CLINICAL STUDY

EVALUATION OF RELATIONSHIP BETWEEN FALL RISK AND BALANCE PERFORMANCE IN MIDDLE-AGED AND OLDER INDIVIDUALS

Banu BAŞ, MD; Beyza SARIYILDIZ, MD; Hüdanur IŞIK, MD; Şeyma BAYKURU, MD
Ankara Yildirim Beyazit University, Audiology, Ankara, Türkiye

SUMMARY

Objective: To investigate the effects of aging on fear of falling and fall risk, and to examine the relationship between fall risk and balance performance across different age groups and genders.

Methods: A total of 75 participants (31 men and 44 women) were divided into three age groups: 45-54, 55-64, and ≥65 years. Balance and fall risk were assessed using dynamic tests (Functional Reach Test, Timed Up and Go Test, Berg Balance Scale), static tests (Modified Romberg Test, One-Leg Stance Test), and the Falls Efficacy Scale-International (FES-I). Group comparisons and correlation analyses were conducted.

Results: No significant differences were observed in FES-I, Functional Reach, and One-Leg Stance scores among the groups. However, Berg Balance Scale and Timed Up and Go Test scores differed significantly between younger and older participants ($p < 0.05$). Women reported higher FES-I scores, whereas men had better performance in dynamic balance tests. The strongest correlation was identified between the Berg Balance Scale and the Functional Reach Test ($\pi = 0.627$).

Conclusion: Age-related changes negatively affect dynamic balance and are associated with increased fear of falling. Gender-based differences were observed, and the findings suggest a strong interrelationship between fear of falling, balance, and mobility. Early and multidimensional assessment approaches are essential to reduce fall risk and support independent aging.

Keywords: Balance; Fear of falling; Risk of falling; Aging

ORTA YAŞLI VE YAŞLI BİREYLERDE DÜŞME RİSKİ İLE DENGE PERFORMANSI ARASINDAKİ İLİŞKİNİN DEĞERLENDİRİLMESİ

ÖZET

Amaç: Yaşlanmanın düşme korkusu ve düşme riski üzerindeki etkilerini incelemek ve düşme riski ile denge performansı arasındaki ilişkiyi yaş ve cinsiyet değişkenlerine göre değerlendirmek.

Gereç ve Yöntemler: Toplam 75 katılımcı (31 erkek, 44 kadın) 45-54, 55-64 ve ≥65 yaş olmak üzere üç gruba ayrıldı. Denge ve düşme riski; dinamik testler (Fonksiyonel Uzanma Testi, Zamanlı Kalk Yürü Testi, Berg Denge Ölçeği), statik testler (Modifiye Romberg Testi, Tek Ayak Üzerinde Durma Testi) ve Uluslararası Düşme Etkinliği Ölçeği (FES-I) kullanılarak değerlendirildi. Gruplar arası karşılaştırmalar ve korelasyon analizleri yapıldı.

Bulgular: FES-I, Fonksiyonel Uzanma ve Tek Ayak Üzerinde Durma testlerinde gruplar arasında anlamlı fark bulunmadı. Ancak Berg Denge Ölçeği ve Zamanlı Kalk Yürü Testi puanları, genç ve yaşlı gruplar arasında anlamlı farklılık gösterdi ($p < 0.05$). Kadınlar FES-I puanlarında daha yüksek skorlar bildirirken, erkekler dinamik denge testlerinde daha iyi performans gösterdi. En güçlü korelasyon Berg Denge Ölçeği ile Fonksiyonel Uzanma Testi arasında gözlendi ($\pi = 0.627$).

Sonuç: Yaşlanma, dinamik dengeyi olumsuz etkilemekte ve düşme korkusunu artırmaktadır. Cinsiyete bağlı farklılıklar gözlenmiş olup, düşme korkusu, denge ve hareketlilik arasında güçlü bir ilişki olduğu belirlenmiştir. Erken dönemde yapılacak çok boyutlu değerlendirmeler, düşme riskinin azaltılmasına ve bağımsız yaşlanmanın desteklenmesine katkı sağlayabilir.

Anahtar Sözcükler: Denge; Düşme korkusu; Düşme riski; Yaşlanma

INTRODUCTION

Aging leads to irreversible physical and biological changes in the organism.[1] One of the notable effects of aging is a decrease in balance performance, primarily associated with changes in the visual, somatosensory, and vestibular systems.

