Effects of Balance Training to Improve Gait and Quality of Life of Elderly in a Low Resource Country

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Cite this paper as: Badrunnesa Ahmed, Maisha Fahmida, Shafiqul Alam, Nuruzzaman Khandaker, Ali Emran, Nadim Kamal, Zikrul Hossain Ullash, Taslim Uddin (2024). Effects of Balance Training to Improve Gait and Quality of Life of Elderly in a Low Resource Country. *Frontiers in Health Informatics*, *Vol.13, No.8,*

ABSTRACT

Background: Balance control is fundamental for independent mobility and daily function. Declining balance due to aging or disease increases the risk of falls, leading to significant health and social burdens. Effective balance training can improve gait stability in the elderly, reducing fall risk. ***Methods:*** This Prospective Experimental study was conducted in the Department of Physical Medicine and Rehabilitation, BSMMU, Dhaka from July 2022 to June 2023. A total of 60 patients were enrolled from inpatient and outpatient settings. Participants were randomly assigned into two groups: Group A (Non-Intervention): Received a home-based balance exercise program demonstrated at baseline, with 2 follow-ups. Group B (Intervention): Underwent supervised balance training sessions in a gymnasium twice weekly for 12 weeks. ***Results:*** The study found that the intervention group was older (66.53 ± 4.67 years) and had more males (60.0%). Both groups had similar baseline balance scores ($p = 0.824$), but the intervention group showed greater improvement at six ($p = 0.012$) and 12 weeks ($p = 0.007$). Quality of life (QoL) significantly improved in bodily pain, general health, social functioning, and role-emotional scores at six and 12 weeks ($p < 0.05$). By 12 weeks, Physical Component Summary, Mental Component Summary, and total QoL were significantly higher ($p = 0.001$), highlighting the intervention's benefits. ***Conclusion:*** A structured balance training program significantly enhances gait and stability in elderly individuals, reducing fall risk. These findings can inform rehabilitation strategies and public health policies to improve elderly care in Bangladesh. The study recommends integrating supervised balance training into routine geriatric rehabilitation programs.

Keywords: Balance training, gait improvement, elderly, fall prevention, quality of life, SF-36, supervised exercise, mobility.

INTRODUCTION

Balance control is fundamental to independent movement and daily functioning. A decline in balance function, whether due to disease or aging, increases the likelihood of clinical balance issues, loss, and falls. Adults over 65 years' experience the highest number of fatal falls, making them the second most common cause of accidental deaths worldwide [1]. Among injuries related to falls, hip fractures are considered the most serious, frequently leading to extended hospital stays [2]. Even nonfatal falls can greatly affect quality of life by causing severe injuries and fractures [3].

It is widely agreed that the decline in postural control among the elderly is associated with sensory impairments, including vestibular, visual, and proprioceptive deterioration, motor system decline, and deficits in higher-level adaptive systems [4, 5, 6]. Additionally, older adults who have experienced a fall are at an increased risk of falling again. The global population aged 60 and older is rapidly increasing and is expected to reach 2 billion by 2050. The elderly population in Bangladesh is expected to rise to approximately 17.62 million by 2025 [7].

Balance-related issues also result in substantial healthcare and social service costs due to loss of confidence, injury, inability to maintain a safe environment, and increased dependence on basic functional activities [8]. Consequently, preventing falls has been recognized as a key priority in national healthcare programs. Many studies have tried to improve balance function; however, some have incorrectly assumed that strength training alone can enhance balance. A Cochrane Review by Gillespie et al., concluded that successful fall prevention strategies are multidisciplinary, combining both muscle strengthening and balance training [9].

The benefits of physical exercise for general health, strength, fitness, and quality of life are well-documented. However, exercise as a rehabilitation technique or preventive measure is not always implemented correctly. Some studies on balance training for the elderly have not fully followed the fundamental aspects of physical training, such as awareness, consistency, motivation, overload, and periodicity [8].

Hu and Woollacott used a multisensory training model that combined visual, vestibular, and somatosensory systems, showing significant gains in balance function after a short training period [10, 11]. Recent studies have included dual-task conditions and perturbation-based interventions, using personalized programs designed to meet individual needs, thereby improving intervention specificity and effectiveness [11].

There is a well-documented relationship between falls and muscle strength in the elderly [11]. However, research findings remain controversial. Certain studies suggest that there may be no notable difference in muscle strength between individuals who experience falls and those who do not. Balance im-provements related to strength training appear to be most prominent in individuals with se-verely compromised muscle function [8]. Several well-designed studies have found no direct interaction between balance and strength [12].

