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Research Article

# Physical Activity as a Preventive Factor to Aging-Related Physical Dysfunction in Iranian Community-Dwelling Elderly

**Mehdi Kushkestani[1], Mahsa Moghadassi[2*],Mohsen Parvani[1],Shiva Ebrahimpour Nosrani[1],Sohrab Rezaei[1]**

*[1]Department of Exercise Physiology, Allameh Tabataba'i University Tehran, Iran;[2]Department of Exercise Physiology, Islamic Azad University Tehran North Branch, Tehran, Iran*

## ABSTRACT

**Background and purpose:** Aging is associated with a significant reduction in biological, physiological and functional capacity. The aim of the present research was to investigate the relationship between physical activity level and physical performance indicators in the community-dwelling elderly people.

**Methods:** In this cross-sectional study, 431 community-dwelling older adults (>60) voluntarily were recruited from the Tehran (Iran). General and demographic features, physical activity levels, and physical performance factors were measured and recorded by demographic, PASE questionnaires, and physical function tests.

**Results:** Age was significantly correlated with mobility, balance, speed, and lower body power ($p<0.00$). Also, there was a significantly positive correlation between balance ($r=0.219$, $p<0.01$), mobility($r=0.140$, $p<0.01$) speed test ($r=0.220$, $p<0.00$) and the lower body power ($r=0.237$, $p<0.01$) with physical activity levels. Also, as expected different physical function factors were significantly difference between insufficient and sufficient physical activity group ($p<0.01$).

**Conclusion:** The use of strategies such as regular exercise training at parks and public places with a focus on exercise physiology experts, in addition to preventing a decline in performance, can lead to the prevention of many aging-related disorders and increase public health.

**Keywords:** Older adult; Geriatric syndromes; Speed; Comorbidity; Aging; Diseases; Exercise

## INTRODUCTION

Studies show that aging is associated with a significant reduction in biological, physiological and functional capacity [1,2]. For example, it has been reported that aging leads to the destruction of motor neurons and muscle fibers, leading to an inability to perform daily activities such as walking, sitting, and standing, and maintaining balance [3]. Besides, many reports suggest that regular physical activity has a significant effect on improving the physical performance of the elderly people, including increasing balance and reducing falls, preventing atrophy, sarcopenia, osteoporosis, osteoarthritis, and obesity [4,5]. On the other hand, previous studies have well demonstrated the role of exercise and physical activity in the prevention and treatment of mental and psychological disorders such as dementia, Parkinson's, Alzheimer's and depression, as well as chronic diseases such as cardiovascular disease, diabetes and cancer [6-8]. McPhee et al. also reported that the elderly people who maintained regular jogging postponed disability by almost 9 years and had three times lower risk of death compared to those elderly people [9]. In addition, another study reported that the risk of cardiovascular diseases is lower in high-intensity activities than in moderate-intensity activities [10].

As mentioned, aging is associated with fundamental changes in the body's organs, including a decline in functional indicators such as strength, muscular endurance, flexibility, balance, mobility, and speed (3). It has been well established that muscle strength is one of the most important factors in maintaining physical function, mobility and vitality in the elderly people [11]. Aging increases the incidence of sarcopenia and osteopenia,

**Correspondence to:** Dr. Mahsa Moghadassi, Student of Exercise Physiology, Department of Exercise Physiology, Islamic Azad University Tehran North Branch, Tehran, Iran, Tel:+989122963606;E-mail:mah.moghadasi1994@gmail.com

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leading to major clinical problems such as loss of balance, frequent falls, osteoporosis, osteoarthritis and pelvic fractures, and overall unhealthy aging [12]. Another research also reported that reduced muscle strength due to aging makes 16%-18% of women and 8-10% of men over the age of 65 unable to move objects weighing 15 pounds (about 7 kg) . On the other hand, this issue also affects the coordination, static and dynamic balance of the elderly people [13]. It has also been well established that maintaining balance requires the interaction of atrial-nervous, visual, sensory, and musculoskeletal systems and includes many of the daily activities of the elderly people ranging from simple standing to more complex activities, such as walking and changing directions. Therefore, impaired body balance increases the likelihood of falls, which in turn leads to a very high risk of pelvic fractures [14]. In contrast, bone fractures are much less common in people who exercise regularly (especially resistance training). Reports indicate that athletes' bone density is significantly higher than non-athletes' [15]. Other aging-related complications include a decrease in type 2 muscle fibers (fast-twitch), which is accompanied by a lower speed in performing movements and increased dependence, which ultimately leads to a decline in performance and loss of mobility in the elderly people [16].