Corresponding Author: Banu BAŞ MD. Ankara Yildirim Beyazit University, Audiology, Ankara, Türkiye, K.B.B., Denizli, Türkiye
E-mail: fzt_banu@hotmail.com

Received: 22 September 2025, accepted for publication: 06 October 2025

Cite this article: Baş B., Sarıyıldız B., Işık H., Baykuru Ş. Evaluation Of Relationship Between Fall Risk And Balance Performance In Middle-Aged And Older Individuals. KBB-Forum 2025;24(4):259-268

As people age, reductions are commonly observed in visual acuity, depth perception, contrast sensitivity, and the ability to detect motion.[2] Notably, impairments in vision have been linked to frequent falling incidents among elderly individuals. Research involving participants aged 63 to 90 years revealed that diminished visual clarity and contrast sensitivity were associated with greater postural instability, potentially increasing fall risk and negatively affecting balance.[3]

With aging, degeneration in the somatosensory system are observed. Sensory information from muscles, tendons, and joint receptors affects postural balance, and inputs from the lower extremities play a critical role in maintaining balance.[4] Age-related neuromuscular

function loss leads to decreased muscle spindle sensitivity, degeneration of Pacinian and Meissner receptors, resulting in reduced skin sensation, weakened reflexes, and diminished vibration perception in the ankles.[5] These negative changes in the somatosensory system can increase postural sway and adversely affect balance.[6]

Balance and motion coordination are regulated by the vestibular system through sensory input integration, including contributions from mechanisms like the VOR (vestibulo-ocular reflex) and the VSR (vestibulospinal reflex). These processes rely on inner ear structures such as the semicircular canals and otolith organs. Degeneration of hair cells in these components, often seen with aging, and a decline in the volume and neural density of the vestibular nuclei, have both been linked to elevated fall risk.[7]

Besides the physiological effects of aging, several other conditions play a role in elevating fall risk. Diabetes can impair balance due to sensory loss in the feet, while postural hypotension may lead to falls as a result of sudden drops in blood pressure. This condition is also associated with certain diseases and the use of medications such as antipsychotics, antidepressants, and diuretics. Cerebrovascular diseases can cause strokes and sudden falling episodes; individuals with Parkinson's disease are particularly prone to falling, primarily because of the movement-related complications the disease entails. Cardiovascular diseases, including arrhythmias and vascular obstructions, can negatively affect balance. Additionally, osteoporosis, by reducing bone density, disrupts body stability during walking and elevates the risk of falls.[8]

Moreover, psychological and environmental factors also play a role in increasing fall risk. Environmental factors that contribute to falls include slippery surfaces, poorly maintained stair railings, unstable furniture, low beds and toilets, and poor lighting conditions.

According to the WHO (World Health Organization), falls are recognized as one of the four major health concerns in old age and can lead to severe consequences such as fractures, head injuries, and post-fall anxiety. These consequences can restrict mobility, increase the need for care, and shorten life expectancy.[9,10] Among the elderly population, falls represent a major public health challenge, ranking high among the causes of illness and death. Globally, the majority of fatalities related to falls—over 80%—are reported from low- and middle-income regions, with estimates suggesting around 684,000 deaths each year.[11]

The first step in fall prevention is identifying individuals at risk.[12] To mitigate this risk, the American Geriatrics Society underlines the necessity of routine fall-risk assessments in older individuals.[13] In Türkiye, vestibular screenings are included in home care and patient care services, and protocols exist for family health centers. However, these screening programs are not sufficiently implemented across the country.[14]

This study seeks to examine how aging influences the fear of falling and susceptibility to falls, while also exploring the connection between elevated fall risk and balance performance in older individuals. Additionally, it aims to enhance public awareness and highlight the critical role of vestibular assessments and early preventive strategies in reducing fall incidents.

MATERIAL and METHODS

This study received ethical approval from Ankara Yıldırım Beyazıt University Ethics Committee with the decision number 08/927. Prior to data collection, each participant provided written informed consent confirming their voluntary participation. Additional approval was obtained from the Yozgat Provincial Health Directorate. Some data were collected from Yozgat Province, while the rest were gathered from volunteer participants in another region.

Participants

This study was conducted with volunteer participants at Yozgat. 1 Family Health Center. A total of 75 individuals were selected through a convenience sampling. The participants were aged 45 years or older, reported no vestibular complaints, and did not have any physical, walking, or visual impairments. Participants were categorized into three distinct age brackets: 45-54 years (Group 1), 55-64 years (Group 2), and 65 years and above (Group 3). There was no

gender-based selection criterion, and all tests and scales were administered individually by trained audiologists.

