participants' standing on one leg was recorded in seconds.

Fall Risk Assessment

Participants' risk of falling was assessed using the Morse Fall Scale (MFS). The Turkish validity and reliability study of the scale was conducted by Demir and İntepeler (13). The scale includes 6 items: history of falling, presence of additional disease, getting help while walking, receiving intravenous treatment, walking style, and mental status. 0-24 is considered "low risk", 25-50 "moderate fall risk", 51 and above "high risk of falling". The scale was filled by the face-to-face interview method.

Reaction Time Measurement

The participants' lower and upper extremity RT's were measured using the Light Trainer Flash Light Exercise System (Model LTV2, Turkey, 2017) before and after the intervention. These assessments were repeated 3 times for 30 s in randomized mode, the results were recorded, and the test parameters were completed.

Upper Extremity Reaction Time Measurement

For this measurement, the participants were seated on a chair at point A, which coincided with the middle of the modules. The participants were placed in a position with their hands on the table. Four light reaction modules were placed in front of the participants. The distance from the midpoint of the modules to point A was set as 50 cm, and the distance between the modules was set as 15 cm. Before the test, each participant was given a trial and informed about the test content. Afterward, when the participants were ready, they were positioned at the starting point for the test. After the start command was given, the participant waiting at point A was asked to react to any burning module and switch it off by hand as soon as possible. It was reported that the participant should switch off the maximum number of modules within 30 s, and at the end of the measurements, their best scores were recorded as upper extremity RT (14).

Lower Extremity Reaction Time Measurement

Participants were positioned on the line at point A in the test field, with both feet in contact with the ground, for lower extremity RT measurement. Four light reaction modules were placed in front of the participants. The distance from the midpoint of the modules to point A was 50 cm, and the distance between the modules was set to 15 cm. Before the test, each participant was given a trial and informed about the test content. Afterward, when the participants were ready, they were positioned at the starting point for the test. Afterward, when the participants were ready, they were positioned at the starting point for the test. After the start command was given, the participant waiting at point A was asked to react to any burning module and switch it off by hand as soon as possible. It was reported that the participant should switch off the maximum number of modules within 30 s, and at the end of the measurements, their best scores were recorded as lower extremity RT (14).

Quality of Life Assessment

The participants' quality of life was evaluated using Short Form-36 (SF-36). A validity and reliability study of the scale in the Turkish population was performed by Koçyiğit et al. (15). The scale consists of 36 items evaluated under 8 sub-headings: Physical Functioning, Social Functioning, Role Limitations due to Physical Problems, Role Limitations due to Emotional Problems, Vitality, Bodily Pain, General Health Perceptions, and General Mental Health. The higher the score for each item in SF-36, the higher the individual's health-related quality of life.

Exercise Protocol

After the evaluations, the participants were given exercise training for 40 minutes, 3 days a week, for 6 weeks. Before each session, a 10-min warm-up exercise consisting of 3 sets of 10 repetitions of flexion-extension movements was performed for the neck, shoulders, elbows, knees, hips, and ankle regions. Then, with the Light Trainer Flash Light Exercise System (Model LTV2, Turkey, 2017), RT exercises were performed for 20 min using four modules in a randomized light mode (Figure 1, 2). After each session, a 10-min cool-down exercise including pectoral stretching, upper trapezius stretching, hamstring stretching, hip flexor stretching, and breathing exercises was performed (10).

Participants were re-evaluated for the same parameters after 6 weeks of exercise training.

Statistical Analysis

Sample Size Calculation

The G*Power version 3.1.7 program was used for sample size and effect size calculations. In the study, the minimum number of people to be included was determined as 40, with an acceptable margin of error of 5% and a confidence level of 95%. The effect size level for this sample group to provide a sampling power of 0.83 was 0.30.

Statistical analysis was performed using SPSS version 23.0 (IBM SPSS Statistics for Windows, Version 23.0. Armonk, IBM Corp., New York, USA).

Descriptive statistics are presented with mean and standard deviation values. The normal distribution of the variables was analyzed using the Kolmogorov-Smirnov test. The Wilcoxon sign test was used to examine the differences in the pre-test and post-test measurements of the parameters. P values 0.05 were considered significant in the study.

Results

Initially, 43 participants volunteered for the study. The study was completed with 40 participants, excluding 2 participants who did not attend 3 consecutive sessions and 1 participant who did not attend 4 sessions in total (Figure 3).

Figure 1. Reaction time exercises for the upper extremities with a Light Trainer Flash Light Exercise System

Figure 2. Reaction time exercises for the lower extremities with a Light Trainer Flash Light Exercise System

The sociodemographic and medical characteristics of 40 participants included in the study are given in Table 1.