Sedentary activities refer to any waking behaviour characterized by an energy expenditure less than 1.5 metabolic equivalents while in a sitting or reclining posture (one metabolic equivalent is defined as the energy expended while sitting at rest). These behaviors include sedentariness, which leads to obesity and metabolic diseases [17,18]. In addition, inactivity and sedentariness are associated with changes in body composition (increase in fat percentage and decrease in muscle percentage), and immune function which results in impaired physical function and daily activities [19-22]. Studies have shown that musculoskeletal disorders are the most common cause of disability in old age, affecting 14% of people over the age of 65 and are associated with diseases such as cardiovascular (10%), metabolic and respiratory (6%) and mental diseases (4%) [23]. It has been well proved that inactivity and sedentariness are the main causes of physiological changes and various diseases at older ages, and the damage is almost equal to the adverse effects of smoking and excessive alcohol consumption [10]. On the other hand, Lee et al. showed that the risk of death was 2 times higher in older people with a sedentary lifestyle compared to those with an active lifestyle [10,24].

Considering the literature and increasing number of elderly people in developing countries and the role of physical activity and exercise in preventing and treating many functional disabilities and aging-associated syndromes, we assumed that physical activity levels were related to physical function in these individuals. Therefore, the aim of the present research was to investigate the relationship between physical activity level and physical performance indicators in the community-dwelling elderly people.

## MATERIALS AND METHODS

### Design and setting

For the purpose of this cross-sectional study, 431 community-dwelling older adults voluntarily were recruited from the parks of Tehran to obtain sufficient variability in both physical performance and physical activity. The G-Power software program was used to calculate the sample size according to the F value in ANOVA analysis, with a power of 80%, and an average effect size of 0.15. All participants gave written informed consent were given information regarding study aim prior to data collection.

### Subjects and data collection

Subjects included if they were older than 60 years, living independently, were residents of Tehran and were able to comprehend and follow instructions and give appropriate responses to interviews. The following exclusion criteria were, orthopedic abnormalities and walk with assistance, current or recent fractures, use of medications that could affect muscle strength and balance, having an acute illness, cognitive impairments and neurological problems such as Parkinson disease and stroke. 6 subjects were excluded due to the missing data and exclusion criteria. The final sample included of 425 individuals.

A questionnaire covering basic demographic characteristics, medical comorbidities, and current medication use filled out by trained staff. Then, physical assessment and physical performance tests were conducted. Physical examination included measurements of weight, height, body mass index (BMI).

### Physical performance tests

**Balance test:** Three balance tests were applied. First subjects were asked to remain standing with their feet as close together as possible, then asked to attempt to maintain their feet with one foot behind the other so that the big toe of one foot is touching the side of the heel of the other and finally asked to stand with one foot in front of the other so that the big toe of one foot is touching the heel of the other foot. If subjects stand for 10 seconds for the first two positions scored 1 point otherwise scored zero. For the third position, holding for 10 seconds scored 2 points, for 3 to 9.99 seconds 1 point and less than 3 seconds zero.

**Mobility test:** Timed up and go (TUG) test was used to measure functional mobility in older adults. Subjects were told to sit on a chair with a height of 43–46 cm without armrests; their feet placed on the floor and back against the back of the chair. After showing the starting signal, subjects should rise from the chair, and walk at their normal pace for 3 meters, then turn and walk back to the chair and sit down with their back against the chair. The amount of time it takes an individual to do this process is measured.

**Lower body power test:** To evaluate subjects' Lower body explosive power, we used five times sit to stand chair test (5XSST). Participants were asked to stand and sit in a chair five

times as quickly as they could with arms crossed over the chest. Time was recorded from the initial sitting position to the fifth standing position. Participant unable to complete 5 chair stands or completes stands in 60 seconds scored zero; if it takes 16.70 seconds or more scored 1 point; between 13.70 to 16.69 seconds 2 points; between 11.20 to 13.69 seconds 3 points and 11.19 seconds or less, 4 points are given.