Research Protocol

After obtaining informed consent from all participants, demographic data and general health history information were collected. To assess participants' fear of falling, fall risk, and balance abilities, surveys and tests were administered following a informational session. The tests evaluated dynamic balance (Functional Reach Test, Timed Up and Go Test, and Berg Balance Scale) and static balance (Modified Romberg Test and One-Leg Stance Test), while the survey measured fear of falling levels (Falls Efficacy Scale- International).

Assessment Tools

FES-I (Falls Efficacy Scale-International)

The FES-I was developed between 2003 and 2006 by Chris Todd, Gertrudis Kempen, and Lucy Yardley as part of the ProFaNE (Prevention of Falls Network Europe) project.[15] This scale was used to evaluate individuals' fear of falling in daily life. This assessment tool, consisting of 16 questions, each scored from 1 to 4, divides individuals into three groups: those with low (16-19), moderate (20-27) and high (28-64) levels of concern regarding the fear of falling.

BBS (Berg Balance Scale)

The BBS was developed in 1989 to assess balance in older adults.[16] This scale is commonly used to assess fall risk and evaluate postural control. It consists of 14 items, each scored between 0 (unable to perform) and 4 (performs independently and safely) based on the individual's ability to complete the activity. Total scores obtained from the scale are divided into three levels in terms of fall risk: 0-20 indicates serious risk, 21-40 indicates moderate risk, and 41-56 indicates low risk.

Modified Romberg Test

Although the Romberg Test takes its name from the 19th century neurologist Moritz Romberg, this assessment method was first described by Marshall Hall, Romberg and Bernardus Brach.[17] It is used to assess individuals' standing balance. The test was conducted on a soft surface, where participants were asked to stand with arms crossed and eyes closed for one minute. If the participant exhibited swaying or a tendency to fall, the test result was recorded as positive. If the participant maintained stability, the result was recorded as negative.

OLST (One-Leg Stance Test)

This test was used to assess static balance. During the balance assessment, participants were asked to bend one leg at 90 degrees and remain stationary on the other leg for 30 seconds. Five measurements were taken for each leg, and the average of these measurements was used in the analyses. A duration of less than 30 seconds was considered abnormal.

FRT (Functional Reach Test)

The FRT was conducted to assess dynamic balance. Participants were instructed to stand in an upright position with one arm extended at 90-degree flexion and a clenched fist, positioned close to but not touching a wall. They were then asked to reach forward as far as possible. The distance between the starting and ending points was measured using a tape measure. The application was carried out in three repetitions, and the arithmetic mean of the values obtained from each trial was recorded. A reach distance of ≤15 cm was classified as a high risk of falling, while a reach distance between 15-25 cm was considered a moderate risk of falling.

TUG (Timed Up and Go Test)

TUG test was used to assess dynamic balance. A 3-meter target was marked from the participant's seated position. During the test, participants were asked to get up from their chair, walk a specified distance, change direction, return, and sit back down in the starting position. The test was repeated three times, and the time taken for each trial was recorded. The average of the three trials was then calculated. Participants who took ≥14 seconds to complete the test were classified as at high risk of falling.

Statistical Analysis

All statistical analyses were conducted using SPSS version 22.0. The distribution of continuous variables was evaluated through the Shapiro-Wilk test. Variables with normal distribution were expressed as mean ± standard deviation, while non-normally distributed data were presented as median and interquartile range

(IQR). Categorical variables were reported as frequencies and percentages. Depending on data distribution, appropriate parametric or non-parametric tests (Mann-Whitney U, Kruskal-Wallis) were applied for group comparisons. Spearman's correlation test was used to assess associations between variables. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 75 participants were included in the study and divided into three age groups: 45-54, 55-64, and 65 years and above. The primary aim was to investigate the impact of aging on fall risk and the fear of falling. Group 1 consisted of 13 women and 11 men, with a mean age of 50.42 ± 2.21 years. Group 2 included 17 women and 8 men, with an average age of 60.20 ± 3.03 years. Group 3 was composed of 14 women and 12 men, and their mean age was calculated as 71.31 ± 4.45 years. The age distribution of the groups is shown in Table 1.

When test results were compared among age groups, no significant difference was found in FES-I scores ($p > 0.05$).

