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The relationship between physical fitness and falling risk and fear of falling in community-dwelling elderly people with different physical activity levels

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Background/aim: The aim of this research was to determine the effects of physical activity level (PAL) and physical fitness on falling parameters in community-dwelling elderly people.

Materials and methods: Seventy-six elderly people were grouped as low PAL group (group 1, n: 38) and high PAL (group 2, n: 38) according to their PAL scores. PAL was measured by the Physical Activity Scale for the Elderly and muscle strength, muscle endurance, aerobic endurance, and flexibility tests were applied; body mass index (BMI) was calculated for physical fitness measurement. Fall assessment included falling risk (Berg Balance Scale), dynamic balance (Time Up and Go Test), and fear of falling (FOF) (Falls Efficacy Scale) evaluation.

Results: While physical fitness parameters except flexibility in group 2 were significantly better than they were in group 1 ($P < 0.05$), no significant difference was found between the groups with regard to fall assessments ($P > 0.05$). In both groups, while physical fitness parameters except BMI showed a positive and low or medium significant correlation with falling risk and FOF, the same fitness parameters showed a negative and low or medium significant correlation with dynamic balance.

Conclusion: The results show that PAL may have an indirect effect on fall parameters by increasing physical fitness.

Key words: Aging, physical activity, fitness, falls

1. Introduction

Falling is the most common cause of nonfatal trauma and injuries in the elderly. One-third of individuals over the age 65 fall every year (1). More than one factor plays a role in most falls and falling risk factors are composed of biological/physiological and social factors (2). Falling risk factors are divided into two main groups: intrinsic (age-related changes, force and mobility changes, acute or chronic diseases, medication, etc.) and extrinsic (environmental) factors (2). Intrinsic risk factors including physical fitness parameters are usually the primary cause of falls (3). However, in addition to physical problems, aging and falling might have psychological consequences such as persistent and transient fear of falling (FOF). Physical inactivity, perceived poor health, and loss of confidence can be observed as a result of FOF (2).

In the normal aging process, people tend to decrease their physical activity level (PAL), which results in decreased physical fitness (4). Gouevia et al. and Furtado report that more active elderly people have increased proficiency and higher physical fitness including muscular strength, flexibility, balance, agility, gait velocity, and cardiorespiratory fitness (5,6). It is reported that both sedentary lifestyle and lower physical fitness result in spending more effort to perform normal daily activities and increase falling risk (7).

The effectiveness of physical activity and fitness programs has been researched in studies about management of falling risk and FOF (3,7,8). It seems that beside physical inactivity, lower physical fitness contributes to falling risk and FOF. Yet it is unclear which component of programs is more effective on falls. As a result of this, it is difficult to distinguish between the effects of PAL and physical fitness on falls in elderly people.

To the best of our knowledge, limited studies have examined the relationship between physical properties and falling parameters including mainly FOF. The aim of the present research was to determine the effects of PAL and health-related physical fitness parameters on falling risk and FOF in healthy community-dwelling elderly people.

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2. Materials and methods

2.1. Participants

This cross-sectional study focused on community-dwelling elderly people at İzmir Governorship Nebahat Dolman Elderly Support Center, Turkey, from October 2012 to February 2013. The study was approved by the Ethics and Human Research committee of Dokuz Eylül University Hospital (İzmir, Turkey). Informed consent was obtained immediately prior to data collection. Among the 461 elderly people registered at the center, 76 fulfilled the inclusion criteria and agreed to participate in the study.

Volunteers over 65 years scoring more than 24 points on the Mini Mental State Examination (MMSE) and physically independent (i.e. with the ability to walk 20 m without resting and assistance) were included in this study. Those with uncontrolled diabetes and hypertension, morbid obesity [body mass index (BMI) > 40 kg/m^2], acute pain, blindness and deafness, cardiovascular disease that could affect gait or balance, or other problems such as physical, psychological, neurological, and respiratory were excluded. The subjects' demographics (age, sex, occupation, marital status, education, personal history, height, body weight, cigarette and alcohol consumption, and medical information) were recorded. The same physiotherapist carried out all the assessments. Since the median value of nonparametric variables can be used to create groups (9,10), the median score of the Physical Activity Scale for the Elderly (PASE) was calculated as 88.68. This calculated value was our cut-off score to divide the subjects into two groups based on their PAL scores as the group with low PAL (group 1, n = 38) and the group with high PAL (group 2, n = 38, PASE scores ≥ 88.68).

