

Relationship between the type of visual impairment and balance among adults in Jakarta, Indonesia: a cross-sectional study

DOI: <https://doi.org/10.5114/pq/209431>

Raden Galuh Gurmadi Gandawidura^{ID}, Yumi Ikeda^{ID}

Graduate School of Human Health Sciences, Department of Physical Therapy, Tokyo Metropolitan University, Japan

Abstract

Introduction. This study aimed to examine the relationship between the type of visual impairment (TOVI) and balance in individuals with visual impairment, using the Berg Balance Scale (BBS).

Methods. This cross-sectional study included 63 participants. Participants completed a questionnaire to collect demographic information and determine the type of visual impairment (TOVI). Inclusion criteria were individuals diagnosed with low vision or blindness, having no neuromuscular disorders, and willing to participate. Participants completed a questionnaire to collect demographic data and determine TOVI (low vision or blindness), followed by a balance assessment using the Berg Balance Scale (BBS). Statistical comparisons were conducted to examine the relationship between TOVI and BBS scores, including other variables such as sex, age, onset of VI, and history of falls (HOF).

Results. Significant associations were found between TOVI and age ($p = 0.017$), HOF ($p < 0.001$), and injury due to falls ($p = 0.003$). Individuals with blindness had significantly lower BBS scores than those with low vision ($p < 0.001$). Among the 34 participants with HOF, 23 were blind, indicating a notably higher incidence of falls. Regression analysis showed a moderate correlation between TOVI and BBS scores ($r = 0.503$, $p < 0.001$), suggesting that a greater severity of VI was associated with reduced balance.

Conclusions. These findings suggest a moderate correlation between visual impairment and balance. Therefore, individuals with visual impairment should be mindful of their balance abilities during daily activities to minimise the risk of falls.

Key words: balance, blindness, falls, low vision, vision disorders

Introduction

Maintaining postural control and balance is essential for performing daily activities, as it helps ensure that the body's centre of gravity remains within its base of support, thereby minimising the risk of both intentional and unintentional falls [1]. The process of maintaining balance is multifaceted and relies on components such as vision, vestibular function, and somatosensory perception, including proprioception, as well as muscle and joint perception [2]. Postural control is the natural ability of the body to achieve and sustain balance during physical activities. Improving balance is essential as it greatly reduces the risk of falls, significantly lowering the chances of disability and mortality.

The visual system plays a crucial role in interpreting spatial positioning and coordinating movements. When visual function is impaired, it disrupts these processes and leads to challenges in maintaining both static and dynamic postural stability [3,4]. Individuals with VI may face challenges in posture regulation, spatial navigation, and reaction timing [5,6]. These issues may not be fully compensated by the remaining sensory modalities, particularly in those with severe or complete vision loss.

Numerous studies have investigated balance in adults with VIs, consistently showing that these individuals have lower dynamic balance scores [7]. Maintaining good balance in adulthood is crucial for daily activities; poor balance can affect various aspects of life, such as the risk of falls and the ability to socialise during daily activities. Reduced information processing in the central nervous system and delayed muscular responses can lead to balance loss in various scenarios

[8]. Falls caused by a loss of balance are not only a common issue but are also significantly associated with higher death rates and increased hospitalisation needs [9].

The complex interaction between the visual and somatosensory systems is crucial for maintaining body stability and spatial orientation. Visual input provides essential information for accurate body positioning, movement precision, motor response timing, and balance control [10]. Addressing deficits in these sensory systems is vital not only for improving balance and reducing fall risk but also for enhancing quality of life in individuals with VI. However, the loss of vision cannot be fully compensated by experiential learning alone. Consequently, individuals with VI face a higher risk of injuries, including falls and accidents. Older adults with self-reported VI have a >25% higher prevalence of recurrent falls compared to those with normal vision. Moreover, poor vision is associated with a fear of falling, which often results in activity restriction [11]. People with VI often struggle to maintain static and dynamic balance without sufficient visual cues and may require compensatory strategies to improve their stability.