In terms of BBS scores, a significant difference was found between Group 1 and Group 2 ($Z = 2.351$; $p = 0.019$). This result likely reflects the differences in interquartile ranges (Group 1: IQR = 0, Group 2: IQR = 5), as both groups had the same median. A significant difference was also observed between Group 1 and Group 3 ($Z = 2.866$; $p = 0.004$), whereas comparisons between the other groups showed no statistically significant results ($p > 0.05$).

For the FRT, no significant difference was found among age groups ($p > 0.05$).

For the TUG test, statistically significant differences emerged between Group 1 and Group 2 ($Z = 2.173$; $p = 0.030$), and between Group 1 and Group 3 ($Z = 2.193$; $p = 0.028$). No meaningful differences were detected across other age groups ($p > 0.05$).

The OLST did not yield any statistically significant results across the age categories ($p > 0.05$).

The Modified Romberg Test showed significant group differences between Groups 2 and 3 ($p = 0.023$), and between Groups 1 and 3 ($p = 0.046$). See Table 2 for descriptive statistics and comparison of tests by age groups.

When the test results were evaluated in terms of gender, it was observed that the median FES-I score was higher in women than in men. This difference was found to be statistically significant ($Z = 4.397$; $p < 0.001$). On the other hand, men had higher median scores on the BBS, and this difference was also statistically significant ($Z = 3.933$; $p < 0.001$). Similarly, the median FRT score was greater in men, and the difference reached statistical significance ($Z = 3.128$; $p = 0.002$).

In contrast to other findings, the results of the OLST did not reveal any statistically significant difference between male and female participants ($Z = 0.663$; $p = 0.507$). A similar outcome was obtained for the TUG test, with no gender-related difference detected ($Z = 0.632$; $p = 0.527$). Likewise, the Modified Romberg Test showed no meaningful variation between genders ($p = 0.072$). Descriptive statistics and comparison of surveys and tests by gender are shown in Table 3.

A weak negative correlation was identified between BBS and FES-I scores ($\pi = -0.235$; $p = 0.042$). No statistically significant correlation emerged between BBS and OLST ($\pi = 0.158$; $p = 0.176$). Similarly, a weak inverse relationship was noted between BBS and TUG scores ($\pi = -0.356$; $p = 0.002$). In contrast, a strong positive association was found between BBS and FRT scores ($\pi = 0.627$; $p < 0.001$). Regarding the FES-I, no meaningful correlation was found with OLST ($\pi = 0.054$; $p = 0.642$). However, a weak positive relationship was observed with TUG ($\pi = 0.242$; $p = 0.037$), while no significant association was found with FRT ($\pi = 0.186$; $p = 0.109$). Additionally, no correlation was identified between OLST and either TUG ($\pi = 0.069$; $p = 0.556$) or FRT ($\pi = 0.090$; $p = 0.441$). Lastly, a weak negative correlation was detected between TUG and FRT scores ($\pi = 0.296$; $p = 0.010$). Inter-Test Correlation analysis is shown in Table 4.

Table 1: Descriptive Statistics of Age Groups

		G1	G2	G3
Age (years)	Mean ± SD	50.42 ± 2.21	60.20 ± 3.03	71.31 ± 4.45
	(Min- Maks)	(45-54)	(55-64)	(65-82)
Gender	Female (n=44)	13(54,2%)[a]	17 (68%)[a]	14 (53,8%)[a]
	Male (n=31)	11(45,8%)[a]	8(32%)[a]	12(46,2%)[a]

Note: [a]= Frequency (Percentage) G1: 45-54 age G2: 55-64 age G3: 65+ age

Table 2: Descriptive Statistics and Comparison of Tests by Age Groups

TESTS	**G1**	**G2**	**G3**	**(G1-G2)**	**(G2-G3)**	**(G1-G3)**
	n=24	**n=25**	**n=26**	**p**	**p**	**p**
FES-I	19(7)[b]	19(8)[b]	18.5(11)[b]	0.888*	0.812*	0.624*
BBS	56(0)[b]	56(5)[b]	53.5(6)[b]	**0.019***	0.284*	**0.004***
FRT	30(8)[b]	29.24±5.50[a]	26.92±5.86[a]	0.920*	0.152**	0.096*
TUG	8(3)[b]	9.24±1.99[a]	9(4)[b]	**0.030***	0.797*	**0.028***
OLST	30(0)[b]	30(0)[b]	30(0)[b]	0.580*	0.564*	0.977*
MR						
Positive	4(16,7%)[c]	5(20%)[c]	0(0%)[c]	0.763***	**0.023*****	**0.046*****
Negative	20(83.3%)[c]	20(80%)[c]	26(100%)[c]			