2.2. Measurements

2.2.1. Physical activity level assessment

PASE was used for PAL assessment. Since PASE is a brief and easy tool for evaluation, it is often used in older people. The PASE consists of self-reported leisure-time, household, and occupational activities over a 1-week period. Participation in leisure time activities is classified as light, moderate, and strenuous sport and recreation. While activity frequency is categorized as never, seldom (1–2 days), sometimes (3–4 days), and often (5–7 days), duration of activities is recorded as less than 1 h, 1–2 h, 2–4 h, and more than 4 h. Household activity is recorded as yes/no. Occupational activity includes work for pay or as a volunteer and it is recorded in total hours per week. The total PASE score is derived from weights and frequency values for each activity and an overall sum score for all activities is calculated. PASE has no cut-off score, high scores show high PAL (11–13), and so we used the median value as the cut-off score to determine the groups.

2.2.2. Health-related physical fitness evaluation

Muscle strength (lower body strength), muscle endurance (upper body endurance), aerobic endurance (functional exercise capacity), flexibility (hamstring and trunk muscle flexibility), and body composition (body mass index) were evaluated (14). In the evaluations of these parameters the following tests were used.

The Chair Stand Test (CST) assesses lower body strength. A chair was placed in front of the wall and the person was asked to stand up from the chair with arms folded across the chest. The number of full stands was recorded in 30 s (15).

The Modified Push-up Test (MPUT) evaluates upper body endurance. The individual lies prone and is asked to lift his/her chest using the upper extremities and trunk. The number of repeats is recorded (16).

The Six-Minute Walking Test (6MWT) was used for functional exercise capacity measurement. Heart rate and systolic and diastolic blood pressure were measured before and after the test on flat ground. Fatigue was assessed using the Borg scale before and after the test as well. Total distance walked was calculated and recorded.

Consumption of max O_2 (VO_2max.) is a direct measurement of aerobic capacity. The following formula was used in order to calculate VO_2max:

VO_2 max = [0.02 (×) distance (m)] – [0.191 (×) age (year)] – [0.007 (×) kilogram (kg)] + [0.09 (×) height (cm)] + (0.26 (×) RPP) + 2.45.

[RPP: velocity – pressure product (heart rate (×) systolic blood pressure × 10^{-3})] (17).

Flexibility was measured by using the sit and reach test (SRT) and trunk extension and lateral side bending tests (18,19).

Body mass index (BMI) is an indicator of body composition and is calculated as weight in kilograms divided by height squared in meters for body composition (19).

2.2.3. Dynamic balance assessment

The Time Up and Go Test (TUGT) is used for dynamic balance assessment. TUGT is composed of independent mobility and functional ability measurements that contain standing up from a chair, walking, turning, stopping, and sitting down. Subjects stood up from a chair, walked 3 m, returned, and sat down. Last time associated functional mobility level was recorded during the test. Normally, the test is completed in less than 10 s. Scores over 30 s point to increased falling risk. TUGT is a sensitive and specific simple screening test for elderly people with a risk of falling (20,21).

2.2.4. Falling risk assessment

Falling risk was measured with the Berg Balance Scale (BBS). The BBS contains 14 items and the assessment of activity proficiency level for each item is scored on a four-point scale (0–4) as 0 (unable) to 4 (accomplish independent and secure). The total point score of the scale is 56 and increased scores show decreased falling risk (22).

2.2.5. Fear of falling evaluation

The Falls Efficacy Scale (FES) was developed to measure FOF by Tinetti and colleagues. The validity and reliability of the Tinetti's FES were tested in previous studies. There are 10 items such as "How confident are you that you can get dressed and undressed without falling?" in the scale assessing the effect of FOF on confidence in performing daily tasks. The scoring is done on a 10-point scale for each item. The total score is derived from the sum of all of questions' scores. While '0' indicates low fall-related self-efficacy, '100' indicates high fall-related self-efficacy (23).