Therefore, VI is not merely a medical condition but also a pressing social and public health issue. It can impair one's ability to recognise hazards, leading to decreased confidence and independence, lower subjective well-being, and restricted social interactions. Furthermore, VI is associated with an increased history and incidence of falls. Despite global evidence, limited research has addressed how specific severities of VI, such as low vision versus blindness, affect balance outcomes in adult populations, especially within the Indonesian context. A study by Rif'Ati et al. [12] revealed that approximately 72% of the Indonesian population experienced some form of VI, with a 3.0% prevalence of blindness, which is the highest in

Correspondence address: Raden Galuh Gurmadi Gandawidura, Tokyo Metropolitan University, 7-2-10 Higashi-Ogu, Arakawa-ku, Tokyo, Japan, e-mail: galuhgurmadi31@gmail.com; <https://orcid.org/0009-0008-7649-5472>

Received: 13.05.2025

Accepted: 12.08.2025

Citation: Gandawidura RGG, Ikeda Y. Relationship between the type of visual impairment and balance among adults in Jakarta, Indonesia: a cross-sectional study. *Physiother Quart.* 2026;34(2):46–51; <https://doi.org/10.5114/pq/209431>.

the Southeast Asia region. VI refers to various visual conditions, generally categorised as low vision or blindness [13].

Low vision is defined as visual acuity of $< 6/12$ but $\geq 3/60$ in the better eye, even with the best correction. In this context, 6/12 signifies that an individual can perceive at 6 m what a person with standard vision can discern at 12 m, suggesting a modest impairment in visual acuity. Visual acuity of 3/60 indicates that an individual can perceive at 3 m what a person with normal vision can perceive at 60 m, signifying a considerably worse impairment. Therefore, blindness is defined as a visual acuity $< 3/60$ or corresponding visual field loss in the eye despite the best possible correction [14]. This study aimed to assess the association between the type of VI (low vision and blindness) and balance performance in Indonesian adults with VI, as well as the link between VI severity and history of falls.

Subjects and methods

Study population

This was a cross-sectional study conducted in Jakarta, Indonesia, focused on adults with VI. The inclusion criteria for this study were individuals with VI (low vision and blindness) based on responses to a structured questionnaire, aged between 17 and 59 years, possessing a healthy neuromuscular system, and willing to participate. Exclusion criteria encompassed individuals with musculoskeletal problems, mental disorders, or communication disorders.

In this study, VI was classified based on functional visual acuity, in accordance with the World Health Organization's definition: low vision (visual acuity $< 6/12$ but $\geq 3/60$) and blindness (visual acuity $< 3/60$ or severe visual field loss) [15], regardless of the underlying clinical etiology. Specific causes such as refractive errors, diabetic retinopathy, or corneal opacities were not used as classification criteria. This approach allowed the study to focus on the severity of visual limitations as a determinant of balance function, rather than the specific medical diagnoses.

The study targeted an age range of 17–59 years for specific reasons. First, the Indonesian Ministry of Health defined productive age as 15–59 years. Second, while the existing literature on falls primarily focuses on older populations, this study aims to expand the current knowledge by investigating the correlation between VI and the risk of falls in adults. The Mitra Netra Foundation (MNF) provided data on 134 potential participants, and purposive sampling was used to recruit 63 participants who met the inclusion criteria and agreed to participate.

The study sample accurately represented the target population. To minimise the sample size, the G*power software package was utilised with specific parameters: statistical power $(1-\beta) = 0.90$, significance level $(\alpha) = 0.05$, and a medium effect size $= 0.3$ [16]. This study used cross-sectional analysis to assess the correlation between balance and postural control, the TOVI, and the HOF among adult individuals with VI in Jakarta, Indonesia.

