



SCIENCE
TECHNOLOGY
PARK
NIS

19th to 21st October 2023

XXIV

International
Scientific
Conference

FIS COMMUNICATIONS
2023 in Physical Education, sport and recreation

Book of **Proceedings**

Niš, 2023.

EFFECTS OF PHYSICAL ACTIVITY ON THE BALANCE OF OLDER ADULTS

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UDC 796.012.412-053.8

ABSTRACT

This research aims to collect relevant studies related to the effects of physical activity on the balance of older adults. The objective of this study is to determine the impact of physical activity on the balance of older adults. To collect data on the effects of physical activity on the balance of older adults, the following electronic databases were utilized: PubMed/Medline, PEDro, SCIndex, ScienceDirect, Google Scholar, journals in the field of sports sciences, as well as relevant literature that could address the research question. The following keywords were used during the search: *Exercises of balance, proprioception, exercise in the water, balance of the elderly*. It was concluded that multidimensional exercise has a positive influence on the balance development of older adults. Proprioceptive physical activities have the most significant impact on balance control among older adults. Research on aquatic exercises indicates that lower body water-based or land-based exercise programs contribute to balance improvement. High-intensity strength training can safely and effectively strengthen the lower limb muscles, leading to significant enhancements in balance and a reduced risk of falls among older adults. In summary, physical activity has numerous positive effects on preserving the health and quality of life of older individuals. Future studies should be well-designed and provide detailed and precise reports.

Keywords: Exercises of balance, proprioception, exercise in the water, balance of the elderly.

INTRODUCTION

Modern living and working conditions, influenced by technological advancements, have shifted human activity from physical to intellectual, resulting in minimal daily physical activity. Intellectual work has led to a sedentary lifestyle, reducing physical activity and thereby jeopardizing human health and the normal functioning of organs and organ systems (Đurašković, 2009). Physical activity, as a specific form of "stress," elicits complex biochemical, physiological, psychological, and functional reactions within the body that are interconnected. Adaptation to workload primarily refers to the body's ability to perform physical work of a certain volume and intensity that was previously unavailable (Đurašković, 2009).

Research has shown that approximately one-third of individuals aged 65 and older experience falls each year, and injuries such as fractures of the arm, leg, or hip, or acute tendon strains resulting from falls, can significantly impact an older person's life by limiting mobility and hindering independent living. Balance exercises, combined with strength training, can prevent falls by improving stability both at rest and in motion. Many take balance for granted, but for many individuals, maintaining balance can be a challenge (Pavić, 2015).

When a young child falls, they simply get up, shake it off, and continue, but when an older adult falls, there can often be negative consequences. Broken bones or head injuries can limit mobility, erode self-confidence, create a fear of falling, and reduce an individual's independence (Means, Rodell & O'Sullivan 2005).

Although balance training is the cornerstone of fall prevention programs, any exercise that enhances endurance, increases muscle strength, and improves flexibility can have the same effect (Orr, Raymond & Singh, 2008).

According to Douris et al (2003), balance exercises can be done anytime, anywhere, and as frequently as people are capable of. In the beginning, it's advisable to have a solid support to grab onto in case stability is compromised. A chair or standing next to a wall can serve this purpose.

Balance can be described as the ability to maintain a specific body or body part position when in contact with a stationary or moving surface. Static and dynamic balance are distinguished. Static balance involves controlling postural movements, i.e., maintaining a static body position and an upright stance when standing still. Dynamic balance is the ability to appropriately respond to changes in balance and predict changes in body movement. Dynamic balance is crucial for walking, which means being mobile, independent, and having a better quality of life (Mekić & Mavrić, 2016).

A group of authors (Kasović, Vlašić & Antolić, 2007) suggests that a particularly vulnerable group of older people is those residing in homes for the elderly and disabled, due to the ongoing reduction in their physical activity, increasing immobility, and growing dependence on others.

The subject of this research is to collect relevant studies related to the effect of physical activity on the balance of older adults.

The aim of this study is to determine the impact of physical activity on the balance of older adults.