Note: p < 0.05 was considered significant.FES-I: International Falls Efficacy Scale BBS: Berg Balance Scale FRT: Functional Reach Test TUG:Timed Up and Go Test OLST: One-Leg Stance Test MR: Modified Romberg [a] = Mean ± standard deviation [b] = Median (IQR) [c]=Frequency (Percentage) *= Mann-Whitney U test ** = Independent Samples t-Test *** = Chi-Square Test G1: 45-54 age G2: 55-64 age G3: 65+ age

Table 3: Descriptive Statistics and Comparison of Surveys and Tests by Gender

TESTS	FEMALE n:44	MALE n=31	p
FES-I	21.5(12)[b]	17(3)[b]	**p < 0.001**[*]
BBS	51(6)[b]	56(0)[b]	**p < 0.001**[*]
FRT	26.5(11)[b]	31.19±3.58[a]	**0.002**[*]
TUG	9(2)[b]	8(3)[b]	0.527[*]
OLST	30(0)[b]	30(0)[b]	0.507[*]
MR			
Positive	8(18,2%)[c]	1(3,2%)[c]	0.072[**]
Negative	36(81,8%)[c]	30(96,8%)[c]	

Note: p < 0.05 was considered significant.FES-I: International Falls Efficacy Scale BBS: Berg Balance Scale FRT: Functional Reach Test TUG: Timed Up and Go Test OLST: One- Leg Stance Test MR: Modified Romberg [a]= Mean ± standard deviation [b] = Median (IQR) [c] = Frequency (Percentage) *= Mann-Whitney U test **= Chi-Square Test

Table 4: Correlation Analysis Between Tests

TESTS	FES-I	BBS	FRT	TUG	OLST
FES-I	ρ = 1	**ρ =- 0.235**	ρ = 0.186	**ρ = 0.242**	ρ= 0.054
		p= 0.042	p= 0.109	**p= 0.037**	p= 0.642
BBS	**ρ=- 0.235**	ρ = 1	**ρ = 0.627**	**ρ =- 0.356**	ρ= 0.158
	p= 0.042		**p < 0.001**	**p= 0.002**	p= 0.176
FRT	ρ = 0.186	**ρ = 0.627**	ρ = 1	**ρ =- 0.296**	ρ= 0.090
	p= 0.109	**p < 0.001**		**p= 0.010**	p= 0.441
TUG	**ρ = 0.242**	**ρ =- 0.356**	**ρ =- 0.296**	ρ = 1	ρ= 0.069
	p= 0.037	**p= 0.002**	**p= 0.010**		p= 0.556
OLST	ρ = 0.054	ρ = 0.158	ρ = 0.090	ρ= 0.069	ρ = 1
	p= 0.642	p= 0.176	p= 0.441	p= 0.556	

Note: p <0.05 was considered significant. ρ =Spearman Correlation Test coefficient

DISCUSSION

With advancements in healthcare systems and technology, the global elderly population continues to increase each year. However, the physical and biological changes associated with aging can negatively affect individuals' quality of life and lead to significant health issues such as risk of falling. Preventing these adverse conditions not only enhances individuals' quality of life but also alleviates the burden on caregivers and reduces the economic strain on governments. The results obtained in this study reinforce the idea that age-related physiological and biological changes may increase the likelihood of falling. These findings highlight the importance of early screening for fall risk, particularly among older adults. In this context, the study examined how both age and gender influence balance ability, fall risk, and the fear of falling.

Field studies indicate that women report falling and fall-related injuries more frequently than men. Gender differences in balance maintenance and recovery are attributed to variations in muscle strength and contraction speed.[18] Additionally, differences in muscle strength, bone density, anatomical structure (hip angle), hormonal changes, and joint flexibility are known to influence risk of falling. The higher levels of physical activity and muscle strength in men may contribute to these differences.[19] Loss of muscle strength, a key factor in risk of falling, is observed more frequently in aging women.[20]

In our study, men obtained higher scores in dynamic balance tests such as the BBS and FRT, indicating better balance. We believe this result is linked to men's better physical and physiological attributes, as well as their greater body awareness and lower fear of falling, as suggested in previous research. Studies have shown that women exhibit higher levels of fear of falling and greater prevalence of fall-related anxiety.[9,21]

Consistent with the literature, our findings indicate that women had a higher fear of falling. The presence of multiple risk factors affecting women, their lower body awareness, and the greater responsibilities and anxieties they face in daily life may contribute to their increased fear of falling.