Data collection

The study employed a quantitative survey design to assess balance and postural control in a specific population. Before data collection, the survey was tested for face and content validity. The survey comprised two parts. The first part involved a questionnaire that collected information on the TOVI and personal demographic factors such as age, sex,

onset of VI, challenges with daily activities, independence in daily tasks, HOF, and injuries resulting from falls. The second part involved assessing static and dynamic balance using the Berg Balance Scale (BBS). The BBS is a widely used assessment tool that measures both static and dynamic balance across all age groups. It comprises 14 tasks that evaluate functional activities related to balance and postural control. The BBS has demonstrated high inter-rater and intra-rater reliability and has proven particularly effective in assessing balance among individuals with VI [17–21]. HOF was defined by incidents of falling within the past year experienced by individuals who are visually impaired.

Procedure

A detailed letter containing comprehensive information about the study was sent to 63 participants who met specific requirements. They actively completed formal documentation to indicate their voluntary informed consent. A physiotherapist administered a questionnaire, which included questions assessing TOVI details (low vision and blindness), personal information, and the risk of falls, such as HOF in the past year, and challenges with daily activities. Subsequently, the participants underwent a balanced assessment using a physiotherapist-administered BBS.

To assess balance using the BBS, the physiotherapist requested the participants to perform specific movements as part of the test. The BBS (Berg Balance Scale) assesses functional activities related to balance and postural control. It includes tasks such as transitioning from sitting to standing, standing independently, sitting without support, moving from standing to sitting, maintaining a standing position with both feet unsupported, reaching forward with outstretched arms, picking up objects from the floor, executing a full 360° turn, counting the number of steps that contact a measuring tool, standing independently, and balancing on one leg. Each activity was scored on a scale of 0–4, with the highest achievable total score being 56. Blinding procedures were not implemented during the BBS assessments, as the physiotherapist administering the tests was also involved in the data collection.

Statistical analysis

The study employed the SPSS 28 statistical software for comprehensive data analysis. Initially, normality was assessed using the Shapiro–Wilk test, and homogeneity of variances was tested using Levene's test. Data met the assumptions for parametric testing (Shapiro–Wilk $p > 0.05$; Levene's $p = 0.076$). Second, the demographic characteristics (sex and age) were used to summarise the participants' characteristics. Age was categorised into three groups: 18–28, 29–39, and 40–59 years, to facilitate age-related comparisons and allow for categorical analyses. Visual conditions (TOVI, onset of VI, and activity challenges due to VI) and fall experiences (HOF and injuries due to falls) of the respondents were examined. This study also used an independent *t*-test to analyse BBS scores between groups, while the chi-square test was used to analyse the relationship between two categorical groups such as those based on the TOVI (1 = low vision, 2 = blindness), with sex, age, onset of VI, activity challenges, HOF, and injury due to fall.

Finally, a linear regression analysis was used to analyse the influence of the TOVI on balance. In the regression model, the BBS score was treated as the dependent variable, while the TOVI was the independent variable, as follows:

$$Y = \alpha + \beta X + e$$

where Y is a dependent variable; the BBS score, X, is an independent variable; the TOVI, α , is a constant; β is a coefficient regression of X; and e is an error.

Results

The results were organised into three sections: (A) identifying the characteristics of the TOVI and individual factors, (B) exploring balance and postural control in persons with VI, and (C) relationship between BBS and TOVI.

Overall characteristics of participants

This study examined the characteristics of adults with VI in Indonesia. Table 1 presents the sex distribution, age group, onset of VI, difficulties faced in daily activities, HOF, and injury due to falls. The study included 63 participants, with 33 (52.4%) individuals with low vision and 30 (47.6%) with blindness. Moreover, 71% of the participants encountered difficulties in daily activities due to VI, and 54% reported a history of falls (HOF) in the past year, of whom 68% sustained fall-related injuries.