There was a significant difference between the results of FIM, SLSL, MFS, UEOrtRT, and LEOrtRT of older adults before and after 6 weeks of exercise training ($p<0.05$), (Table 2).

It was determined that there was a statistically significant difference between the measurement values of the participants before and after the exercise training between Physical Functioning, Social Functioning, Role Limitations due to Physical Problems, Role Limitations due to Emotional Problems, Vitality, Bodily Pain, General Health Perceptions, and General Mental Health ($p<0.05$), (Table 3). Comparisons of the SF-36 quality of life variables of older adults before and after exercise training are shown in Table 3.

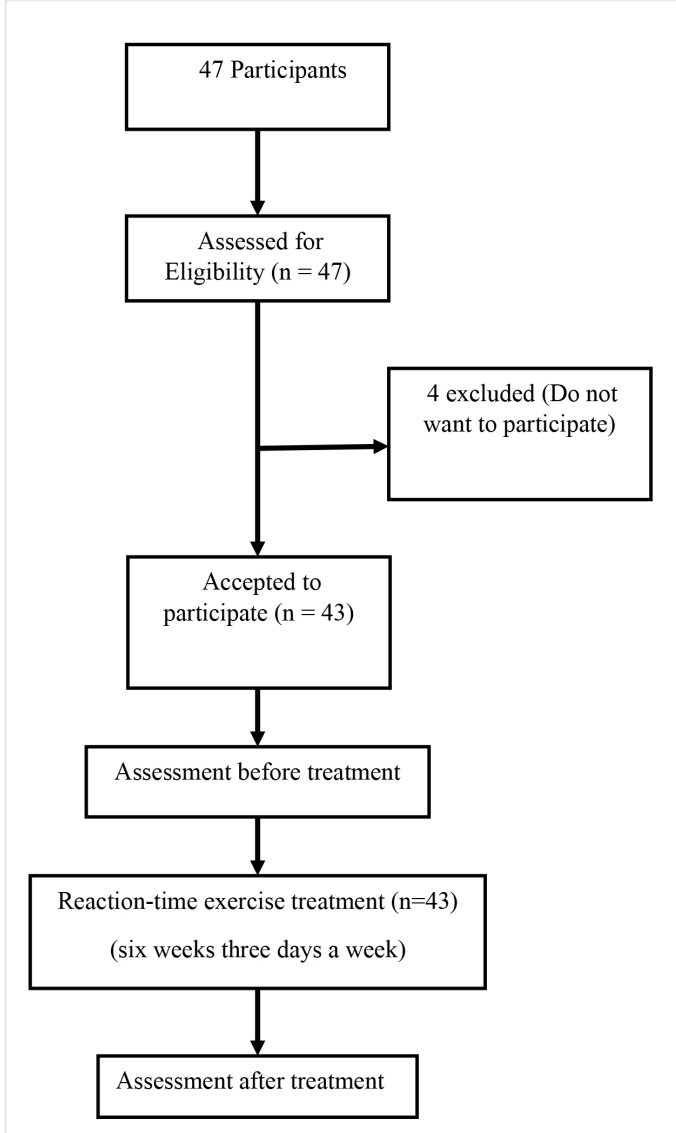

Figure 3. Study flowchart

Table 1. Sociodemographic characteristics of the participants

Age years (X ± SD)	72.48±5.13
Height (cm) (X ± SD)	165.84±9.42
Weight (kg) (X ± SD)	69.92±15.8
Gender (n/%)	
Woman	26 (65%)
Man	14 (35%)
Chronic disease (n/%)	
No	9 (22.5%)
Yes (HT/ DM)	31 (77.5%)

%: Percent, N: Participant number, X ± SD: Mean ± Standard deviation

Discussion

This study examined the effect of RT exercises on functional independence, balance, risk of falling, RT, and quality of life in the elderly population. The study findings showed that RT exercises applied to older adults had positive effects on functional independence, balance, fall risk, and quality of life in these individuals.