2.3. Data analysis

SPSS 20.00 for Windows (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. All continuous variables were evaluated for normality using the Kolmogorov–Smirnov test. Continuous variables were expressed as mean ± standard deviation (if data were normally distributed) or as medians in combination with quartiles and percentiles (if data were not normally distributed).

After physical fitness, falling risk, dynamic balance, and FOF results of the groups were compared via independent sample t-test and Mann–Whitney U test, Spearman's correlation test was used to examine the relationship between physical fitness, balance, falling risk, and FOF in both groups. Level of significance was set at $P < 0.05$.

3. Results

Seventy-six elderly people over 65 years of age were included in this study. According to the median value of PASE scores they were grouped as group 1 or 2. There were 3 males and 35 females whose PAL scores were lower in group 1 and 6 males and 32 females whose PAL scores were higher in group 2. The characteristics of the participants and a comparison of their demographic data are shown in Table 1. Significant differences were found between the groups in terms of age and number of medications ($P < 0.05$).

The physical fitness parameters, falling risk, balance, and FOF scores of the groups are given and compared in Table 2. All participants (100%) in both groups had low falling risk. While scores of 30-s CST, MPUT, walking distance, VO_2max, and BMI in group 2 were significantly better than those in group 1 ($P < 0.05$), flexibility in the groups was similar ($P > 0.05$). Other measurements including BBS, TUGT, and Tinetti's FES scores were similar in the two groups ($P > 0.05$).

In order to understand the cause of physical fitness effect on falling risk and FOF regardless of PAL, the relationship between physical fitness and falling risk, dynamic balance, and FOF was also investigated in groups with low and high PAL separately. In group 1, a positive and medium significant correlation was found between BBS and 30-s CST, MPUT, walking distance, VO_2max, trunk extension, and right and left lateral side bending tests ($P < 0.01$). On the other hand, there was a negative and medium significant correlation between TUGT and 30-s CST, MPUT, walking distance, VO_2 max, and trunk extension test ($P < 0.01$) as shown in Table 3.

In group 2, a positive and medium significant correlation was found between BBS and 30-s CST, MPUT, walking distance, VO_2max, trunk extension, and right

Table 1. Demographic characteristics of the subjects.

		Group 1 (n: 38)	Group 2 (n: 38)	P
Age* (years)		74 (65–93)	69 (65–84)	**0.001†**
Sex [n(%)]	Female	35 (92.1)	32 (84.2)	0.287$
	Male	3 (7.9)	6 (15.8)	
Occupation [n(%)]	Housewife	23 (60.5)	14 (36.8)	0.87$
	Retired	15 (39.5)	24 (63.1)	
Marital status [n (%)]	Married	14 (36.8)	14 (36.8)	0.124$
	Widow	23 (60.5)	18 (47.4)	
	Single	1 (2.6)	6 (15.8)	
Medication [n (%)]	Less than 4	31 (81.6)	37 (97.4)	**0.025$**
	4 and above	7 (18.4)	1 (2.6)	

boldface P values were statistically significant.
†: Mann–Whitney U test,
$: Chi-square test.
*: expressed as medians in combination with quartiles and percentiles (25%–75%).

Table 2. Comparison of physical fitness and falling parameters of groups (mean ± standard deviation).

		Group 1 (n: 38)	Group 2 (n: 38)	P
CST[§]	number of repetitions in 30 s	12 (6–22)	14 (8–9)	**0.048[†]**
MPUT	number of repetitions	13.32 ± 8.55 (0–33)	19.29 ± 9.76 (0–38)	**0.007***
WD	m	357.26 ± 91.22 (135–532.5)	429.12 ± 82.17 (205.80–564.5)	**0.002***
VO_2max	mL/kg per min	11.60 ± 3.10 (3.16–17.97)	14.07 ± 2.72 (7.13–18.16)	**0.001***
SRT[§]	cm	1.5 [(−29)–22]	2 [(−26)–20]	0.751[†]
TET[§]	cm	11 (5–26)	14 (5–34)	0.489[†]
RLSBT	cm	10.16 ± 2.75 (4–17)	11.39 ± 2.68 (5–18)	0.057*
LLSBT[§]	cm	10 (4–18)	11 (5–17)	0.513[†]
BMI	kg/m^2	31.30 ± 4.40 (22.77–39.82)	28.83 ± 4.68 (21.37–39.11)	**0.017***
BBS	total score	52.94 ± 3.32 (41–56)	53.92 ± 2.29 (44–56)	0.33*
TUGT	sec	9.72 ± 2.85 (5.4–16.9)	8.76 ± 2.73 (5.4–15.84)	0.07*
FES	total score	91.10 ± 8.26 (74–100)	94.07 ± 8.63 (54–100)	0.06*