Table 1 provides information about the relationship between participant characteristics and the TOVI (blindness and low vision). Significant differences were observed in age ($p < 0.017$), HOF ($p < 0.001$), and injury due to falls ($p < 0.003$), based on the TOVI. Notably, 80% of the participants aged

Table 1. Overall characteristics of participants and types of visual impairment

Characteristics	All [n (%)]	Low vision (n)	Blindness (n)	p-value
Sex				
male	39 (62)	20	19	0.824
female	24 (38)	13	11	
Age (years)				
18–28	27 (43)	19	8	0.017*
29–39	26 (41)	12	14	
40–59	10 (16)	2	8	
Onset				
since birth	41 (65)	21	20	0.081
not since birth	22 (35)	12	10	
Difficulty with activities				
yes	45 (71)	21	24	0.151
no	18 (29)	12	6	
History of falls (HOF) in 1 year				
yes	34 (54)	11	23	< 0.001*
no	29 (46)	22	7	
Injury due to fall				
yes	43 (68)	17	26	0.003*
no	20 (32)	16	4	

* statistically significant at p -value < 0.05

40–59 were classified as blind, suggesting a possible age-related trend in VI severity. The proportion of individuals with HOF was higher in the blind group (23 people) than in the low-vision group (11). Furthermore, 26 participants with blindness experienced injuries due to falls.

BBS scores and other factors in individuals with visual impairment

Table 2 illustrates the balance ability of individuals with VI. The average BBS score across all participants was 50.4 ± 3 out of a maximum score of 56, showing a significant difference in mean values based on the TOVI ($p < 0.001$). Furthermore, significant differences in balance scores were found according to the difficulty with activities of daily living ($p = 0.001$). Those experiencing difficulty with daily activities had a much lower balance score (mean = 49.7). Moreover, individuals with a history of at least one fall in the past year showed a significant difference score in balance ($p = 0.027$). Participants who experienced injuries from falls had significantly lower balance scores than those without injuries ($p = 0.007$), highlighting the functional consequences of impaired balance.

Table 2. BBS scores, demographics, and other participant characteristics

Characteristics	n	BBS score (mean \pm SD)	p-value
All individuals	63	50.4 \pm 3	
Sex			
male	39	50.8 \pm 3.1	0.235
female	24	49.9 \pm 2.9	
Age (years)			
18–28	27	51.0 \pm 3.1	0.809
29–39	26	50.1 \pm 3.0	
40–59	10	49.9 \pm 2.64	
Type of Visual Impairment (TOVI)			
blindness	33	48.8 \pm 3.1	< 0.001*
low vision	30	51.9 \pm 2.1	
Onset			
since birth	41	50.4 \pm 2.9	0.74
not since birth	22	50.6 \pm 3.2	
Difficulty with activities			
yes	45	49.7 \pm 3.1	< 0.001*
no	18	52.2 \pm 1.8	
History of falls in 1 year (HOF)			
yes	34	49.7 \pm 3.5	0.027*
no	29	51.3 \pm 2.1	
Injury due to fall			
yes	43	49.8 \pm 2.9	0.007*
no	20	51.9 \pm 2.7	

* statistically significant at p -value < 0.05

Table 3. Results of the relationship between BBS and TOVI

Model	Coefficients								
	R	R squared	unstandardised B	coefficients std. error	standardised coefficients beta	t	sig.	95% confidence interval for B	
								lower bound	upper bound
Constant			54.952	1.044		52.636	< 0.001	52.864	57.039
Type of visual impairment	0.503	0.253	-3.042	0.67	-0.503	-4.542	< 0.001	-4.382	-1.703

Relationship between BBS and TOVI

In this sub-analysis, a regression analysis was conducted to examine the relationship between the BBS balance score (dependent variable) and the TOVI (1 = low vision, 2 = blindness). The analysis revealed a moderate negative correlation of 0.503 (R squared of 25.3%) between the TOVI and balance, indicating that 25.3% of the variation in balance scores could be explained by the type of VI ($p < 0.001$). The regression equation was: $BBS\ score = 54.95 - 3.04 \times TOVI$ (Table 3). Descriptive analysis showed that the mean BBS score for the low vision group was 51.9 ± 2.1 , while the blindness group had a lower mean score of 48.8 ± 3.1 . This difference aligns with the regression result, indicating that individuals with blindness tend to score approximately 3 points lower on balance compared to those with low vision.