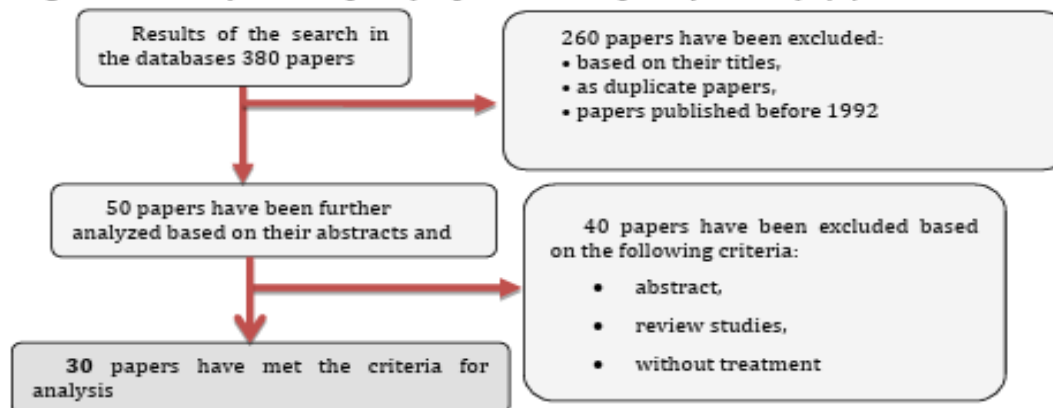
METHODS

To collect data on the effects of physical activity on the balance of older adults, the following electronic databases were utilized: PubMed/Medline, PEDro, SCIndex, ScienceDirect, Google Scholar, journals in the field of sports sciences, as well as relevant literature that could address the research question. The following keywords were used during the search: Exercises of balance, proprioception, exercise in the water, balance of the elderly.

Procedure

The selection of studies was based on titles and keywords. Two selection criteria were applied. The first criterion pertained to the research topic, focusing on the effects of physical activity on the balance of older adults. The second criterion was the analysis of studies published from 1992 to 2009. During this specified time frame, thirty original scientific papers closely related to the research topic and meeting all criteria for further consideration were identified. The process of collecting the studies is presented in Figure 1. In the time frame from 1992 to 2009, studies that were most closely related to addressing the given research topic were included.

Figure 1. Procedure for collecting, analyzing, and eliminating identified scientific papers:



RESULTS

The table provides information about authorship, listing the lead author and publication year, while co-authors are referenced. Basic information about the number of participants, age categories, and gender within the sample of participants is included. In the "Research Results" column, the results of the authors and partial conclusions are presented, from which we have drawn personal conclusions for further analysis. The table displays thirty original scientific papers from the period of 1992 to 2009.

Study	Sample of participants			Research results
	number	aged	gender	
Shumway et al. (1996)	105	65	male/ female	The first group served as the control group (n=21), the second group (n=52) engaged in full-spectrum endurance exercises, and the third group (n=32) followed a partial endurance exercise routine. The second and third groups achieved better results than the control group in terms of balance and mobility. Additionally, both the second and third groups exhibited a lower risk of falling compared to the control group. The group that engaged in full-spectrum endurance exercises showed the most significant reduction in fall incidents.
Buchner et al. (1996)	105	68-85	male/ female	The first group (n=25) implemented strength training, the second group (n=25) engaged in endurance training using a bicycle, and the third group (n=25) combined strength and endurance training. There was no significant impact of exercise on walking, balance, physical, or health status. However, exercise had a protective effect on the risk of falling.
Madureira et al. (2007)	66		female	The participants were randomly divided into two groups: "GROUP 1," which underwent balance training, and "GROUP 2," which did not receive training. Using the Berg Balance Scale (BBS), Clinical Test of Sensory Interaction on Balance (CTSIB), and the Timed Up and Go Test (TUGT), this longitudinal prospective study demonstrated that the use of training was effective in improving functional and static balance, mobility, and fall frequency in older women with osteoporosis.
Judge et al. (1992)	38	62-75	female	The first group (n=12) underwent combined training, while the second group, serving as the control group, received flexibility training (n=9). The first group engaged in training three times a week, which included knee joint extension exercises and seated leg press machine exercises, followed by 20 minutes of brisk walking and simple Tai Chi movements. The second group focused on flexibility training, including postural exercises. The average displacement of the center of pressure improved by 17% in the first group and showed no significant change in the second group.
Wolf et al. (1996)	200	76	male/ female	The study involved three groups (TC, BT, and ED) with a duration of 15 weeks. The primary outcomes were measured before and after the intervention, as well as at a 4-month follow-up. Falls were continuously monitored throughout the study. Fear of falling was reduced after the intervention in the TC group compared to the ED group ($p = .046$ and $p = .058$, respectively). After adjusting for fall risk factors, the TC group was found to reduce the risk of multiple falls by 47.5%.
Rubenstein et al. (2000)	59		male	They were randomly divided into a control group and an exercise group in a 12-week program. The exercise regimen consisted of 90 minutes of exercise three times a week, focusing on increasing strength and endurance, as well as improving mobility and balance. Exercise where no significant impact was achieved was on balance. These results suggest that physical activity can improve endurance, strength, and gait in older individuals with health conditions. Furthermore, increased physical activity is associated with reduced fall rates.
Wolf et al. (1996)	72		male/ female	In contrast to computerized balance training, Tai Chi does not seem to improve balance measures. However, Tai Chi exercises have been shown to delay falls in older individuals. Interestingly, this effect does not appear to be directly associated with improvements in balance.