CST: Chair Stand Test, MPUT: Modified Push-Up Test, WD: Walking Distance, VO_2max: Maximum Volume of O_2 Consumption, SRT: Sit and Reach Test, TET: Trunk Extension Test, RLSBT: Right Lateral Side Bending Test, LLSBT: Left Lateral Side Bending Test, BMI: Body Mass Index, BBS: Berg Balance Scale, TUGT: Time Up and Go Test, FES: Fall Efficacy Scale
Boldface P values were statistically significant.
[†]: Mann–Whitney U test,
*: Independent sample t test.
[§]: expressed as medians in combination with quartiles and percentiles (25%–75%).

and left lateral side bending tests, while a positive and low significant correlation was found between BBS and the sit and reach test ($P < 0.05$). TUGT had a negative and medium significant correlation with MPUT, walking distance, and VO_2max ($P < 001$) and a negative and low significant correlation with 30-s CST and the trunk extension test ($P < 0.05$) as shown in Table 3.

While a positive and medium significant correlation was found between Tinetti's FES and MPUT ($P < 0.01$), a positive and low significant correlation was found between Tinetti's FES and 30-s CST, walking distance, and right and left lateral side bending tests in group 1 ($P < 0.05$). However, in group 2, Tinetti's FES had a positive and medium significant correlation with CST and MPUT ($P < 0.01$) and had a positive and low significant correlation with walking distance and the trunk extension test ($P < 0.05$) as shown in Table 4.

4. Discussion

The effects of PAL and physical fitness on falling risk and FOF in healthy elderly people were investigated in our study. The results confirmed that while physical fitness had an effect on falling risk and FOF, PAL affects these parameters via increasing physical fitness. To the best of our knowledge, no study has focused on the holistic effects of PAL and health-related physical fitness on falls in community-dwelling elderly people.

Falls are a common phenomenon in the elderly and degradation in health status contributes to increasing falling risk (24). With aging, falling risk increases in

Table 3. Relation of health-related physical fitness, balance, and falling risk in the groups.

		CST	MPUT	WD	VO_2max	SRT	TET	RLSBT	LLSBT	BMI
Group 1										
BBS	r	0.521**	0.685**	0.719**	0.636**	0.050	0.512**	0.597**	0.553**	–0.017
	P	0.001	0.001	0.001	0.001	0.765	0.001	0.001	0.001	0.920
TUGT	r	–0.545**	–0.659**	–0.792**	–0.637**	0.184	–0.517**	–0.270	–0.177	0.190
	P	0.001	0.001	0.001	0.001	0.270	0.001	0.101	0.287	0.254
Group 2										
BBS	r	0.459**	0.451**	0.526**	0.450**	0.332*	0.519**	0.455**	0.513**	–0.243
	P	0.004	0.004	0.001	0.005	0.042	0.001	0.004	0.001	0.141
TUGT	r	–0.365*	–0.527**	–0.599**	–0.500**	–0.296	–0.327*	–0.262	–0.237	0.128
	P	0.024	0.001	0.001	0.001	0.071	0.045	0.112	0.152	0.444

CST: Chair Stand Test, MPUT: Modified Push-Up Test, WD: Walking Distance, VO_2max: Maximum Volume of O_2 Consumption, SRT: Sit and Reach Test, TET: Trunk Extension Test, RLSBT: Right Lateral Side Bending Test, LLSBT: Left Lateral Side Bending Test, BMI: Body Mass Index, BBS: Berg Balance Scale, TUGT: Time Up and Go Test.
* Correlation is significant at 0.05 (2-tailed), Spearman's correlation test
** Correlation is significant at 0.01 (2-tailed), Spearman's correlation test

Table 4. Relation of health-related physical fitness and fear of falling in the groups.

