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Factors affecting balance and fall risk among elderly people over 60 years in Hebron, Palestine: A Cross–Sectional Study

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Factors affecting balance and fall risk among elderly people over 60 years in Hebron, Palestine: A Cross–Sectional Study

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Dedication

This thesis is dedicated to the soul of my beloved father, whose memory continues to inspire and guide me.

To my dear daughters, for their love, patience, and motivation that brighten my life every day. And to this accomplishment.

I also dedicate this work to my professors and mentors who guided me with knowledge and wisdom, and who contributed to the completion of this research.

Declaration

I certify that this thesis, which is submitted for the degree of master, is the result of my own research, except where otherwise acknowledged, and that this study (or any part of the same) has not been submitted for a higher degree to any other university or institution.

Signed:

Safa Arafat Essa Al-Batsh

Date: 12 / 01 /2026

Acknowledgment

Alhamdulillah, all praise is due to Allah for granting me the strength and guidance to complete this work.
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Abstract

Background: Falls among older people pose a serious health issue and have been associated with injuries, disability, and loss of quality of life. It is necessary to have a comprehensive outlook on factors influencing physical, cognitive, psychological, and social domains associated with balance and risk of falls.

Objective: To explore factors that affect balance and risk of falls among older adults, above 60 years, living within the community of Hebron, Palestine.

Methods: A total of 323 participants were given demographic questionnaires and physically and cognitively assessed with balance measures (Berg Balance Scale [BBS], Timed Up and Go Test [TUG], Single Leg Stance [SLS]) and cognitive function measurement tools (Mini-Mental State Examination), as well as psychosocial tools (Fear of Falling Scale, community participation, and domains of quality of life). Correlation and regression analyses were conducted.

Results: The average age was 67.8 ± 6.54 years, and females accounted for 56% of the sample. Balance risk testing showed 64.4%, 20.7%, and 14.9% were at low, medium, and high risk for falls, respectively. A significant association with low balance performance existed for cognitive impairment, assistive device use, physical inactivity, difficulty walking on uneven ground, and loss of functional independence ($p < 0.001$). The Berg Balance Scale (BBS) predicted fall risk better than any other measure and influenced social participation and falls concern but not overall life satisfaction and fear of falls on the Falls Efficacy Scale-International (FES-I). Regression analysis pointed to physical and cognitive variables, such as problems with memory and assistive device use, as vital determinants of balance. Functional change as measured by Fisher Score significantly predicted balance.

Conclusion: Balance among older people requires consideration of physical, cognitive, and functional variables. Strategies that focus on enhancing physical activity levels, cognitive functions, usage of assistive devices, addressing sensory impairments, and encouraging independence with activities of daily living should be promoted among elderly populations within the city of Hebron.

Keywords: balance, fall risk, elderly, Hebron, physical activity, cognitive function, functional independence

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List of Abbreviations

Term	Abbreviation
World Health Organization	(WHO)
Middle East and North Africa	(MENA)
Central nervous system	(CNS)
Rehabilitation and Care Society	(RCS)
Multiple Sclerosis	(MS)
Timed Up and Go	(TUG)
Berg Balance Scale	(BBS)
Mini-Mental State Examination	(MMSE)
Quality of life	(QoL)
Nottingham Extended Activities of Daily Living	(NEADL)
Statistical Package for the Social Sciences	(SPSS)
Institutional Review Board	(IRB)
Analysis of Variance	(ANOVA)
Analysis of Covariance	(ANCOVA)
Standard deviations	(SD)
Activities of daily living	(ADL)
Single Leg stance	(SLS)
Falls Efficacy Scale-International	(FES-I)
Kilogram	(kg)
Centimeter	(cm)

Chapter one

Introduction

1.1 Background

Falls are one of the most relevant causes of mortality, morbidity, and disability among older adults and represent a significant health issue in every country in the world regarding ageing populations (James et al., 2020). It is estimated by the World Health Organization (WHO) that about 28-35 percent of individuals 65 years and older experience a fall annually, and that this percentage increases with age and degree of frailty (WHO, 2007). There are severe outcomes of falls, including hip fractures, head injuries, loss of independence, fear of falls, and the extension of healthcare utilization (Phelan et al., 2015; Florence et al., 2018).