**Gait speed test:** The time taken by an elderly person to travel 4 meters at a maximum pace was measured to assess walking speed. Subjects stood with their feet against a line. At a start signal, they walked at maximal pace and passed a second line.

**Physical activity assessment:** Physical activity of the elderly was assessed by the PASE. It is a validated 12-item scale evaluating the ordinary physical activity of the past 7 days in recreational, household and work-related activities sections (25). It uses frequency, duration, and intensity level of activities to specify a total score, with higher scores suggesting greater physical activity. In the current study, the PASE was conducted through the interviewer, since in this manner has been proven to be more reliable than the self-administered one. The recommended value of 100 was considered sufficiently active.

**Statistical analysis:** Individuals' characteristics are presented as means ± standard deviations. Pearson and Spearman's correlation coefficient were performed in order to assess the two-dimensional correlation between examined variables. The T-test was used for normally distributed variables to compare the characteristics of participants according to physical activity status. All analysis was calculated using SPSS software with a two-sided p-value of <0.05 considered significant.

## RESULTS

The sample consisted of 425 older adult participants, with a mean age of 71.81 ± 6.23 years. Table 1 shows anthropometric measurements and general physical performance assessment. The mean BMI was 27.17 ± 3.52 which is prober for elderly and the average number of diseases was 27.17 ± 3.52.

The relationship among age, BMI, balance, mobility, lower body explosive power, and PASE score in older adults is shown in Table 2. Age was negatively correlated with BMI (r=-0.230, p<0.01) and physical activity level (r=-0.113, p<0.01)

There was a significant positive correlation between BMI and comorbidity showing that with an increase in weight the number of chronic diseases increases too(r=0.141, p<0.01). While a negative correlation was found between physical activity level and comorbidity (r=-0.100, p<o.05)

In addition, there was a significantly positive correlation between balance (r=0.219, p<0.01), mobility(r=0.140, p<0.01) and the lower body power (r=0.237, p<0.01) with physical activity level suggesting the role of physical activity in having better functional performance. Also, there was a positive correlation between the explosive power of the lower body with mobility (r=0.408, p<0.01) and balance (r=0.249, p<0.01). Moreover, a significant positive correlation was found between the elderlies' balance and mobility (r=0.336, p<0.01).

Participants' physical performance and general characteristics according to two physical activity levels are reported in Table 3. As expected, participants with insufficient physical activity significantly had higher age and comorbidity compared to other group. Also, BMI in this group was significantly more than the group with sufficient physical activity. Meanwhile, individuals with a higher level of activity had passed more years of education. Moreover, there was a significant difference in balance performance between groups in which participants with insufficient physical activity suffer lower performance in balance. Similarly, insufficient physical activity group had the lower power of the lower body in comparison with the other group.

**Table 1:** Demographic data of subjects.

| Variables | Mean ± SD |
|---|---|
| Age (years) | 71.81 ± 6.23 |
| Height (cm) | 170.21 ± 5.61 |
| Weight (kg) | 77.83 ± 10.35 |
| BMI (kg/m$^2$) | 27.17 ± 3.52 |
| Comorbidity | 1.90 ± 1.44 |
| PASE score | 94.26 ± 65.51 |
| Balance test (score) | 3.55 ± 0.83 |
| Mobility test (second) | 3.84 ± 0.53 |
| Lower body power test (score) | 2.84 ± 1.11 |
| Gait Speed test (second) | 10.79 ± 3.21 |