		CST	MPUT	WD	VO_2max	SRT	TET	RLSBT	LLSBT	BMI
Group 1										
FES	r	0.381*	0.462**	0.391*	0.213	0.001	0.294	0.366*	0.382*	0.063
	P	0.018	0.004	0.015	0.200	0.997	0.073	0.024	0.018	0.709
Group 2										
FES	r	0.462**	0.435**	0.406*	0.271	0.225	0.358*	0.281	0.263	–0.088
	P	0.003	0.006	0.011	0.099	0.175	0.027	0.087	0.111	0.599

CST: Chair Stand Test, MPUT: Modified Push-Up Test, WD: Walking Distance, VO_2max: Maximum Volume of O_2 Consumption, SRT: Sit and Reach Test, TET: Trunk Extension Test, RLSBT: Right Lateral Side Bending Test, LLSBT: Left Lateral Side Bending Test, BMI: Body Mass Index
* Correlation is significant at 0.05 (2-tailed), Spearman's correlation test.
** Correlation is significant at 0.01 (2-tailed), Spearman's correlation test.

healthy elderly people as well as in other elderly people who have falling risk factors (3). That is the reason why medical problems must be ruled out and healthy seniors should be handled in a separate category to determine fall-related risk factors for this population (25). This requirement makes it necessary to test this particular cluster with specific measurements. In contrast to the literature, we evaluated all fitness parameters in detail, especially focusing on health-related physical fitness including the body instead of functional fitness.

Physical inactivity, lower physical fitness, and the interaction between them directly lead to deterioration in the health status and functional capacity of the elderly (4). Deficiencies in health status cause the falling risk and FOF to increase through the interaction of many factors such as neuromuscular dysfunction, cardiovascular instability, and balance disability, and this is important in terms of morbidity, mortality, and economic costs (26). In previous studies, the general consensus is that physical activity has a close relationship with falling risk and FOF (8,27). Research must focus on building associations between PAL and falling risk or FOF without any bias (27). However, it is emphasized that sufficient physical activity and higher physical fitness might contribute to preventing falls and FOF (6,28,29). Jefferis et al. stated that falling risk and FOF may be complex adverse consequences of physical inactivity (27). Our results showed that PAL might be ineffective on falling risk and FOF. Significant differences were found between the groups in terms of age and medication numbers. These variables are intrinsic falling risk factors (24). We thought that the high PAL group's being both significantly younger and taking less medication would increase falling risk and FOF significantly. However, the similarity in the falling risk and FOF between the groups strengthens the idea that PAL may not be an effective factor on these variables.

According to the general analysis in our study, even though falling risk and FOF of the groups were similar, some of the physical fitness parameters were affected by PAL. In our study, we attempted to rule out PAL by dividing the subjects into two groups according to PAL. Separation of participants into two groups made each group more homogeneous with regard to PAL. Thus it provided us with an opportunity to evaluate the main effect of physical fitness on fall parameters by correlation analyses. However, we thought that detailed correlation analysis by taking into consideration the comparison of physical fitness parameters between the groups would also enable us to interpret the effect of PAL on falling risk, dynamic balance, and FOF. The results of the correlation analyses suggest that the increase in falling risk and FOF may result from differences in physical fitness parameters between the groups. Klenk et al. reported that physical inactivity was not a risk factor for falls, but increasing PAL with improving physical fitness components might be protective against falls. In reduction of falling risk and FOF, physical fitness may be a more decisive factor than PAL (7). In parallel to that study, falling risk and FOF were found to be associated with physical fitness in both groups through further analysis. It seems that PAL shows an effect on falls by improving fitness. Yet it is not clear which parameters of fitness are related to falling risk and FOF.

The effectiveness of a multifactorial exercise approach on the incidence of falls, falling risk, consequences of falls, and functional performance have been investigated before (8,30). In these studies, it was indicated that purposeful physical activity was effective and useful in terms of falls, but how fall efficacy should be measured and which intervention programs control the falling risk and FOF could not be determined. In this regard, Arnold et al. proposed that the relationship between falling risk, FOF, and physical fitness parameters should be defined clearly (8,31). We think that our study will give an insight to professionals about these relationships and will help them in deciding which component of physical fitness and fall prevention programs should be focused on.