Advancement in age has been linked to increasingly physiological alterations, such as a decrease in muscular strength, proprioception, vision, vestibular activity, and cognitive processing, though all of these factors have the potential to compromise postural control and make an individual prone to fall (Horak, 2006; Muir et al., 2010). Besides, chronic diseases of diabetes, stroke, osteoarthritis, and polypharmacy still aggravate the cases of lack of balance in the old population (Li et al., 2022).

The population change associated with aging in Palestine and Hebron, specifically, creates new challenges in healthcare. A large number of elderly people reside in multigenerational families and depend on them without seeking geriatrics rehabilitation services. They can be compounded by environmental obstacles, including uneven roads, busy markets, and inaccessibility of the urban environment (Palestinian Central Bureau of Statistics, 2023). How the elderly manage impairments to mobility and balance is also affected by cultural beliefs as well as low awareness regarding fall prevention.

It is crucial to know what factors are particularly involved in creating a poor balance with a high risk of falling in this situation. This knowledge can be utilized in context to locally relevant, culturally sensitive interventions to mitigate the morbidity and mortality of falls. Moreover, functional activity levels, involvement in day-to-day activities, and the quality of life in aged adults are highly interrelated with balance performance (Shumway-Cook & Woollacott, 2016). Thus, evaluation and management of balance problems among geriatric groups in the region of Hebron are a significant step towards the enhancement of health conditions and healthy aging.

1.2 Statement of the Problem

Even though falls have been identified as a significant public health problem among the older adults of the global population, there is limited research on the same problem among the Palestinian population and especially in Hebron. In the southern West Bank, the initial study of Palestinian fall-related causal factors reported correlations between obesity, decreasing functional capacity and cardiovascular diseases and falls; it failed to examine the environmental and socio-cultural issues of older people in Hebron (Badrasawi et al., 2021).

Moreover, the risk to health access is associated with older residents of such areas as H2 of Hebron, where access barriers are seen in terms of security restrictions, which increase care and rehabilitation service inequalities (Médecins Sans Frontières, 2019).

the relation between the effectiveness of balance as one of the most critical determinants of independence, injury prevention has no studies proved and the consequences of dysfunction in maintaining balance on the quality of life, functional activity, and social interaction of the senior population that resides in Hebron are still not investigated. According to regional data in the Middle East and North Africa (MENA), startlingly, about 17.6 percent of the older adults have reported falling once or several times; the data is not restricted to the Palestinian case (Chaabna et al., 2025).

1.3 The objectives of the Study

The purposes of the study were:

1. To investigate the status of balance and risk of falling among elderly individuals aged 60 years and older in Hebron, Palestine.
2. To highlight the factors affecting balance and fall risk among elderly individuals aged 60 years and older in Hebron, Palestine.
3. To study the effect of balance status on functional activity, quality of life, and participation level of elderly individuals aged 60 years and older in Hebron, Palestine.

1.4 Hypotheses

- H1: There is a statistically significant association between physical, cognitive, and psychological factors and the risk of falls and balance impairment among elderly individuals aged 60 years and above living in Hebron, Palestine.
- H2: Higher levels of balance performance are positively associated with improved functional activity, greater social participation, and better quality of life in the elderly population.

1.5 Significance of the Study

Our review identified serious health outcomes associated with falls in the elderly, such as fracture injuries, functional impairment, loss of independence, and deaths (Ambrose et al., 2013; James et al., 2020). In areas such as Hebron, where the aging population rates are

continuously advancing, and where healthcare facilities might lack or be divided, it is crucial to learn the exact reasons which lead to the loss of balance and which can predispose a person to falls. These factors recognized in the local setting will enable the formulation of culturally competent and resource-sensitive prevention and rehabilitation efforts (James et al., 2020).