With advancing age, structural and functional impairments occur in most physiological systems, even without the presence of a specific diagnosed medical condition.[22] These changes associated with aging affect multiple tissues, organs, systems, and functions in a cumulative manner, potentially compromising the physical independence of older individuals. Notably, aging-related alterations in cardiovascular function and skeletal muscles play a major role in affecting physical fitness.[23] As a result, the loss of strength, mobility, and balance associated with aging can limit the amount of energy elderly individuals expend during daily activities.[24] These physiological changes negatively affect physical activity levels, leading to a decline in overall functional performance.

In this context, the impact of age-related physiological changes on physical performance was also evident in our study, particularly in the results of the TUG and BBS. Significant differences were observed among age groups, with lower performance in older groups, which can be attributed to slower muscle reflexes and increased reaction times due to aging.

However, some studies suggest that age-related physiological changes may not always be reliable indicators of balance performance and risk of falling.[25] Similarly, a study by Goldberg et al. found no significant effect of aging on balance performance in the Modified Romberg, FRT, and OLST.[26] This suggests that the impact of aging on balance may vary depending on different populations or individual characteristics.

The analysis conducted in this research revealed a notable association between the TUG and FRT tests, indicating that both tests share common components in evaluating dynamic balance and functional mobility.

Significant correlations were found between the BBS and the FES-I, TUG, and FRT tests. The correlation between BBS and FES-I suggests that fear of falling is linked to objective balance performance. The finding that

individuals with higher fear of falling had lower BBS scores implies that those at higher risk of falling may avoid daily activities, further reducing their physical capacity.

The correlations between BBS, TUG, and FRT further support the interconnection between balance control and functional mobility. Lower BBS scores were associated with longer TUG times and shorter FRT distances, indicating an increased risk of falling and reduced functional independence. These findings suggest that different tests complement each other in assessing balance and risk of falling and that combining multiple assessments in clinical decision-making can provide more comprehensive evaluations. Specifically, for older adults and high-risk populations, integrating physical performance tests and self-reported scales may offer a more holistic approach.

In this regard, the USPSTF (U.S. Preventive Services Task Force) recommends interventions for reducing fall-related risk in the elderly population, including balance training exercises, environmental hazard modifications, and medication adjustments.[27] Among single-factor interventions, exercise and physical therapy programs—particularly balance training—have been found effective in risk of falling reduction. Additionally, home safety assessments have been shown to reduce risk of falling by 20%, particularly among individuals with a history of falls.[28]

Moreover, discontinuing psychotropic medications can reduce risk of falling by 66%, although high relapse rates require careful management.[29] On the other hand, while hip protectors are known to prevent hip fractures, their low adherence rates and potential discomfort limit their practicality.[30]

Overall, these findings highlight the need for a multidimensional approach to fall prevention in older adults.

These vestibular screenings, which are easy to apply and can be completed in a short time, can make a significant contribution to preventive healthcare services by enabling the early detection of potential falls, particularly in older individuals at risk. Therefore, in order to preserve the quality of daily life in the elderly and to minimize the risk of falls, the widespread implementation of comprehensive and regular assessment programs is essential. In this context, engaging in regular exercise, supporting bone health, ensuring a safe home environment, enhancing sensory support, and providing regular health check-ups should be integrated into a multidisciplinary approach to effectively reduce risk of falling and improve overall well-being in elderly.

CONCLUSION

This study comprehensively evaluated the effects of aging on balance performance, fear of falling, and risk of falling using various balance assessment tests. Findings from BBS, TUG, and Modified Romberg indicate a significant decline in balance performance with aging, which may negatively impact the quality of life of older individuals. This age-related decline in balance performance can increase risk of falling and potentially limit independent living.

Additionally, gender was found to be a significant factor, as results from FRT and BBS suggest that men demonstrate better physical balance performance, whereas women exhibit a higher fear of falling compared to men.

These findings highlight the importance of early detection of age-related balance disorders to help preserve the quality of life in the elderly. Therefore, conducting regular vestibular screenings could aid in the early identification of at-risk groups. Furthermore, implementing balance-strengthening exercises at an early stage could reduce risk of falling, alleviate fear of falling, and ultimately enhance individuals" overall well-being.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Acknowledgments

We sincerely thank Yozgat No. 1 Family Health Center and Dr. Metin Sami Işık from Unit No. 4 for their valuable contributions to this study.