RT is a reliable indicator of processing speed, as it reflects the perception of stimuli by the central nervous system and its response in the form of a motor reaction. It can determine a person's alertness, as an individual's response to a stimulus is dependent on their RT (16). RT is more adversely affected in older adults than in younger individuals. This condition leads to a decline in functional capacity and an increase in the rate of falls. According to the findings of Okubo et al.'s (17) systematic review, stepping exercises have been shown to reduce RT and the

Table 2. Comparison of participants' Functional Independence measures, Single-Leg-Squat tests, Morse Fall Scale, and Upper and Lower Extremity Reaction Time scores before and after exercise training

Assessments	T1 (n=40) M ± SD (min-max)	T2 (n=40) M ± SD (min-max)	p value
FIM	111.52±7.51 (96-123)	117.19±6.42 (104-126)	**<0.001***
SLST	19.84±10.24 (5-38)	22.11±10.03 (11-48)	**<0.001***
MFS	33.19±23.17 (0-70)	23.86±18.8 (0-55)	**0.003***
UEOmnRT	1.68±0.36 (1.02-2.18)	1.20±0.29 (0.85-1.87)	**<0.001***
LEOmnRT	1.70±0.35 (0.96-2.11)	1.34±0.29 (0.81-1.74)	**<0.001***

LEOmnRT: Lower extremity mean reaction time, UEOmnRT: Upper extremity mean reaction time, FIM: Functional independence measure, MFS: Morse Fall Scale, SLST: Single-Leg-Squat Test, T1: Before treatment, T2: After treatment, M ± SD: Mean ± standard deviation, min-max: Minimum-maximum, *Wilcoxon sign test, p<0.05

Table 3. Comparison of participants' SF-36 scores before and after exercise training

SF-36	T1 (n=40) M ± SD (min-max)	T2 (n=40) M ± SD (min-max)	p value
Physical functioning	57.35±20.70 (20-90)	70.00±19.76 (40-100)	**<0.001***
Role limitations due to physical problems	61.76±26.68 (0-100)	77.35±23.39 (25-100)	**0.006***
Role limitations due to emotional problems	70.59±26.04 (33.33-100)	84.37±23.86 (33.33-100)	**0.015***
Vitality	44.75±21.58 (20-85)	59.41±18.69 (40-95)	**<0.001***
General mental health	66.11±11.41 (44-88)	76.00±9.79 (60-96)	**<0.001***
Social functioning	64.11±19.24 (25-100)	78.82±15.46 (50-100)	**0.002***
Bodily pain	52.35±20.52 (22.50-90)	74.26±14.10 (55-100)	**<0.001***
General health perceptions	48.75±19.27 (18.89-80)	58.82±18.83 (30-95)	**<0.001***

SF-36: Short Form-36, M ± SD: Mean ± standard deviation, min-max: Minimum-maximum, T1: Before treatment, T2: After treatment, *Wilcoxon sign test, p<0.05

incidence of falls. The moderate or intense supervised exercise training thrice-weekly for 12 weeks exercise intervention applied by Morrison et al. (18) on elderly individuals with type II diabetes reduced the RT and therefore the risk of falling. The aim of the current study was to shorten the RT of elderly individuals and reduce the risk of falling with a RT exercise program. In this respect, this study complies with the current literature. Because of the study, individuals' RT's and risk of falling decreased.

Although there are many studies on the functionality of older adults, there is still a need to develop multi-component rehabilitation programs to increase functional independence (19). Kocic et al. (20) demonstrated that a group-based Otago exercise program combining 6-month strengthening and balance exercises is effective in improving balance and functional mobility in older adults staying in nursing homes, and a significant improvement was achieved in the level of functional independence. The virtual reality-based Tai Chi exercise program implemented by Hsieh et al. (21), which included 60 older adults, increased the functional independence level and cognitive performance of these individuals. Silva et al. (22), on the other hand, investigated the effectiveness of aquatic exercise in older adults, and as a result, it was determined that depression and anxiety levels decreased in these individuals and that the level of balance and functional independence showed a positive improvement. The Multi-system Physical Exercise program created by Chittrakul et al. (23) includes balance, coordination, muscle strength, and RT exercises. RT exercises were performed for 15 repetitions each, and participants were instructed to maintain the movements for 10 s. Rest periods between each set were determined as 10 s. According to the results of the study, individuals' functional independence, health-related quality of life, muscle strength, proprioception, and postural sway improved significantly (23). In the current study, we observed that the functional independence level of older adults increased with RT exercises. The difference between the RT exercises applied in the current study and the RT exercises applied in Chittrakul et al.'s (23) study is that the training was given with the Light Trainer Flash Light Exercise System (Model LTV2, Turkey, 2017). Thus, the study differs from the literature. We believe that this result may be due to the fact that RT exercises were performed with the Light Trainer Flash Light Exercise System (Model LTV2, Turkey, 2017) including parameters such as functionality, balance, coordination, attention, and skill.