This research fills a significant gap in the available literature because it will present empirical information on the factors that determine balance and fall risk among elderly people in Hebron. The research will also provide meaningful recommendations to both medical workers and policymakers, as well as caregivers, as they will help in instituting specific, evidence-based interventions that will prove useful in enhancing safety, functional autonomy, and a good life for the elderly in Palestine.

Chapter Two

Lıterature revıew

2.1 Introduction

Falls in elderly populations are a significant issue in terms of public health to countries around the globe because they have a high preponderance, they are associated with severe consequences and even with the concept of population aging, the occurrence of these falls is on an upward trend. According to the World Health Organization (WHO), an estimated 28 % to 35 % of individuals 65 years and above fall once a year, and a percentage of persons over 70 years increase up to 32-42 % (WHO, 2021). Not only are these events physically damaging such as causing hip fractures and traumatic brain injuries, but they also may result in the deterioration of independence, psychological distress, and overall quality of life (Ambrose et al., 2013).

Falls become of special significance in low- and middle-income states, to which Palestine belongs, where there is a lack in collecting data on falls and developing the fall prevention measures. In this environment, other issues such as the influence of environment, culture and the healthcare system can also increase the issue. Such falls may result in hospitalization, disability, institutionalization or even death putting a huge burden on both-health systems and families (Florence et al., 2018).

The information about the factors leading to fall risk is requisite in designing effective prevention programs. These involve both intrinsic risks, which include age physiologic alterations and chronic illnesses, and extrinsic risks that include the home hazards, poor illumination as well as unsafe footwear. Furthermore, such psychosocial factors as fear of falling and social isolation can possibly augment susceptibility (Rubenstein, 2006).

In Palestine, in general, and Hebron, in particular, where older people can live in high-rise buildings with sloping floors and have difficulty accessing mobility aid or rehabilitation facilities, a heightened risk of falling is to be expected. Nevertheless, there

are limited local studies related to the prevalence and determinants of falls in this population group.

This chapter summarizes or reviews the existing literature on balance, fall risk and related factors in the old population. It begins by defining what is meant by the balance and falling concept, then examines how the body changes physiologically with age, and subsequently presents both intrinsic and extrinsic risk factors. Available epidemiological evidence, the implications of falls and the research gap that has led to the execution of the current research are also discussed in the chapter.

2.2 Definition of Balance and Fall Risk

One of the essential motor skills is balance that is essential to keep the center of gravity of the body within its base of support. It is a multidimensional physiological process that implies involvement of several sensor systems, central integration, and motor outputs. The main sensations in the sensory inputs are visual system, vestibular apparatus in the inner ear, and the somatosensory receptors like proprioceptors in the muscles and joints. The central nervous system, the brainstem and the cerebellum of the central nervous system integrate these inputs and coordinate through muscle activations maintenance or restoration of stability under both still and moving situations (Shumway-Cook & Woollacott, 2016).

Two major types of balance can be distinguished: the first is known as static balance, and involves regulation of posture during a stationary state; dynamic balance is the process of regulating posture during motion, or following perturbations (Horak, 2006). These two types play a critical role in the completion of day-to-day activities and the avoidance of falls.

A fall is usually classified as an event that causes an individual to be in an unwanted position where he or she rests accidentally on the ground, floor or to some lower level (Lamb et al., 2005). Older adults commonly experience falls that may be caused due to intrinsic (e.g., muscle weakness, sensory deficits) as well as extrinsic factors (e.g., environmental hazards).