For the purpose of this study, strength is defined as the ability to generate torque around a joint, while balance is considered a task-specific, multijoint skill relying on the interaction of various physiological sensory systems, including neuromuscular, visual, vestibular, and somatosensory components [11]. Therefore, strength training should be incorporated within balance training programs. To effectively design balance interventions for different populations, it is essential to understand the interplay between voluntary and postural movements. This study aims to assess the impact of balance training on mobility and stability in the elderly, emphasizing the importance of targeted interventions that incorporate key aspects of physical training to improve gait and quality of life.

METHODOLOGY & MATERIALS

This prospective experimental study was conducted at the Department of Physical Medicine and Rehabilitation, Bangabandhu Sheikh Mujib Medical University (BSMMU) over one year (July 2022–June 2023). The study population included all patients aged 60–80 years suffering from balance problems who attended the outpatient department. A purposive sampling method was used to select 60 participants, screened based on history, physical examination, necessary investigations, and baseline assessments. Eligible participants were randomly assigned to two groups using a lottery method. Group A (Intervention Group) underwent supervised balance training in a gymnasium twice weekly for 12 weeks, while Group B (Non-Intervention Group) received a home-based balance exercise program, demonstrated at baseline.

Inclusion criteria included individuals aged 60–80 years with, independent mobility (using no more than a single-point stick), no cognitive impairment, telephone accessibility for follow-up, willingness to participate, and residency in Dhaka city. Exclusion criteria included recent stroke or myocardial infarction (past six months), acute or active chronic conditions, diabetes mellitus with complications, uncontrolled hypertension, diagnosed heart disease, neurological conditions, or dementia.

The intervention program included five progressive levels of balance training, incorporating voluntary balance control, perturbation exercises, and dual-task training. The training focused on enhancing postural control, muscle strength, and balance recovery, using tools such as Balance Balls. The Non-Intervention Group received conventional therapy focusing on functional activities, assisted walking, mobility aid assessments, and lower limb strengthening.

Data was collected using a structured questionnaire, including clinical history, examination findings, and baseline characteristics. Assessments were conducted using the Tinetti Balance Scale and SF-36 Health Survey at baseline, follow-ups, and study completion. SPSS version 22.0 was used for statistical analysis, with categorical variables summarized as percentages. A p-value < 0.05 was considered statistically significant.

Ethical approval was obtained from the Institutional Review Board (IRB) of BSMMU. Participants provided written informed consent, ensuring confidentiality and the right to withdraw at any stage. No experimental drugs, placebos, or invasive procedures were used, and all participants received standard medical care.

RESULTS

Table 1: Socio-demographic profiles of the study subjects (n=60)

Socio-demographic profiles	Intervention group (n=30)	Non-intervention group (n=30)	p-value
Age (years)	66.53 ± 4.67	63.93 ± 3.94	[a]0.023
60-65	16 (53.3)	22 (73.4)	
66-70	8 (26.7)	4 (13.3)	
71-75	6 (20.0)	4 (13.3)	
Gender			[b]0.021
Male	18 (60.0)	10 (33.3)	
Female	12 (40.0)	20 (66.7)	
Education			[b]0.382
Primary	6 (20.0)	10 (33.3)	
Secondary	6 (20.0)	4 (13.3)	
Higher secondary	0 (0.0)	2 (6.7)	
Graduate and above	18 (60.0)	14 (46.7)	
Occupation			[b]0.164
Housewife	12 (40.0)	14 (46.7)	
Sedentary worker	2 (6.7)	6 (20.0)	
Business	0 (0.0)	2 (6.7)	
Retired	16 (53.3)	8 (26.7)	
Socio-economy			[b]0.064
Lower income	2 (6.7)	0 (0.0)	
Lower middle Income	4 (13.3)	2 (6.7)	
Middle income	14 (46.7)	14 (46.7)	
Higher Income	10 (33.3)	14 (46.7)	

Unpaired t test and b Chi-square test was done

Table 1 shows that, most of the participants of the intervention group (16, 53.3%) and non- intervention group (22, 73.4%) were aged between 60 to 65 years. The age distribution showed a statistically significant difference (p < 0.023).