Discussion

This study aimed to assess the association between the type of VI (low vision vs blindness) and balance performance in Indonesian adults with VI, as well as the link between VI severity and fall history. The findings indicate that the severity of VI significantly impacts balance, with individuals who are blind demonstrating lower BBS scores compared to those with low vision. The regression analysis confirmed a moderate correlation ($r = 0.503$) between the type of VI and the balance score, which is consistent with previous research indicating that individuals with VI experience greater challenges in both static and dynamic postural control [22]. Although this 3.04-point difference in BBS scores was statistically significant, its clinical relevance must be interpreted cautiously, considering that the BBS has a maximum score of 56. This implies a relatively small difference in functional terms, and further studies should explore whether such variations meaningfully impact the fall risk in daily life.

Individuals with low vision tend to perform better in balance assessments than those who are blind, suggesting that lower visual acuity is associated with greater difficulty in maintaining functional balance [23]. This may be attributed to physiological and behavioural mechanisms: the absence of visual cues disrupts anticipatory and reactive postural adjustments, forcing greater reliance on the somatosensory and vestibular systems [10]. The absence of visual input can also contribute to spatial disorientation and reduced confidence, often resulting in a more cautious gait and diminished physical activity levels, which may further compromise balance over time. These patterns are consistent with previous studies, which indicate that the severity of VI is directly linked to impairments in both static and dynamic balance [24, 25]. The visual system, alongside the somatosensory and vestibular systems, plays a central role in maintaining postural control [26, 27]. In individuals with profound visual loss, especially those who are blind, the absence of visual feedback neces-

sitates a greater reliance on compensatory mechanisms, such as tactile and vestibular cues, to maintain equilibrium.

Age also emerged as a relevant factor. Participants in the 40–59 age group were disproportionately represented in the blindness category and had lower balance scores compared to younger participants. This pattern aligns with age-related declines in sensory integration and postural reflexes [28, 29], as well as with findings by Lee [17], who reported a strong link between reduced visual acuity and impaired balance. In Indonesia, the high prevalence of untreated or late-treated causes of blindness such as cataracts, glaucoma, and diabetic retinopathy among the working-age population may explain the higher rate of blindness in older adults [12].

A key finding of this study is the strong relationship between the type of VI and history of falls (HOF). Participants with blindness experienced significantly more falls (23) than those with low vision (11), which is consistent with studies highlighting the increased fall risk in individuals with greater VI severity [17]. Moreover, those who sustained fall-related injuries had significantly lower balance scores than those who did not ($p = 0.007$), underscoring the functional consequences of impaired postural control.

This elevated fall risk is supported by earlier research showing that individuals with VI are 1.7 times more likely to suffer falls and injuries compared to those with normal vision [30, 31], and that VI is associated with increased mortality risk [32–33]. The implications are profound, especially in settings where access to rehabilitation or fall-prevention services may be limited.

Individuals with VIs often face challenges with daily activities, which can substantially affect their overall well-being. For example, they may experience a loss of autonomy and freedom as a result of reduced visual input. In this study, 24 participants from the group with blindness experienced activity-related difficulties, whereas only six participants from the low vision group reported similar issues. A significant relationship was observed between difficulties in daily activities and balance performance. Although the study by Ramrattan et al. [34] focused on older adults, their findings support the idea that visual field loss is associated with limitations in daily functioning and autonomy, which may also extend to younger adult populations with VI. These findings have practical implications. From a clinical perspective, physiotherapists should incorporate balance training programs that utilise sensory substitution strategies (e.g., tactile or auditory feedback) tailored to individuals with different types of VI. Future research should investigate intervention efficacy in diverse cultural and healthcare contexts and consider longitudinal designs to assess changes over time.