Balance is the key element of maintaining posture, standing upright, and the ability to move. Balance training plays an important role in preventing falls (24). Most studies investigating the risk of falls in older adults have stated that physical activity and even leisure time exercises are effective methods to maintain balance control and prevent falls (24). In a review that analyzed different types of exercises aimed at increasing static balance in older adults, interventions such as resistance exercise programs, aerobic exercise, balance training, T-bow and balance board training, aerobic steps, exercises with a stability ball, pilates, and Wii Fit training have been shown to be effective exercise programs in increasing balance ability (5,25). In the current study, it was observed that the balance levels of older adults increased and the risk of falling decreased with RT exercises, which was consistent with the literature. In addition to many exercise types in the literature, it is thought that RT exercises can be an effective approach to improving balance in older adults.

Providing good postural control in older adults plays a crucial role in preserving cognitive and functional capacity (26). Although balance exercises are considered to be one of the most effective modalities in rehabilitation programs aimed at reducing falls, there is no consensus in the literature on this issue (26). In a study conducted by Bumin et al. (27), it was stated that while almost half of the participants had a history of falling in older adults staying in nursing homes, balance, walking problems, and other risk factors increased the risk of falling, and falls made older adults more dependent. Schoene et al. (3) stated that falling and the fear of falling reduce the quality of life and affect it negatively. In this study, we believe that increasing the balance in the participants with the RT exercises reduces the risk of falling. We believe that this situation provides older adults with the opportunity to act more freely and without fear and plays an important role in increasing functional independence.

Prolongation of the RT, reduction in protective reflexes, and more fragile body systems increase the possibility of injury (5). Hunter et al. (28) investigated changes in RT with aging and the relationship between reaction speed, strength, and physical exercise in 270 healthy women. They found a significant difference between physically active and inactive women and concluded that there was an improvement in RT with exercise (28). Mohamed et al. (29) determined that corrective exercises applied together with biofeedback had positive effects on the RT in individuals with forward head posture between the ages of 40 and 60 years. In another study, it was determined that whole body vibration and balance exercises applied to individuals with diabetic peripheral neuropathy had positive effects on RT and muscle strength (30). The current study determined that the reaction speed of older adults increased with RT exercises. Increasing the reaction speed enables older adults to react more easily to external stimulation. We believe that results such as an increase in the speed of reaction, an increase in the level of balance, and a decrease in the risk of falling will pave the way for an increase in the quality of life. We also believe that the automatic activation of attention-concentration skills and the fact that these exercises are fun, short, and effective play a role in the recovery of these functions.

Health problems associated with aging and the psychological and physical aspects of life can affect the quality of life of older adults (31). In a review investigating the effect of exercise training programs on the quality of life in older adults, it was stated that there were improvements in the quality of life in these individuals after exercise training (32). In this review, various exercises such as balance, strengthening, aerobics, Tai chi, and group-based and aquatic exercises were examined within the exercise programs (32). To the best of our knowledge, no study has examined the effect of RT exercises on quality of life parameters in older adults. Because of this study, it was determined that the subheadings

of quality of life, physical functioning, social functioning, role limitations due to physical problems, role limitations due to emotional problems, vitality, bodily pain, general health perceptions, and general mental health were improved in older adults who were subjected to RT exercises.

Study Limitations

There are some limitations to this study. First, it was non-controlled, and second, it was non-randomized. These conditions may affect the interpretation of the results. Further research is needed to investigate the effects of RT exercises on physical functionality and quality of life using a randomized controlled study protocol. In addition, the sample size in this study was not sufficient to assess the correlation between lower and upper extremity RT, static balance, and fall risk. In future studies, the appropriate sample size should be calculated to evaluate the correlation between lower and upper extremity RT, static balance, and fall risk. The results of a future study comparing different exercise training methods with RT exercises may bring different perspectives to the subject.

Conclusion

In conclusion, this study showed that RT exercises applied to older adults have positive effects on functional independence levels, balance, fall risk, upper and lower extremity RT, and quality of life. RT exercises can be added to existing rehabilitation protocols in the clinical practice of older adults.

Ethics

Ethics Committee Approval: Ethics committee approval was obtained from the Non-Invasive Ethics Committee of Üsküdar University (no: 61351342/2020-231). This study was conducted according to the principles of the Declaration of Helsinki.

Informed Consent: Participants were informed about the purpose and procedures of the study. The "Informed voluntary consent" form was signed.

Peer-review: Externally peer reviewed.

Authorship Contributions

Surgical and Medical Practices: B.E.O., Concept: Y.E., B.E.O., Design: Y.E., B.E.O., Data Collection or Processing: B.E.O. Analysis or Interpretation: Y.E., B.E.O., Literature Search: B.E.O., S.S., Writing: Y.E., B.E.O., S.S., F.B.

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