BMI: Body Mass Index; PASE: Physical Activity Scale for Elderly

**Table 2:** Correlation between Age, BMI, Physical performance variable and physical activity level.

| | | Age | Educational status | BMI | Balance test | Mobility test | Power test | Speed test | Comorbidity | PASE score |
|---|---|---|---|---|---|---|---|---|---|---|
| | P | 1 | -0.104$^*$ | -0.100$^*$ | -.230$^{**}$ | -.169$^{**}$ | -.268$^{**}$ | -.289$^{**}$ | 0.066 | -.113$^*$ |
| Age | R | | 0.032 | 0.037 | 0 | 0 | 0 | 0 | 0.173 | 0.018 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | P | 1 | -0.127** | 0.108* | 0.057 | 0.130** | 0.117* | -0.123* | 0.099* |
| Educational status | R | - | 0.009 | 0.027 | 0.25 | 0.008 | 0.017 | 0.012 | 0.042 |
| | R | - | 1 | -0.094 | 0.017 | -0.034 | -0.075 | 0.141** | -0.188** |
| BMI | P | - | - | 0.054 | 0.726 | 0.484 | 0.124 | 0.004 | 0 |
| Balance | R | - | - | 1 | 0.336** | 0.294** | 0.345** | -0.061 | 0.219** |
| test | p | - | - | - | 0 | 0 | 0 | 0.213 | 0 |
| | R | - | - | - | 1 | 0.408** | 0.471** | -0.048 | 0.140** |
| Mobility test | p | - | - | - | - | 0 | 0 | 0.313 | 0.004 |
| | R | - | - | - | - | 1 | 0.522** | -0.085 | 0.237** |
| Lower body Power test | p | - | - | - | - | - | 0 | 0.082 | 0 |
| | R | - | - | - | - | - | 1 | 0.094 | 0.220** |
| Gait speed test | p | - | - | - | - | - | - | 0.055 | 0 |
| | R | - | - | - | - | - | - | 1 | -0.100* |
| Comorbidity | P | - | - | - | - | - | - | - | 0.038 |
| | R | - | - | - | - | - | - | - | 1 |
| PASE score | P | - | - | - | - | - | - | - | - |

* Correlation is significant at the 0.05 level (2-tailed) ;** Correlation is significant at the 0.01 level (2-tailed).

**Table 3:** Comparison of general features and physical performance factors in subjects with sufficient and insufficient physical activity.

| Variables | insufficient PA (IPA) 177 | sufficient PA (SPA) 248 | p-value |
|---|---|---|---|
| Age (years) | 70.98 ± 7.61 | 69.28 ± 7.25 | 0.020* |
| Education (years) | 8.93 ± 5.2 | 10.15 ± 4.68 | 0.014* |
| BMI (kg/m$^2$) | 27.44 ± 3.85 | 26.28 ± 3.82 | 0.002** |
| Comorbidity | 2.06 ± 1.49 | 1.7 ± 1.34 | 0.011* |
| Balance test | 3.40 ± 0.99 | 3.78 ± 0.58 | 0.000** |
| Mobility test | 3.91 ± 0.36 | 3.78 ± 0.62 | 0.008** |
| Lower body power test (score) | 2.62 ± 1.2 | 3.15 ± 0.90 | 0.000** |
| Gait speed test (second) | 11.35 ± 3.55 | 10.02 ± 2.49 | 0.000** |

* Correlation is significant at the 0.05 level (2-tailed);** Correlation is significant at the 0.01 level (2-tailed).

## DISCUSSION

Aging is associated with multiple physiological and anatomical changes, leading to a decline in performance indicators such as mobility, strength, speed, and balance. Consequently, the elderly people are exposed to many musculoskeletal disorders such as sarcopenia, osteoarthritis and non-communicable diseases such as hypertension, metabolic diseases, cardiovascular diseases, and premature death. Hence, it is important to identify safe and

cost-effective interventions and strategies to improve the physical performance of the elderly people. According to the literature, low levels of physical activity and sedentary lifestyle play a causative role in the occurrence and development of many age-related diseases [10]. To the best of our knowledge, it was the first research to investigate the relationship between physical activity level and physical performance indicators in community-dwelling elderly people in Tehran.

The present study revealed a positive and significant relationship between the physical activity level and balance in elderly people ($p<0.000$). Also, the mean balance in the sufficient physical activity (SPA) group was significantly higher than the insufficient physical activity (IPA) group ($p<0.000$). Aging is associated with a disruption in physiological systems, including your central nervous system, peripheral nervous system, and neuromuscular system, leading to incoordination of body movements, poor spatial perception towards their body, and imbalance [25,26]. On the other hand, physical activity and exercise play an effective role in improving balance and preventing falls in elderly people [27,28]. It has also been well proved that physical activity prevents loss of balance in the elderly people by slowing down age-related physiological changes, including neuromuscular function, muscle weakness, and coordination of movements [29]. In fact, frequent sedentary behaviors lead to a higher risk of loss of balance and falls in elderly people.