Limitations

This study has certain limitations. First, the number of participants in the 40–59 age group was limited, with only 10 par-

ticipants, which is notably fewer than in the other age groups. Second, further studies, such as longitudinal studies, are necessary since cross-sectional studies cannot definitively establish causality in comparison to longitudinal studies. Moreover, a more in-depth analysis of the risk factors contributing to balance scores and fall risk among individuals with VI is essential. Third, the classification of visual participant status relies solely on questionnaires completed by the participants, without any additional objective visual tests conducted during the assessment study. Fourth, participants were recruited from a single foundation (Mitra Netra Foundation), which may introduce selection bias and limit the generalisability of the findings to the broader population with VI in Indonesia. Finally, researchers should evaluate muscle ability, particularly in the lower limbs, to assess its correlation with balance in individuals with VI.

Conclusions

This study examined the impact of different TOVIs (low vision and blindness) on balance and the risk of falls in individuals with VI. Our findings indicate that the severity of VI significantly influences balance, with individuals who are blind scoring substantially lower compared to those with low vision. Based on the existing literature, individuals with a BBS score ranging between 41 and 56 can walk independently [19], suggesting that the participants in this study could still perform activities on their own.

Besides balance impairments, individuals with visual impairment (VI) are also at an increased risk of falls [35]. In this study, the incidence of falls was significantly higher among those with blindness (23 cases) compared to individuals with low vision (11 cases). Repeated falls can elevate the likelihood of injuries ranging from mild to severe. Reduced visual capacity may also limit individuals' engagement in daily activities and diminish their confidence, resulting in decreased physical activity levels [36]. These findings highlight the urgent need for targeted research and interventions to prevent or mitigate the adverse effects of VI on balance and fall risk at both the individual and societal levels.

These findings highlight the urgent need for targeted interventions to prevent and manage balance deficits and fall risk in people with VI. Future research should investigate the longitudinal effects of visual deterioration on mobility, as well as the efficacy of balance interventions tailored to varying degrees of VI. Finally, examining the influence of environmental and psychosocial factors on fall risk could help inform more holistic prevention strategies.

In summary, individuals with VI face considerable challenges related to balance and fall risk, which in turn affect their independence and quality of life. It is essential that healthcare professionals, particularly physiotherapists, develop and implement evidence-based interventions to enhance balance and reduce fall-related injuries in this vulnerable population.

Acknowledgement

This study was supported by the Asian Human Resources Development Project for Medical Professionals during master's study.

Ethical approval

The research related to human use complied with all the relevant national regulations and institutional policies, followed the tenets of the Declaration of Helsinki, and was approved by the Ethics Committee of the Arakawa campus, Tokyo Metropolitan University, Japan (approval No.: 21071,

December 2021). This study was conducted in collaboration with the MNF in Jakarta, using data collected between January and March 2022.

Informed consent

Informed consent was obtained from all individuals included in this study.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

Funding

This research received no external funding.