Toraman et al. reported that falling risk decreases with improving upper and lower extremity muscle strength but it is not affected by flexibility (3). Our study revealed that improving health-related physical fitness parameters except BMI has an effect on falling risk. Increasing trunk extension and lateral side bending flexibility may reduce falling risk by causing adaptive changes in postural lineup when an elderly person is exposed to a stimulus. Our results also indicated that trunk extension and lateral side bending flexibility are more effective than flexion flexibility in preventing falls through lowering the center of gravity on the body support surface. It should be noted that the body axial, lateral, and rotational mobility have major importance in ensuring and continuation of postural stability (32). Although no study has been found related to the effect of low physical fitness on FOF, Deshpande et al. revealed that only chair stand performance was associated with FOF (33). In line with these studies, our findings suggest that body strength and endurance had an effective role in preventing FOF.

Our results showed that the properties of the trunk such as strength, endurance, and flexibility have more relationship with falling risk and less with FOF. This observation is in accordance with some studies concluding that impairment in postural muscles and their synergistic characteristics lead to coordination and balance problems that in turn increase falling risk and FOF prevalence (32). Helbostad et al. demonstrated that fatigue of trunk muscles impairs trunk control during activity and alters postural sway and gait parameters (34). Mediolateral oscillations of the trunk are closely associated with increased falling risk (3). However, structural and functional changes in the trunk muscle attributes cause some negative outcomes such as decreasing flexibility, strength, and endurance of extensor and flexor muscle with aging. These changes are especially caused by postural impairment like kyphotic and rigid posture. Due to muscle imbalance and the deficiencies in postural adjustments, these deformities are directly related to balance and falling parameters (35). In intervention approaches for preventing falls that are focused on postural stability, enhancing health-related physical fitness parameters associated with the trunk may be useful.

Our study found a relationship between falling risk, FOF, and aerobic fitness. To the best of our knowledge, a few studies have investigated the relationship between aerobic endurance and fall-related factors. In parallel to our findings, in one of these studies, the results indicate that declining aerobic endurance increases falling risk (3). In another study, Mertz et al. emphasized that women with low cardiorespiratory fitness had 2 times more falling risk than women with high cardiorespiratory fitness during walking (36). As a result of decreased aerobic capacity in elderly people, walking and balance changes may cause a decrease in functional capacity and increase susceptibility to falls (37). However, no study examining the effects of aerobic fitness on FOF has been found.

Body composition is taken into consideration in falling risk factors due to the effects it has on postural adjustments and the importance of controlling antigravitational movement. Dropping gravity line on the support surface can be difficult because of the changes in body composition (38). Body composition is usually assessed by calculating the BMI (19). We found no relation between BMI and falling risk or FOF. In contrast to our study, Grundstrom et al. showed a relation between BMI and falling risk (39). Differences in findings may arise because elderly people might be exposed to more risk factors such as uncontrolled disease as stated in other studies. The presence of diseases that increase falling risk may cause the main effect of fitness on fall parameters to be overlooked.

In our study, dynamic balance was associated with similar physical fitness parameters in both groups. These findings give us an idea about the action mechanism of physical fitness on decreasing falling risk and FOF. In the literature it has been suggested that imbalance is one of the basic factors that increase falling risk. Even for the estimation of falling risk, both static and dynamic balance tests have been used (3,20). According to our results, especially declining lower body and upper body strength, aerobic endurance, and trunk extension flexibility might impair dynamic balance and increase falling risk and FOF. Declining lateral side bending flexibility might cause falling risk by affecting static balance rather than dynamic balance.

There are several limitations to this study. First, the sample size was relatively small and lots of data were used for the analysis; these made generalization of the results difficult. Secondly, a longitudinal study might be more objective but our study was planned as a cross-sectional one. We hope that these results will be addressed in ongoing studies. Future large-scale trials are warranted to investigate which factors are more effective on fall parameters using sensitive measures.

In conclusion, this study points to the simultaneous effects of both PAL and physical fitness on fall parameters. While physical fitness improves with PAL, falling risk and FOF may not change in healthy community-dwelling elderly people. However, further analysis revealed that improving health-related physical fitness has a positive effect on falling risk and FOF. Maintenance of physical activity can contribute to preventing falls by enhancing health-related physical fitness.