Authorship Contributions

All authors contributed equally to the conception, design, data collection, analysis, and writing of this study.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflict of Interest Statement

The authors declare that there is no conflict of interest regarding the publication of this article.

Ethics Statement

Ethical approval for this study was obtained from the Ankara Yıldırım Beyazıt University Ethics Committee with decision number 08/927. Written informed consent was obtained from all participants prior to data collection. Additionally, permission was granted by the Yozgat Provincial Health Directorate to conduct the study.

REFERENCES

1. Koldaş, Z.L.: What is aging and cardiovascular aging? Arch Turk Soc Cardiol. (2017). https://doi.org/10.5543/tkda.2017.40350
2. Van Impe, A., Coxon, J.P., Goble, D.J., Wenderoth, N., Swinnen, S.P.: Ipsilateral coordination at preferred rate: Effects of age, body side and task complexity. NeuroImage. 47, 1854-1862 (2009). https://doi.org/10.1016/j.neuroimage.2009.06.027
3. Lord, S.R., Menz, H.B.: Visual contributions to postural stability in older adults. Gerontology. 46, 306-310 (2000). https://doi.org/10.1159/000022182
4. Sturnieks, D.L., St George, R., Lord, S.R.: Balance disorders in the elderly. Neurophysiol Clin. 38, 467-478 (2008). https://doi.org/10.1016/j.neucli.2008.09.001
5. Van Impe, A., Coxon, J.P., Goble, D.J., Wenderoth, N., Swinnen, S.P.: Ipsilateral coordination at preferred rate: effects of age, body side and task complexity. Neuroimage. 47, 1854-1862 (2009). https://doi.org/10.1016/j.neuroimage.2009.06.027
6. Kristinsdottir, E.K., Fransson, P.A., Magnusson, M.: Changes in postural control in healthy elderly subjects are related to vibration sensation, vision and vestibular asymmetry. Acta Otolaryngol. 121, 700-706 (2001). https://doi.org/10.1080/00016480152583647
7. Park, J.J., Tang, Y., Lopez, I., Ishiyama, A.: Age-related change in the number of neurons in the human vestibular ganglion. J Comp Neurol. 431, 437-443 (2001). https://doi.org/10.1002/1096-9861(20010319)431:4<437::aid-cne1081>3.0.co;2-p
8. Jacobson, G.P., McCaslin, D.L., Liu, B., Zhang, H.: [Contemporary issues in the recording of vestibular evoked myogenic potentials]. Lin Chuang Er Bi Yan Hou Tou Jing Wai Ke Za Zhi. 30, 1827-1833 (2016). https://doi.org/10.13201/j.issn.1001-1781.2016.23.001
9. Caner, Ş., Avcı, İ.A.: YAŞLILARDA DÜŞME RİSKİ, KORKUSU VE DÜŞME DAVRANIŞLARI İLE DÜŞMEYE YÖNELİK EVDE BAKIM GEREKSİNİMLERİNİN İNCELENMESİ. JSHS. 7, 193-208 (2022). https://doi.org/10.47115/jshs.1036750
10. WHO global report on falls prevention in older age, https://www.who.int/publications/i/item/9789241563536
11. Falls, https://www.who.int/news-room/fact-sheets/detail/falls
12. US Preventive Services Task Force, Grossman, D.C., Curry, S.J., Owens, D.K., Barry, M.J., Caughey, A.B., Davidson, K.W., Doubeni, C.A., Epling, J.W., Kemper, A.R., Krist, A.H., Kubik, M., Landefeld, S., Mangione, C.M., Pignone, M., Silverstein, M., Simon, M.A., Tseng, C.-W.: Interventions to Prevent Falls in Community-Dwelling Older Adults: US Preventive Services Task Force Recommendation Statement. JAMA. 319, 1696-1704 (2018). https://doi.org/10.1001/jama.2018.3097
13. Panel on Prevention of Falls in Older Persons, American Geriatrics Society and British Geriatrics Society: Summary of the Updated American Geriatrics Society/British Geriatrics Society clinical practice guideline for prevention of falls in older persons. J Am Geriatr Soc. 59, 148-157 (2011). https://doi.org/10.1111/j.1532-5415.2010.03234.x
14. Kayacık, S.N., Selek, F.Z.G.: Yaşlanma Sürecinde İşitme ve Vestibüler Taramalar. GBD. 6, 132-141 (2023). https://doi.org/10.47141/geriatrik.1223326
15. FES-I, https://sites.manchester.ac.uk/fes-i/
16. Berg, K.: Measuring balance in the elderly: preliminary development of an instrument. Physiotherapy Canada. 41, 304-311 (1989). https://doi.org/10.3138/ptc.41.6.304
17. Berge, J.E., Goplen, F.K., Aarstad, H.J., Storhaug, T.A., Nordahl, S.H.G.: The Romberg sign, unilateral vestibulopathy, cerebrovascular risk factors, and long-term mortality in dizzy patients. Front Neurol. 13, 945764 (2022). https://doi.org/10.3389/fneur.2022.945764
18. Garber, C.E., Blissmer, B., Deschenes, M.R., Franklin, B.A., Lamonte, M.J., Lee, I.-M., Nieman, D.C., Swain, D.P., American College of Sports Medicine: American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. Med Sci Sports Exerc. 43, 1334-1359 (2011). https://doi.org/10.1249/MSS.0b013e318213fefb
19. Duck, A.A., Stewart, M.W., Robinson, J.C.: Physical activity and postural balance in rural community dwelling older adults. Applied Nursing Research. 48, 1-7 (2019). https://doi.org/10.1016/j.apnr.2019.05.012
20. Schultz, A.B., Ashton-Miller, J.A., Alexander, N.B.: What leads to age and gender differences in balance maintenance and recovery? Muscle Nerve Suppl. 5, S60-64 (1997)
21. Tuna, H., Gürpınar, B., Şahin, C.D., Kaşlı, K., İlçin, N., Kartal, İ., Ulusoy, A., Topçu, B.: Toplumda yaşayan