Schlicht et al. (2000)	24	61-87	male/ female	These results suggest that strength training alone may not improve balance but can enhance walking speed. The relationship between gaining strength and the risk of falls remains unclear. The data will reinforce the idea that intensive strength training is a safe and effective way to increase muscle strength in this population.
Gauchard et al. (1999)	40	60	male/ female	Nineteen healthy individuals were divided into three groups: proprioceptive exercise (Group I), bioenergetic exercise (Group II), and a control group (Group III) that engaged in regular walking. The control group exhibited the poorest balance and muscle performance. Group I participants showed the best balance with average muscle strength. In Group II, muscle strength significantly increased, but balance was poor. Proprioceptive exercises appear to have the most significant impact on balance.
Kaneda et al. (2008)	30	60	male/ female	Participants were given exercises, either deep water running exercises (DVRE, n=15) or regular water exercises (NVE, n=15). The findings of this study indicate that the deep water running exercise program is significantly more effective than normal water exercises in improving balance abilities in older individuals.
Campbell et al. (2005)	233	80	male/ female	In a randomized controlled study comparing an individually tailored physical therapy program (Group I, n=116) to usual care (control group, n=117), it was found that individual strength and balance exercise programs improved physical function and increased effectiveness in reducing falls and injuries in women aged 80 years and older.
Kevin et al. (2005)	205		male/ female	Participants in the first group (n=122) significantly outperformed those in the control group (n=83). Our intervention can improve functional performance and protect against falls and fall-related injuries in older individuals.
Lord et al. (2002)	669	75-93	male/ female	Sitting to Stand (STS) is often used as a measure of lower extremity strength in older individuals and those with weaknesses. However, recent research results suggest that this test is influenced by factors related to balance and mobility. Findings indicate that in older individuals, the STS test is influenced by multiple physiological and psychological processes and represents a specific skill rather than a measure of lower extremity strength.
Bird et al. (2009)	32	66.9	male/ female	The research investigates balance in older individuals participating in a resistance and flexibility training program. Resistance training resulted in a significant increase in strength that was not observed in flexibility training. Balance was significantly improved after both resistance and flexibility training. However, further research is needed to determine the mechanisms responsible for these improvements.
Swanenburg et al. (2007)	24	65	male/ female	The three-month program, consisting of strength, coordination, balance, and endurance training, led to a significant reduction in the risk of falls, increased muscle strength, and an increase in activity levels observed in the experimental group compared to the control group. Furthermore, there was an 89% reduction in reported falls in the experimental group compared to the control group.
Faber et al. (2006)	278	85	male/ female	The fall frequency rate was higher in the first group compared to the balance exercise program (IB) group and the control group, but this difference was not statistically significant.
Hong et al. (2000)	58	66-67	male	Twenty-eight Tai Chi (TCC) practitioners, who had been practicing Tai Chi exercises were compared with 30 sedentary males serving as the control group. +Long-term regular Tai Chi practice has favorable effects on balance, flexibility, and cardiovascular fitness in older individuals.
Barnett et al. (2003)	163	65	male/ female	These findings suggest that participation in a weekly group exercise program with accompanying home exercises can improve balance and reduce the risk of falls in older individuals.
Topp et al. (1993)	55	71	male/ female	Participants were instructed to complete three strength training sessions per week for 12 weeks using elastic bands. After the test, participants showed slower walking speed, improved balance, and enhanced ability to walk backward, although none of these post-test measures significantly differed from the control group.