References

1. Udell JE, Drahota A, Dean TP, Sander R, Mackenzie H. Interventions for preventing falls in older people: an overview of Cochrane Reviews. Cochrane Database of Systematic Reviews 2011; 4: 1-11.
2. Pollock RD, Martin FC, Newham DJ. Whole-body vibration in addition to strength and balance exercise for falls-related functional mobility of frail older adults: a single-blind randomized controlled trial. Clin Rehabil 2012; 26: 915-923.
3. Toraman A, Yıldırım NÜ. The falling risk and physical fitness in older people. Archives of Gerontology and Geriatrics 2010; 51: 222-226.
4. Possamai LT, Zogo A, Boni J, Jacques M, Dorst LM, Dorst DB. Fitness for elders: a comparison between practioners and non-practioners of exercise. Age 2015; 37: DOI 10.1007/s11357-015-9772-2.
5. Gouevia ER, Maia JA, Beunen GP, Blimkie CJ, Fena EM, Freitas DL. Functional fitness and physical activity Portuguese community-residing older adults. J Aging Phys Act 2013; 21: 1-19.
6. Furtado HL, Sousa N, Simão R, Pereira FD, Alves JV. Physical exercise and functional fitness in independently living vs institutionalized elderly women: a comparison of 60- to 79-year-old city dwellers. Clin Interv Aging 2015; 10: 795-801.
7. Klenk J, Kerse N, Rapp K, Nikolaus T, Becker C, Rothenbacher D, Peter R, Denkinger MD. Physical activity and different concepts of fall risk estimation in older people–results of the ActiFE-Ulm Study. PLoS ONE 2015; 10: DOI:10.1371/journal.pone.0129098.
8. Hao Q, Yang M, Luo L, Hai S, Ding X, Dong B. The association of falls and various physical activities in Chinese nonagenarians/centenarians. Archives of Gerontology and Geriatrics 2015; 61: 21-26.
9. Miyatake K, Nagaya N, Satoh T, Kyotani S, Fujita M, Nakanishi N, Miyatake K. Clinical correlates and prognostic significance of six-minute walk test in patients with primary pulmonary hypertension. Comparison with cardiopulmonary exercise testing. Am J Respir Crit Care Med 2000; 161: 487-492.
10. Marques A, Santos R, Ekelund U, Sardinha LB. Association between physical activity, sedentary time, and healthy fitness in youth. Med Sci Sports Exerc 2015; 47: 575-580.
11. Washburn RA, McAuley E, Katula J, Mihalko SL, Boileau RA. The physical activity scale for the elderly (PASE): evidence for validity. J Clin Epidemiol 1999; 52: 643-651.
12. Schuit AJ, Schouten EG, Westerterp KR, Saris WHM. Validity of the physical activity scale for the elderly (PASE): according to energy expenditure assessed by the doubly labeled water method. Clin Epidemiol 1997; 50: 541-546.
13. Ayvat E. Comparison of the physical activity and performance measurements in elderly. MSc, Hacettepe University, Ankara, Turkey, 2011.
14. Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public Health Rep 1985; 100: 126-131.
15. Jones CJ, Rikli RE. Measuring functional fitness of older adults. J Active Aging 2002; 24-30.