yaşlılarda algılanan ve ölçülen düşme riskinin belirteçleri. JETR. 8, 73-81 (2021)

22. Hayashi, D., Gonçalves, C.G., Parreira, R.B., Fernandes, K.B.P., Teixeira, D.C., Silva, R.A., Probst, V.S.: Postural balance and physical activity in daily life (PADL) in physically independent older adults with different levels of aerobic exercise capacity. Arch Gerontol Geriatr. 55, 480-485 (2012). https://doi.org/10.1016/j.archger.2012.04.009
23. Chodzko-Zajko, W.J., Proctor, D.N., Fiatarone Singh, M.A., Minson, C.T., Nigg, C.R., Salem, G.J., Skinner, J.S.: Exercise and Physical Activity for Older Adults. Medicine & Science in Sports & Exercise. 41, 1510 (2009). https://doi.org/10.1249/MSS.0b013e3181a0c95c
24. Taylor, L.M., Maddison, R., Pfaeffli, L.A., Rawstorn, J.C., Gant, N., Kerse, N.M.: Activity and energy expenditure in older people playing active video games. Arch Phys Med Rehabil. 93, 2281-2286 (2012). https://doi.org/10.1016/j.apmr.2012.03.034
25. Kozinc, Z., Löfler, S., Hofer, C., Carraro, U., Sarabon, N.: Diagnostic Balance Tests for Assessing Risk of Falls and Distinguishing Older Adult Fallers and Non-Fallers: A Systematic Review with Meta-Analysis. Diagnostics. 10, 667 (2020). https://doi.org/10.3390/diagnostics10090667
26. Goldberg, A., Casby, A., Wasielewski, M.: Minimum detectable change for single-leg-stance-time in older adults. Gait & Posture. 33, 737-739 (2011). https://doi.org/10.1016/j.gaitpost.2011.02.020
27. Rao, S.S.: Prevention of Falls in Older Patients. afp. 72, 81-88 (2005)
28. Gillespie, L.D., Gillespie, W.J., Robertson, M.C., Lamb, S.E., Cumming, R.G., Rowe, B.H.: Interventions for preventing falls in elderly people. Cochrane Database Syst Rev. CD000340 (2003). https://doi.org/10.1002/14651858.CD000340
29. Campbell, A.J., Robertson, M.C., Gardner, M.M., Norton, R.N., Buchner, D.M.: Psychotropic medication withdrawal and a home-based exercise program to prevent falls: a randomized, controlled trial. J Am Geriatr Soc. 47, 850-853 (1999). https://doi.org/10.1111/j.1532-5415.1999.tb03843.x
30. Parker, M.J., Gillespie, L.D., Gillespie, W.J.: Hip protectors for preventing hip fractures in the elderly. Cochrane Database Syst Rev. CD001255 (2003). https://doi.org/10.1002/14651858.CD001255