Fall risk is defined as the likelihood of an individual falling over some time. It is a multifactor phenomenon influenced by physical, psychological, environmental and social factors. To determine fall risk, the possibility of falling should be measured as well as the severity and the outcomes of eventual falls (Tinetti, 2003). Considering the multidimensional nature of fall risk, multifactor assessment tools may capture balance, walking and gait, muscle strength, thinking, and safety measures in the environment.

2.3 Physiological Changes with Aging Affecting Balance

Aging is a multidimensional biological event that influences nearly all systems within the human body the resulting in progressive functional losses. These physiological alterations largely affect the balance capacity and raise the vulnerability of falls among elderly individuals. These changes play a huge role in explaining why fall risk increases with age.

2.3.1 Musculoskeletal System

The musculoskeletal system is one of the most affected by musculoskeletal changes, especially sarcopenia, which is age-related muscle loss and diminished strength. The lower limbs are chiefly affected with sarcopenia, and they are more involved in working on body position and reacting to balance changes. Muscle loss affects the lower speeds of posture change, making patients unable to recover swiftly after falling or tripping (Cruz-Jentoft et al., 2019).

Also, aging leads to increased rigidity of the joints and the loss of ranges of motion that restrict the possibility of carrying out corrective movements efficiently. Further factors affecting mobility and pain in older adults, leading to the development of compensatory gait patterns and disorders of gait dynamics leading to a loss of balance, are degenerative processes (e.g., osteoarthritis) (Hurley, 1999).

2.3.2 Sensory Systems

Balance depends heavily on accurate sensory information from the visual, vestibular, and somatosensory systems:

- Visual System: Sensory: Visual acuity, contrast sensitivity, depth perception, and peripheral vision are lowered with age (Lord et al., 2010). These weaknesses diminish awareness of the environment, especially in dim light situations, which place them at a higher risk of falling.
- Vestibular System: The inner ear has the vestibular apparatus that senses the movement of the head and orientation of space. Degeneration of age-related serving and neurons of vestibular hair cells causes reduced vestibular performance that undermines postural control (Maheu et al., 2015).
- Somatosensory System: The body position and movement sense, Proprioception, degenerates with time because of decreased activity of the mechanoreceptors in muscles and joints. Such impairment causes delays in recognizing body sway and positional changes and makes it hard to adjust balance in time (García-Piqueras et al., 2019).

2.3.3 Central Nervous System

The central nervous system (CNS) is important in the processing of sensory input and the formation of motor response to ensure stability:

- Diminished Neural Function: The neural processes responding to the external factors are reduced in speed and there is delay in conduction velocity and synaptic transmission. Such a time delay damages the capacity to produce rapid postural adjustments following disturbances (Ebaid et al., 2017).
- Impaired Cognitive Function: Cognitive Cassette, such as reduced attention, executive function, and processing speed, influences the capability of the CNS to maintain balance in dual-task or complicated circumstances. Such a relationship between cognition and balance is especially topical because most falls take place when a person is multitasking (Anna Brachman et al., 2024).
- Altered Motor Control: The alterations in the structure of the CNS also lead to changes in the CNS that include the diminished size of the brain, especially those areas that deal with motor planning and coordination (e.g., cerebellum, basal ganglia). These alterations have the capacity to negatively affect postural tactics and motor output quality (Seidler et al., 2010).

2.3.4 Postural Reflexes and Coordination

Postural reflexes assist in stabilizing the body automatically when there is unexpected turbulence. As one ages, these reflexes are not as sensitive and slow down as well hence becoming less effective (Borrelli et al., 2019). Coordination of muscle activation patterns also breaks down commonly, leading to reduced efficient reserve of balance strategies, increased co-contraction of antagonistic tissues, leading to rigidity and loss of balance (Camillo et al., 2015).