Douris et al. (2003)	11	75-83	male/ female	Performed a similar set of lower body exercises (2 times a week for 6 weeks), but one group did the exercises in the pool, while the others did them on land. The results, as measured by the Berg Balance Scale (BBS), showed significant improvements in BBS scores between the pre-test and post-test, regardless of the treatment intensity. Whether the exercises were performed in water or on land, they led to improved balance.
Woo et al. (2007)	180	65-74	male/ female	The aim was to investigate the impact of Tai Chi (TC) exercises and resistance training exercises (RTE) on bone density (BMD), muscle strength, balance, and flexibility in older adults. There were no significant differences observed in balance, flexibility, or the number of falls between any of the interventions or the control group after 12 months.
Ming-hsia et al. (1993)	24	65-90	male/ female	Subjects were randomly divided into an experimental group (n = 12) and a control group (n = 12). The subjects' training showed a significant improvement in balance after training in five out of eight training conditions (p < 0.006). When tested four weeks after the completion of training, subject (a) fell less when minimized to somatosensory inputs from the ankle/foot, and subject (b) stood more on one leg compared to the control group (p < 0.001).
Harmer et al. (2004)	256	70-92	male/ female	It was investigated whether functional balance improves through Tai Chi intervention in relation to a subsequent reduction in falls among older adults. Tai Chi participants demonstrated improvement in measures of functional balance. The improvement in functional balance through Tai Chi training is associated with a later reduction in the frequency of falls in older adults.
Wolf et al. (2001)	94	75	male/ female	A short individualized exercise program can improve functional balance in people aged 75 and older. This improvement was maintained for at least one month but disappeared after one year.
Kammerlind et al. (2001)	23		male/ female	Balance training in older individuals with dizziness and instability can improve both issues and enhance balance.
Ballard et al. (2004)	40	65-89	female	The exercise program resulted in increased balance and leg strength but did not result in a significant difference in falls during the follow-up period.
Hess et al. (2005)			male/ female	The aim of the study was to assess the effect of a 10-week, high-intensity lower extremity muscle strength training program to improve balance in older adults. High-intensity strength training can safely and effectively strengthen lower extremity muscles in impaired older adults, resulting in significant improvements in balance and a reduced risk of falls.
Rhonda et al. (2005)	112	69	male/ female	The study investigated the 8-12 weeks of strength training at 20%, 50%, or 80% of their maximal strength, or no training (CON group). Strength training improved balance, particularly when using lower loads and a high-velocity regimen, in older adults with initially lower muscle strength and slower contractions.
McAuley et al. (2002)	44	60	female	Fifteen participants regularly practiced proprioceptive physical activities (Group I), 12 regularly practiced bioenergetic physical activities (Group II), and 18 participants in the control group engaged in regular walking (Group III). Proprioceptive exercises appeared to have the best influence on balance regulation and precision.
Taggart (2002)			female	The aim of the study was to determine the effects of Tai Chi exercise in older women. Regression analysis showed statistically significant improvements in balance (p < .001), mobility (p < .05), and fear of falling (p < .001). Three months of twice-weekly, 30-minute Tai Chi classes were associated with statistically significant improvements in balance and a reduction in the fear of falling in this sample of older women.

DISCUSSION

A reduced ability to maintain balance can be associated with an increased risk of falling, particularly in older individuals. Falls in older adults often lead to injuries, a loss of confidence, a higher likelihood of illnesses, and premature death.

Table 1 provides an overview of scientific studies that investigate the impact of physical activity on improving balance in older individuals. The table demonstrates that the studies have been presented and analyzed according to five groups of parameters: reference, participants' age, number of participants, participants' gender, and measurement results.

A total of 30 studies were included in the review, with a combined total of 3240 participants, the majority of whom were women and on average over 60 years old. In the study by Helen M. Taggart (2002), the number of participants and their age were not emphasized, but it is known that the participants were female, and the conclusion is that Tai Chi exercises can be an acceptable form of exercise for older women. In the work by Hess & Woollacott (2005), the number of participants and their age were not specified, and the research was conducted to assess the impact of a 10-week program of high-intensity strength training of the lower extremity muscles on the balance of older adults. The study by Lord et al. (2002) had the largest number of participants, with 669 individuals, while the study by Douris et al. (2003) had the smallest number of participants, with 11 individuals.

Five different studies by various authors were found to analyze strength training and its impact on balance. Research on the impact of physical activity on the balance of older individuals applied a strength training program by authors such as Buchner et al. (1996), Schlicht et al. (2005), Topp et al. (1993), Rhonda et al. (2005), and Ballard et al. (2004).

Two studies were found that analyzed aquatic exercise training and its impact on the balance of older individuals: Douris et al. (2003) and Kaneda et al. (2008).

Two studies were found that analyzed proprioceptive training and its impact on the balance of older individuals: Gauchard et al. (1999) and Gauchard et al. (2002).

There were seven studies found that analyzed the effects of Tai Chi programs on the balance of older individuals: Taggart (2002), Judge et al. (1992), Wolf et al. (1996), Harmer et al. (2004), Jean Woo et al. (2007), Wolf et al. (1996), and Hong et al. (2000).

Furthermore, studies that analyzed the effects of multidimensional exercises on the balance of older individuals were conducted by the group of authors Shumway-Cook et al. (1996).