16. San Juan JG, Suprak DN, Roach SM, Lyda M. The effects of exercise type and elbow angle on vertical ground reaction force and muscle activity during a push-up plus exercise. BMC Musculoskelet Disord 2015; 16: 1-9.
17. Cahalin LP, Mathier MA. The six-minute walk test predicts peak oxygen uptake and survival in patients with advanced heart failure. Chest 1996; 110: 325-332.
18. Tomchuk D. Companion Guide to Measurement and Evaluation for Kinesiology. 2nd ed. London, United Kingdom: Jones & Bartlett Learning, 2011.
19. Suni JH, Oja P, Miilunpalo SI, Pasanen ME, Vuori IM, Bös K. Health-related fitness test battery for adults: associations with perceived health, mobility and back function and symptoms. Arch Phys Med Rehabil 1998; 79: 559-569.
20. Donat H, Belhan ZB, Yıldırım Y. Relation of history of falls among the elderly to functional ability measurements. Fizyoterapi Rehabilitasyon 2003; 14: 115-120.
21. Shumway-Cook A, Brauer S, Woollacott M. Predicting the probability for falls in community-dwelling older adults using the Timed Up & Go Test. Phys Ther 2000; 80: 896-903.
22. Pereira VV, Maia RA, Silva SMCA. The functional assessment Berg Balance Scale is better capable of estimating fall risk in the elderly than the posturographic Balance Stability System. Arq Neuropsiquiatr 2013; 71: 5-10.
23. Gillespie SM, Friedman SM. Fear of falling in new long-term care enrollees. J Am Med Dir Assoc 2007; 8: 307-313.
24. Al-Aama T. Falls in the elderly: spectrum and prevention. Can Fam Physician 2011; 57: 771-776.
25. Aoyama M, Suzuki Y, Onishi J, Kuzuya M. Physical and functional factors in activities of daily living that predict falls in community-dwelling older women. Geriatr Gerontol Int 2011; 11: 348-357.
26. Edwards MH, Jameson K, Denison H, Harvey NC, Aihie SA, Dennison EM, Cooper C. Clinical risk factors, bone density and fall history in the prediction of incident fracture among men and women. Bone 2013; 52: 541-547.
27. Jefferis BJ, Iliffe S, Kendrick D, Kerse N, Trost S, Lennon LT, Ash S, Sartini C, Morris RW, Wannamethee SG et al. How are falls and fear of falling associated with objectively measured physical activity in a cohort of community-dwelling older men? BMC Geriatrics 2014; 14: 1-9.
28. Pereira CLN, Baptista F, Infante P. Role of physical activity in the occurrence of falls and fall-related injuries in community-dwelling adults over 50 years old. Disabil Rehabil 2014; 36: 117-124.
29. Hilgenkamp TIM, Wijck RV, Evenhuis HM. Low physical fitness levels in older adults with ID: results of the HA-ID Study. Res Dev Disabil 2012; 33: 1048-1058.
30. Lee HC, PhD, Chang KC, Tsauo JY, PhD, Hung JW, Huang YC, Lin S. Effects of a multifactorial fall prevention program on fall incidence and physical function in community-dwelling older adults with risk of falls. Arch Phys Med Rehabil 2013; 94: 606-615.
31. Arnold CM, Sran MM, Harrison EL. Exercise for fall risk reduction in community-dwelling older adults: a systematic review. Physiother Can 2008; 60: 358-372.
32. Rogers MW, Mille ML. Lateral stability and falls in older people. Exerc Sport Sci Rev 2003; 31: 182-187.
33. Deshpande N, Metter EJ, Bandinelli S, Lauretani F, Windham BG, Ferrucci L. Psychological, physical and sensory correlates of fear of falling and consequent activity restriction in the elderly: The Inchianti Study. Am J Phys Med Rehabil 2008; 87: 354-362.
34. Helbostad JL, Sturnieks DL, Menant J, Delbaere K, Lord SR, Delbaere MP, Lord SR, Pijnappels M. Consequences of lower extremity and trunk muscle fatigue on balance and functional tasks in older people: a systematic literature review. BMC Geriatr 2010; 10: DOI: 10.1186/1471-2318-10-56.
35. Suri P, Kiely DK, Leveille SG, Frontera WR, Bean JF. Trunk muscle attributes are associated with balance and mobility in older adults: a pilot study. PMR 2009; 1: 916-924.
36. Mertz KJ, Lee D, Sui X, Powell KE, Blair SN. Falls among adults the association of cardiorespiratory fitness and physical activity with walking-related falls. Am J Prev Med 2010; 39: 15-24.
37. Lima GA, Vilaça KHC, Lima NKC, Moriguti JC, Ferriolli E. Balance and aerobic capacity of independent elderly: a longitudinal cohort study. Rev Bras Fisioter 2011; 15: 272-277.
38. Maciaszek J. Muscle strength and aerobic endurance as factors differentiating falling and non-falling men over 70 years. J Hum Kinet 2010; 25: 35-40.
39. Grundstrom AC, Guse CE, Layde PM. Risk factors for falls and fall-related injuries in adults 85 years of age and older. Arch Gerontol Geriatr 2012; 54: 421-428.