Table 2.1: Summary of Physiological Changes:

System	Age-Related Changes	Impact on Balance
Musculoskeletal	Sarcopenia, reduced strength, decreased flexibility	Weakness limits corrective responses
Visual	Reduced acuity, contrast sensitivity, depth perception	Poor environmental awareness, especially in low light
Vestibular	Degeneration of hair cells and neurons	Impaired spatial orientation, dizziness
Somatosensory	Decreased proprioception	Delayed detection of body sway
CNS	Slower processing, cognitive decline, structural brain changes	Delayed and reduced motor responses, impaired multitasking
Postural Reflexes	Reduced sensitivity and speed	Ineffective automatic balance corrections

2.4 Risk Factors for Falls in the Elderly

Most falls among the older adults are multifactorial and this is attributed to the complexities of interactions between intrinsic, extrinsic, behavioral, and medication-related factors. Precisely diagnosing and comprehending these risk factors is an imperative measure in gleaning sound fall prevention measures.

2.4.1 Intrinsic Risk Factors

Intrinsic factors are also called individual characteristics and health conditions predisposing to falls. Most frequently reported in intrinsic factors are:

- Age: As one gets older the risk of falling increases, especially after the age of 80 years. This comes because of cumulative physiological failure loss in various systems that manage balance and mobility (Li et al., 2023).
- Previous Falls: A case history of one or more falls is perhaps the strongest indicator of future falls. A history is frequently a sign of predisposing weakness like poor balance, strength, or reasoning (Ganz et al., 2007).
- Muscle Weakness: The impairment of lower limb muscle strength impairs postural stability and ability to perform compensatory steps, which greatly threatens fall risk (Dao et al., 2020).
- Impairments affecting Gait and Balance: Irregular gait, impaired balance, and slow walking are the important risk factors (Jeannette et al., 2017).
- Chronic Diseases: Disorders like arthritis, stroke, parkinsons disease, diabetes, cardiovascular disease, and sensory neuropathies have an impairment effect on balance and physical ability (Waterval et al., 2023; Deandrea et al., 2010).
- Cognitive Impairment and Dementia: The deficit in cognition occurs in judgment, attention, and executive resources and deprives a person of the possibility of safe navigation of the environment and reaction to factors of danger (Montero-Odasso & Speechley, 2018).
- Sensory Deficits: The eyesight, vestibular system and nerves reluctance in the extremities are impeded, thereby limiting the sensory information required to stay upright (Casabona et al., 2024).
- Depression and Anxiety: Depression and anxiety are psychological disorders that may contribute to less physical activity, problems with concentration, and the development of a fear of falling which on its part paradoxically increases the risk of falls (Delbaere et al., 2010).

2.4.2 Extrinsic Risk Factors

The extrinsic risk factors are caused by the surrounding environmental and exogenous factors:

- Environmental Hazards: Dark conditions, uneven floors, slippery floors, hanging rugs, labyrinthine mazes, and the absence of grab bars or handrails have a great impact on causing falls ((Jiang et al., 2024).
- Poor Footwear: Footwear that has poor grip or support enhances the risk of falls due to slips and tripping (Menz et al., 2003).
- Assistive Devices Misuse: When they are used wrongly, such as canes, walkers, or wheelchairs cannot help solve the problem of falls; instead, they result in elevated fall risk (Bateni, 2012).

2.4.3 Behavioral Risk Factors

Behavioral factors are linked to the behavior and lifestyles of people:

- Physical Inactivity: The lack of physical activity results in the poor muscle strength and loss of control over balance (Sherrington et al., 2017).
- Risk-taking Behaviors: Rushing, climbing a ladder, or walking without proper care over rough terrain are some examples that augment the falls (Lord et al., 2006).
- Alcohol: Alcohol use causes reduced coordination and decreased judgment and increases the risk of falls (Smithson et al., 2019).

2.4.4 Medication-Related Risk Factors

Some drugs and polypharmacy (the use of more than one drug) have also been very closely related to the risk of falls:

- Psychotropic Drugs: Sedative, antidepressants, antipsychotics, and benzodiazepines may result in sedation, dizziness and poor cognition (Max de Vries et al., 2018).
- Antihypertensives and diuretics: These can bring about orthostatic hypotension and alterations to the electrolytes, resulting in dizziness and weakness (Campbell et al., 1999).
- Polypharmacy: The interactions of multiple drugs may breed severe side effects and interactions to give rise to falls (Maher et al., 2014).