References

- [1] Onofrei RR, Amaricai E. Postural balance in relation with vision and physical activity in healthy young adults. *Int J Environ Res Public Health*. 2022;19(9):5021; doi: 10.3390/ijerph19095021.
- [2] Shumway-Cook A, Woollacott MH. *Motor Control. Translating research into clinical practice*. 5th ed. Philadelphia: Wolters Kluwer Health; 2017.
- [3] Gandawidura RGG, Ikeda Y. Correlation analysis of balance and postural stability as a risk for falls in individuals with visual impairment. *Br J Vis Impair*. 2024;43(2) doi: 10.1177/02646196241226836.
- [4] Redfern MS, Yardley L, Bronstein AM. Visual influences on balance. *J Anxiety Disord*. 2001;15(1–2):81–94; doi: 10.1016/s0887-6185(00)00043-8.
- [5] Ardakani MK, Shalamzari MH, Mansori MH. Effect of core stability training on postural training on postural control, risk of falling, and function of the blind: a randomized controlled trial. *Balt J Health Phys Act*. 2020; 12(3):11–22; doi: 10.29359/BJHPA.12.3.02.
- [6] Fabre JM, Ellis R, Kosma M, Wood RH. Fall risk factors and a compendium of falls risk screening instruments. *J Geriatr Phys Ther*. 2010; 33(4):184–97; doi: 10.1097/JPT.0b013e3181ff2a24.
- [7] Urbaniak-Olejnik M, Loba W, Stieler O, Komar D, Majewska A, Marcinkowska-Gapińska A, Hojan-Jezińska D. Body balance analysis in the visually impaired individuals aged 18–24 years. *Int J Environ Res Public Health*. 2022;19(21):14383; doi: 10.3390/ijerph192114383.
- [8] Ivers RQ, Cumming RG, Mitchell P, Attebo K. Visual impairment and falls in older adults: The blue mountains eye study. *J Am Geriatr Soc*. 1998;46(1):58–64; doi: 10.1111/j.1532-5415.1998.tb01014.x.
- [9] Gashaw M, Janakiraman B, Minyihun A, Jember G, Sany K. Self-reported fall and associated factors among adult people with visual impairment in Gondar, Ethiopia: a cross-sectional study. *BMC Public Health*. 2020;20: 498; doi: 10.1186/s12889-020-08628-2.
- [10] Horak FB. Postural orientation and equilibrium: what do we need to know about neural control of balance to prevent falls?. *Age Ageing*. 2006;35(Suppl 2):ii7–11; doi: 10.1093/ageing/af1077. PMID: 16926210.
- [11] Ehrlich JR, Hassan SE, Stagg BC. Prevalence of falls and fall-related outcomes in older adults with self-reported vision impairment. *J Am Geriatr Soc*. 2019;67(2):239–45; doi: 10.1111/jgs.15628.
- [12] Rif'Ati L, Halim A, Lestari YD, Moeloek NF, Hans L. Blindness and visual impairment situation in Indonesia