The present study also revealed a positive and significant relationship between the level of physical activity and speed ($p<0.004$). Also, the mean speed score in the SPA group was significantly higher than the IPA group ($p<0.008$), which is consistent with several relevant researches [30,31]. Aging researches show that factors such as cortical declines in neuropil and myelin, whole-brain gray matter volume, and white matter fractional anisotropy lead to a decrease in processing speed (one of the most important factors in reducing the speed of performing movement) in the elderly people. In fact, aging and subsequent slower neural stimulus processing leads to a decrease in receiving and responding to stimuli, as well as the reduced speed in performing activities of daily living [32]. Previous studies well proved that exercise and physical activity increase speed of performing movements in the elderly people firstly by improving the function of the nervous system, motor neurons, increasing the speed of response to stimuli, secondly by preventing age-related weight loss and muscle mass (especially type 2 muscle fibers), and improving motor capabilities [33,34].

The present study also demonstrated a positive and significant relationship between physical activity level and lower body muscle strength ($p<0.000$). Also, the mean score of the strength test in the SPA group was significantly higher than the IPA group ($p<0.000$). Decreased strength and muscle mass are crucial factors leading to a decline in physical performance in elderly people. Studies show that people aged 50 and older lose 1-2% of their muscle mass and 1.5-5% of their muscle strength each year [35]. Factors such as decreased number and size of muscle fibers and motor units, loss (apoptosis) of nerve cells, and decreased muscle metabolism lead to decreased muscle strength, increased risk of frailty and musculoskeletal disorders in the elderly people [36,37]. Physical activity and exercise, especially strength training, are one of the most effective methods to prevent reduced muscle strength and associated disorders in elderly people [38]. The most important mechanisms underlying the role of physical activity and exercise in improving the strength of the elderly people include increasing the expression of structural and functional proteins of mitochondria, intensified anabolic processes, reduced apoptosis of nerve cells and preventing decreased protein synthesis [39]. Interestingly, comparison of physically active older people and sedentary older people showed that routine day-time physical activity was associated with decreased activity of inflammatory factors in the muscles, leading to improved satellite cell function, increased muscle regeneration, and improved strength, increased physical function, and prevention of musculoskeletal disorders such as sarcopenia [40,41].

The present study showed a positive and significant relationship between the physical activity level and mobility ($p<0.000$). Also, the mean mobility test score was significantly higher in the SPA group than the IPA group ($p<0.000$). Decreased mobility is an important step in the process of disability and frailty of the elderly people [42]. Previous researches show that aging can lead to reduced mobility by causing physiological changes in muscles, bones, and joints. On the other hand, aging is associated with frequent sedentary behaviors, which can independently reduce muscle mass and bone density, leading to stiffness and reduced joint flexibility, reduced cartilage thickness, and ultimately reduced mobility [43]. Physical activity is one of the most important modifiable factors promoting mobility in elderly people [44]. Magistro et al. reported that physical activity and reduced sedentary behaviors improved the mobility of the elderly people by improving the function of erector spinae muscles and maintaining body structure [44]. Besides, active elderly people are less likely to develop age-related diseases such as sarcopenia and osteoarthritis, which brings better health and mobility, and thus improved physical function in these people [45].

The present study showed a significant inverse relationship between physical activity level and comorbidity ($p<0.038$). Also, the mean odds ratio of diseases was significantly lower in the SPA group than the IPA group ($p<0.011$). Previous studies have shown the positive role of exercise in the prevention, control and treatment of many age-related disorders and diseases [46,47]. In fact, physical activity and exercise increase the number of healthy years in elderly people by improving protective functions and preventing the decline in physical function. Overall, the elderly people can reduce aging-related decline in physical and functional capacity by increasing the level of physical activity through routine daily activities such as walking, housework and reducing sedentary times, and have a higher quality of life.

## CONCLUSION

The present study provides evidence that moderate-to-high levels of physical activity can prevent many of the age-related disorders by improving physical performance factors such as balance, speed, strength, and mobility. Therefore, the use of strategies

such as regular exercise training at parks and public places with a focus on exercise physiology experts, in addition to preventing a decline in performance, can lead to the prevention of many aging-related disorders and increase public health.

## LIMITATIONS

The present study was limited to the elderly people in Tehran that reduces the generalizability of the results. On the other hand, investigating the history, type and intensity of physical activity of the elderly people for a longer period of time could provide more accurate information about the most effective activities to improve various physical performance indicators in the elderly people.

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