2.5 Epidemiology and Consequences of Falls

2.5.1 Epidemiology of Falls

Falls become most frequent as individuals advance in age and approximately one-third of individuals aged 65 years and over report at least one fall during a year with percentage

subsequently rising to almost 50 among individuals aged 80 years and older (Ambrose et al., 2013).

In Palestine, as in most other low- and middle-income countries, information on falls in the elderly is incomplete yet tends to be underreported because there is no systematic collection of data, and because there may also be a cultural reluctance to report (Khalil & Alnahhas et al., 2014). Nonetheless, there are regional research studies that indicate that the occurrence of falls among older populations in Middle East is similar to the rest of the world. As a case in point, research in Jordan and Gaza indicated a prevalence rate of falls of 30-35 per cent of community-living populations of older age groups (Al-Faouri et al., 2019; El-Haddad et al., 2022).

2.5.2 Consequences of Falls

Some adverse consequences of falls include an extensive effect on physical and psychological health and social engagement and economic burden.

2.5.2.1 Physical Consequences

- Fits of injury: Approximately 5-10 percent of falls cause severe injuries like fractures (hip, wrist, vertebrae), and traumatic brain injury (Rubenstein, 2006). Special attention should be paid to hip fractures which results in hospitalization, surgery and long-term disability in most of cases.
- Loss of Function: Immobility after a fall may result in weaker muscles, the stiffness of joints, a further loss of balance and strength, and a higher risk of a fall in the future (Tinetti & Williams, 1997).

2.5.2.2 Psychological Consequences

- Fear of Falling: Fear of falling is developed by many older adults following the first fall and can result in a limitation of activities, social isolation and poor quality of life (Delbaere et al., 2010).
- Depression and Anxiety: These two psychological disorders can cause and lead to falls, establishing a vicious circle of deterioration of balance and locomotion (Makino et al., 2018).

2.5.2.3 Social and Economic Consequences

- Loss of Independence: Falls usually require enhanced support of caregivers or a change to assisted living or nursing homes.
- Healthcare Cost: Falls, including emergency care, hospitalization, rehabilitation services, and long-term care, comprise a significant proportion of healthcare spending (Stevens et al., 2006). To take a particular example, falls in the United States among older people were estimated to cost direct medical expenses over 50 billion dollars per year (Florence et al., 2018).

2.6 Evidence from Previous Studies

Previous studies have become more concerned with the determination of the occurrence and prevalence, risk factors and outcomes of falls in elderly individuals among various global populations, such as those of the Middle East, like Palestine. Such studies contribute to setting fall risk within a particular environment, culture, and providing specific prevention approach.

2.6.1 Prevalence of Falls

The cross-sectional study of Korkut et al. 2020 in Turkey among 750 community-dwelling older adults promotes the finding that the prevalence of falls was 32%, with a female gender, gait impairment, and depressive symptoms being shown as crucial factors affecting a higher risk of falls. Likewise, a 2021 study in Lebanon revealed that about 29 percent of the participated elderly had fallen once or more within the last year and polypharmacy and vision affectivity have been adopted as significant risks (Nasreddine et al., 2021).

In the Palestinian setting, a 2022 community-based study in Gaza showed that 30 percent of people aged above 65 years reported at least one fall within the past year amongst 400 elderly people. The researchers found that the key factors included muscle weakness, chronic diseases (primarily, diabetes and hypertension), and the hazards of home environment (El-Haddad et al., 2022). This falls in line with regional trends that show that socio-economic and environmental factors are also important besides the physiological changes.