Table 2: Outcome of Tinetti Balance Scale at baseline and after 6 weeks (1st follow up) and after 12 weeks (2nd follow up)

Timepoint	Intervention group	Non- intervention group	p-value
Baseline (n=30)	18.3 ± 4.1	18.0 ± 3.9	0.824
At 1st follow up (n=60)	23.7 ± 3.5	20.5 ± 3.8	0.012*
At 2nd follow up (n=58)	24.1 ± 3.2	20.3 ± 3.5	0.007*

Unpaired t test was done

Table 2 shows both groups had similar baseline scores (p = 0.824), but the intervention group demonstrated greater balance improvement at 6 weeks (p = 0.012) and 12 weeks (p = 0.007), suggesting the positive impact of supervised balance training.

Table 3: Quality of life assessed by SF 36 at baseline (n=60)

Quality of life	Intervention Group (30)	Non-intervention Group (30)	p-value
Physical functioning (PF)	18.13 ± 2.73	19.20 ± 2.56	0.122
Role-physical (RP)	5.87 ± 1.59	7.13 ± 1.45	0.002
Bodily pain (BP)	6.80 ± 1.72	5.27 ± 1.84	0.001
General health (GH)	7.67 ± 1.25	7.00 ± 0.82	0.017
Social functioning (SF)	6.67 ± 0.47	6.27 ± 0.44	0.001
Role-emotional (RE)	5.93 ± 0.25	5.73 ± 0.77	0.001
Physical component Summary (PCS)	36.87 ± 1.89	36.53 ± 2.06	0.508
Mental component Summary (MCS)	11.93 ± 0.57	11.93 ± 0.44	0.169
Total	**12.48 ± 1.31**	**12.38 ± 1.30**	**0.767**

Unpaired t test was done

Table 3 shows that, there was no significant difference in any of the components of quality of life assessed by SF 36 between intervention group and non-intervention group at baseline, $p > 0.05$.

Table 4: Quality of life assessed by SF 36 after 6 weeks (at 1st follow up) (n=60)

Quality of life	Intervention Group (30)	Non-intervention Group (30)	P-value
Physical functioning (PF)	18.20 ± 2.74	19.20 ± 2.56	0.149
Role-physical (RP)	6.47 ± 1.67	7.20 ± 1.33	0.066
Bodily pain (BP)	6.60 ± 1.54	5.07 ± 1.77	0.001
General health (GH)	7.60 ± 1.20	6.93 ± 0.77	0.012
Social functioning (SF)	6.67 ± 0.47	6.27± 0.57	0.004
Role-emotional (RE)	6.00 ± 0.00	5.73 ± 0.77	0.001
Physical component summary (PCS)	36.40 ± 2.42	36.73 ± 2.14	0.512
Mental component summary (MCS)	12.00 ± 0.63	11.87 ± 0.50	0.219
Total score	**12.49 ± 1.33**	**12.38 ± 1.30**	**0.747**

Unpaired t test was done

Table 4 shows that, only bodily pain and role emotional was significantly higher in intervention group than non-intervention group after 6 weeks (at 1stfollow up) ($p < 0.05$). The mean difference of other components of quality of life assessed by SF 36 between the two groups were not statistically significant ($p > 0.05$).

Table 5: Quality of life assessed by SF 36 after 12 weeks (2nd follow up) (n=58)

Quality of life	Intervention Group (30)	Non- intervention Group (28)	p-value
Physical functioning (PF)	18.27 ± 2.67	19.20 ± 2.56	0.181
Role-physical (RP)	7.47 ± 1.09	7.73 ± 0.77	0.073
Bodily pain (BP)	6.07 ± 1.48	4.80 ± 1.72	0.003
General health (GH)	7.53 ± 1.15	6.53 ± 1.89	0.010
Social functioning (SF)	6.40 ± 0.49	5.93 ± 1.24	0.002
Role-emotional (RE)	6.00 ± 0.00	5.80 ± 0.75	0.001
Physical component Summary (PCS)	37.07 ± 2.05	34.20± 9.34	0.002
Mental component Summary (MCS)	12.00 ± 0.89	11.20 ± 3.04	0.001
Total score	**12.60 ± 1.23**	**11.93 ± 2.66**	**0.003**

Unpaired t test was done

Table 5 shows that, all the components of quality of life assessed by SF 36 were significantly higher ($p < 0.05$) in intervention group than non-intervention group except physical functioning, role-emotional and general health after 12 weeks (at 2nd follow up)

DISCUSSION

In the present study, data were collected from a total of 60 participants. Among intervention group had a significantly higher mean age (66.53 ± 4.67 years) compared to the non-intervention group (63.93 ± 3.94 years, p

= 0.023), with a greater proportion of participants aged 66-75 years. The gender distribution also showed a significant difference (p = 0.021), with 60.0% males in the intervention group versus 33.3% males in the non-intervention group. Educational levels were comparable, with most participants having at least a graduate degree (p = 0.382). Occupational status varied, with a higher proportion of retired individuals (53.3%) in the intervention group, while the non-intervention group had more sedentary workers and business professionals (p = 0.164). Socio-economic status differences were not statistically significant (p = 0.064), although the non-intervention group had a slightly higher proportion of higher-income individuals. Overall, while age and gender showed significant differences, other socio-demographic factors remained relatively balanced between the groups.