In the study by Barnett et al. (2003), a group exercise program was implemented. Participants were assessed using the Berg Balance Scale (BBS), the Clinical Test for Sensory Interaction on Balance, the Dynamic Gait Index, postural sway with eyes open and eyes closed, and coordinated stability. Based on the results, it can be concluded that strength training alone does not significantly improve long-term balance.

It was concluded that the effect of multidimensional exercises on the balance of older individuals has a positive impact on balance development. The effect of proprioceptive physical activities on balance control in older individuals has the greatest impact on balance control in this group. Research on the effects of aquatic exercises on balance shows that lower extremity water exercise programs, whether in water or on land, lead to improved balance.

High-intensity training can safely and effectively strengthen the lower extremity muscles, resulting in significant improvements in balance and a reduced risk of falling in older individuals. Some authors argue that the effects of Tai Chi Kuan exercises cannot be directly associated with measures of improved balance. However, other authors believe that long-term regular Tai Chi Kuan (TCC) practice has favorable effects on balance and flexibility in older individuals.

Based on the results, it can be recommended to include high-intensity strength training and proprioceptive physical activity training in older individuals, as they have been shown to have the most significant impact on balance control in older individuals. The review has established that physical activity has statistically significant positive effects on balance compared to regular activities in older adults.

The effects of physical activity on the balance of older individuals have been observed in their ability to stand on one leg with both eyes open and closed, walk backward, and increase walking speed.

Future studies should be well-designed and provide detailed and precise reports. Ideally, research should follow participants for one year after their participation to assess long-term effects, rather than solely focusing on immediate post-intervention results in improving balance in older individuals.

CONCLUSION

Based on the analysis of results and conclusions drawn by the authors in the mentioned studies, it can be concluded that balance can be successfully improved in older individuals who engage in moderate physical activity and everyday life activities. The most significant impact on improving balance comes from resistance training, where proper load dosage is crucial. High-intensity strength training can safely and effectively strengthen the lower extremity muscles, resulting in significant improvements in balance and a reduced risk of falling in older individuals. Research on the effects of various exercise programs on balance remains highly relevant. Other exercise programs applied in the analyzed studies also have certain positive effects on balance development. Some authors believe that deep-water exercise programs are more effective than regular water exercises in improving balance. Recent research conducted by Gauchard, Gangloff, Jeandel & Perrin (2002) shows that bioenergetic activity improves postural control in simple tasks, and proprioceptive exercises have the greatest impact on balance control in older individuals.

This relevance allows proven balance-enhancing exercise programs for older adults to be successfully used in practice. In fall prevention, physical activity programs must be based on a multidimensional aspect of balance maintenance and focus on activating all relevant sensory systems in balance maintenance, such as the musculoskeletal system, visual, vestibular, and somatosensory systems. Long-term regular exercise has favorable effects on balance in older individuals. In addition to improving balance, there are other benefits of a combined exercise program that includes balance, endurance, strength, and flexibility exercises, such as:

- Faster reaction time - can help you quickly grab onto something stable if you start to fall.
- Improved coordination - can prevent falls and help you land more smoothly and gracefully, reducing the risk of injury upon falling.
- More muscle mass - stronger and larger muscles can cushion a fall and protect bones and joints.
- Stronger bones - resistance exercises strengthen bones, making them more resistant to fractures.
- Better brain function - regular exercise helps maintain normal brain function as you age. Sharper thinking can help you avoid situations that increase the risk of falling.

Based on all the above, it can be concluded that physical activity has numerous positive effects on maintaining the health and quality of life of older individuals. When conducted correctly, tailored to age-related characteristics, and individual needs, there should be no contraindications or side effects that could jeopardize the health of the participants.

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CIP - Каталогизација у публикацији Народна библиотека Србије, Београд

796/799(082)

SCIENTIFIC Conference "FIS Communications 2023" in physical education, sport and recreation (24 ; 2023 ; Niš)

Book of Proceedings / XXIV Scientific Conference "FIS Communications 2023" in physical education, sport and recreation, (Niš, Serbia, october 19-21, 2023) ; [editor in chief Nenad Stojiljković]. - Niš : University, Faculty of sport and physical education, 2023 (Niš : Medivest). - 408 str. : ilustr. ; 29 cm

Tiraž 200. - Str. 7: Foreword / Nenad Stojiljković. - Bibliografija uz svaki rad.

ISBN 978-86-81474-28-0

a) Спорт -- Зборници b) Физичка култура -- Зборници

COBISS.SR-ID 131064841