- based on rapid assessment of avoidable blindness surveys in 15 provinces. *Ophthalmic Epidemiol.* 2021;28(5):408–19; doi: 10.1080/09286586.2020.1853178.
- [13] American Academy of Ophthalmology. Vision rehabilitation ICD-10 quick reference guide. San Francisco: AAO. Available from: <https://www.aao.org/Assets/101a334c-a338-454f-9bcc-b6a23f08d4a5/636410015228330000/bc-1903-vision-rehabilitation-icd10-guide-d-pdf?inline=1> (accessed 25.09.2024).
- [14] American Foundation for the Blind (AFB). Low vision and legal blindness: terms and descriptions. New York: AFB. Available from: <https://www.afb.org/blindness-and-low-vision/eye-conditions/low-vision-and-legal-blindness-terms-and-descriptions> (accessed 25.09.2024).
- [15] World Health Organization. World report on vision. 2019. Geneva: WHO. Available from: <https://www.who.int/publications/i/item/9789241516570> (accessed 25.08.2024).
- [16] Cohen J. *Statistical Power Analysis for the Behavioral Science*. New York: Lawrence Erlbaum; 1988.
- [17] Lee HK, Scudds RJ. Comparison of balance in older people with and without visual impairment. *Age Ageing.* 2003;32(6):643–49; doi: 10.1093/ageing/afg110.
- [18] Franjoine MR, Gunther JS, Taylor MJ. Pediatric balance scale: a modified version of the Berg Balance Scale for the school-age child with mild to moderate motor impairment. *Pediatr Phys Ther.* 2003;15(2):114–28; doi: 10.1097/01.PEP.0000068117.48023.18.
- [19] Dijkhuizen A, Krijnen WP, van der Schans CP, Waninge A. Validity of the modified Berg Balance Scale in adults with intellectual and visual disabilities. *Res Rev Diasbil.* 2017;62:58–68; doi:10.1016/j.ridd.2017.01.005.
- [20] Waninge A, van Wijck R, Steenbergen B, van der Schans CP. Feasibility and reliability of the modified Berg Balance Scale in persons with severe intellectual and visual disabilities. *J Intellect Disabil Res.* 2011;55: 292–301; doi: 10.1111/j.1365-2788.2010.01358.x.
- [21] Haibach-Beach P, McNamera S, Lieberman L. Home-based balance pilot intervention for adults with visual impairments. *Br J Vis Impair.* 2020;40(2):145–59; doi: 10.1177/0264619620935937.
- [22] Zarei H, Norasteh AA, Lieberman LJ, Ertel MW, Brian A. Balance control in individuals with visual impairment: A systematic review and meta-analysis. *Motor Control.* 2023;27(4):677–704; doi: 10.1123/mc.2022-0127.
- [23] Rutkowska I, Bednarczuk G, Molik B, Morgulec-Adamowicz N, Marszałek J, Kaźmierska-Kowalewska K, Koc K. Balance functional assessment in people with visual impairment. *J Hum Kinet.* 2015;48:99–109; doi: 10.1515/hukin-2015-0096.
- [24] Brambling M. Divergent development of gross motor skills in children who are blind or sighted. *J Visual Impair Blin.* 2006;100(10):620–34; doi: 10.1177/0145482X0710100404.
- [25] Ray CT, Wolf SL. Gender differences and the risk of falls in individuals with profound vision loss. *J Vis Impair Blin.* 2010;104(5):311–6; doi: 10.1177/0145482X1010400507.
- [26] Friedrich M, Grein HJ, Wicher C, Schuetze J, Mueller A, Lauenroth A, Hottenrott K, Schwesig R. Influence of pathologic and simulated visual dysfunctions on the postural system. *Exp Brain Res.* 2008;186:305–14; doi: 10.1007/s00221-007-1233-4.
- [27] Schmid M, Nardone A, De Nunzio AM, Schmid M, Schieppati M. Equilibrium during static and dynamic tasks in blind subjects: no evidence of cross-modal plasticity. *Brain.* 2007;130(8):2097–107; doi: 10.1093/brain/awm157.
- [28] Crews JE, Campbell VA. Health conditions, activity limitations, and participation restrictions among older people with visual impairments. *J Vis Impair Blind.* 2001;95(8):453–67; doi: 10.1177/0145482x0109500802.
- [29] Stones MJ, Kozma A. Balance and age in the sighted and blind. *Arch Phys Med Rehabil.* 1987;68:85–9.
- [30] Legood R, Scuffham P, Cryer C. Are we blind to injuries in the visually impaired? A review of the literature. *Inj Prev.* 2002;8(2):155–60; doi: 10.1136/ip.8.2.155
- [31] Newton M, Sanderson A. The effect of visual impairment on patients' fall risk. *Nurs Older People.* 2013;25(8):16–21; doi: 10.7748/nop2013.10.25.8.16.e489.
- [32] McCarty CA, Nanjan MB, Taylor HR. Vision impairment predicts 5 year mortality. *Br J Ophthalmol.* 2001;85(3) 322–6; doi: 10.1136/bjo.85.3.322.
- [33] Taylor HR, Katala S, Muñoz B, Turner V. Increase in mortality associated with blindness in rural Africa. *Bull World Health Organ.* 1991;69:335–8.
- [34] Ramrattan RS, Wolfs RC, Panda-Jonas S, Jonas JB, Bakker D, Pols HA, Hofman A, de Jong PT. Prevalence and causes of visual field loss in the elderly and associations with impairment in daily functioning. *Arch Ophthalmol.* 2001;119(12):1788–94; doi: 10.1001/archophth.119.12.1788.
- [35] Harwood RH. Visual problems and falls. *Age Ageing.* 2001;30:13–8; doi: 10.1093/ageing/30.suppl_4.13.
- [36] Singh RR, Maurya P. Visual impairment and falls among older adults and elderly: evidence from longitudinal study of ageing in India. *BMC Public Health.* 2022;12;22:2324; doi: 10.1186/s12889-022-14697-2.