Another study found that significant changes in human balance, as indicated by Center of Pressure (CoP) parameters, typically begin around the age of 60 [13]. According to Pyykkö et al., and Hytönen et al., sway velocity in the oldest individuals studied (up to 90 years) began to increase after the age of 60, with a more pronounced rise when standing on a foam surface [14, 15].
Sauvage LR et al. found that a 12-week moderate-to-high intensity strengthening and endurance exercise program significantly enhances gait and balance in the elderly [16]. Similarly, Weerdesteyn V et al. developed the Nijmegen Falls Prevention Program, incorporating balance, gait, and coordination training within an obstacle course that simulates daily activities with fall risks [17]. This customized exercise program was effective in reducing falls, while also enhancing confidence in balance and the ability to navigate obstacles.

A multi-component exercise program emphasizing strength and balance training has been identified as the most effective approach for fall prevention in older adults [18, 19]. Clemson L et al. demonstrated a 31% reduction in fall rates through such training. Strength and balance exercises have proven successful in minimizing fall incidents among the elderly [20]. Additionally, ankle joint muscles play a crucial role in balance recovery, and maintaining a near-normal range of motion in the ankle is essential for effective balance strategies and stable posture during perturbations [21].

The study showed significant improvements in balance performance and gait in the intervention group, as measured by the Tinetti Balance Scale. At baseline, both groups had similar scores, but after six weeks, the intervention group improved to 23.7 ± 3.5, while the non-intervention group reached 20.5 ± 3.8 (p = 0.012). By 12 weeks, the intervention group further improved to 24.1 ± 3.2, while the non-intervention group showed minimal change at 20.3 ± 3.5 (p = 0.007). These results indicate that the balance training program significantly enhanced balance and gait over time.

The study evaluated the quality of life (QoL) using the SF-36 questionnaire, comparing an intervention and non-intervention group at baseline, six weeks, and 12 weeks. Baseline comparisons showed the non-intervention group had a higher RP score (p = 0.002), while the intervention group had significantly imoroved BP (p = 0.001), GH (p = 0.017), SF (p = 0.001), and RE (p = 0.001). At six weeks, the intervention group had significantly better BP (p = 0.001), GH (p = 0.012), SF (p = 0.004), and RE (p = 0.001), though total QoL remained comparable. At 12 weeks, the intervention group showed significantly improved scores in BP (p = 0.003), GH (p = 0.010), SF (p < 0.001), RE (p = 0.001), PCS (p = 0.002), MCS (p = 0.001), and total QoL (p = 0.001), highlighting the positive impact of an intervention on overall well-being.

The 10-meter gait time, as a measure of physical ability, was identified as a key contributor to quality of life (QOL) and demonstrated correlations with both the SF-36 Physical Component Summary (PCS) and Mental Component Summary (MCS). It exhibited significant correlations with all factors except the sacral inclination angle, indicating its potential as a dependable indicator of aging, muscle strength, physical activity, and overall quality of life in older adults. Previous studies have linked kyphosis to gait function in older adults [22]. Hongo et al. found that back muscle training significantly improved QOL in a randomized controlled trial [23]. This highlights the importance of exercise in maintaining spinal balance, mobility, muscle strength, and overall physical function in the elderly. Enhancing these factors is expected to contribute to the preservation of QOL as individuals age.

Limitations of the study
This study was limited by its single-center design, small sample size, and short study period. Long-term follow-up was beyond its scope, and as the sample was selected purposively, randomization was not performed.

CONCLUSION
This study confirms that structured balance training significantly enhances gait, balance, and mobility in elderly individuals, reducing fall risk and improving confidence. The intervention group showed greater improvements in gait and quality of life, highlighting the importance of targeted exercises in rehabilitation. Integrating balance

training into geriatric care can enhance mobility, prevent falls, and improve overall well-being. Future research should explore long-term adherence and diverse training methods for broader applicability.

Financial support and sponsorship: *No funding sources.*
Conflicts of interest: *There are no conflicts of interest.*

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