2.6.2 Risk Factors and Associated Conditions

Longitudinal studies in the past have supported the multifactorial concept of fall risk. One recent study was a 2019 cohort study conducted in Iran that indicated that poor balance, lower limb strength, and cognitive deterioration were all factors associated independently with falls in ten years during the follow-up of older individuals (Ghasemi et al., 2019). A research study conducted in Saudi Arabia (2021) gave importance to the occurrence of vitamin D deficiency and its connection with muscle weakness and elevated danger of falls (Alhumaid et a., 2021).

2.6.3 Interventions and Prevention

The research over the past ten years also stressed the adequacy of multi-component interventions to fall prevention, such as the mix of exercise (particularly balance and strength training), home safety evaluation, and medication review. A randomized controlled trial in the UAE conducted in 2020 indicated that a 12 weeks of specialized exercise program substantially increased the balance score and lowered the nil count in old persons (Alqahtani et al., 2020). Moreover, telehealth interventions have been found

effective as a promising mode to access the elderly through limited mobility or access to healthcare services (Almarwani et al., 2023).

The current research confirms various worldwide studies and supports the idea that fall risk among elderly individuals crosses various domains. The relationship between older age and lower balance and mobility capacity also supports research conducted by Lord et al. in 2007 and proved these deficiencies directly affect postural stability because of neuromuscular, sensory, and musculoskeletal changes. At the same time, the predictive relationship with cognitive performance among functional abilities confirms research conducted by Sturniek et al. in 2025 and pointed out that planning and control abilities have an essential role within ambulation

Psychological factors, especially fear of falling, were also shown to have an effect on functionality, and these have been supported by another research conducted within Japan, the UK, and Jordan (Donoghue et al., 2013; Lenouvel et al., 2023; Mullen et al., 2012). Fear of falling will often accelerate functional complications due to avoidance reactions, causing muscle deconditioning and low levels of activity. It would be imperative for these factors to be addressed within fall prevention.

Physical activity revealed itself as a protective factor, as evidenced by research conducted by Sherrington et al. (2019), indicating that structured physical exercise enhances balance and physical function. Its relevance and importance will be realized with the implementation of exercise programs within the community.

However, there were some discrepancies. BMI failed to be an important predictor variable within this research, as some Western research had shown obesity as an influential predictor among falls (Vincent et al., 2010). Also, gender failed to have an impact on falls as a predictor variable, but some research had shown women as being at higher risk for falls as compared to males (Deandrea et al., 2010). These inconsistencies might be due to the ecological and cultural variables that differentiate Palestinian older people from Eastern cultures, as there may be some discrepancies in daily physical activity and some duties among women.

Therefore, based on regression and comparative analyses, it can be ascertained that age, cognitive functions, physical activity, and fear of falling are major factors influencing balance and mobility among older people, while chronic disease status, BMI, and gender might be secondary factors. These findings will help develop specific intervention strategies against falls among elderly Palestinians.

2.7 Summary

This chapter surveyed the massive literature on balance and fall risk in older adults by focusing on physiological, intrinsic, extrinsic, behavioral, and medication-related risks that lead to falls. Age-related changes of musculoskeletal, sensory systems, and central nervous systems have been identified as predominant factors that influence poor balance. The high complexity of the fall risk was highlighted in the analysis of health factors, environmental risks, and lifestyle behaviors.

The epidemiological evidence exhibited the increasing incidence of falls in the globe and the region, such as Palestine, not mentioning the severe physical, psychological, social, and economic impacts of the falls. The issue of culturally sensitive fall prevention strategies was highlighted in recent studies in countries located in the Middle East.

Finally, this chapter identified important research gaps within the Palestinian setting, especially in the Hebron region, where complete community-based data are very minimal. In the context of the management of these gaps, the current study is intended to explore causes influencing balance performance and fall risk in older adults so that to provide specific interventions, which can positively impact the health and well-being.

Chapter Three

Methodology

3.1 Study Design

The research study was designed cross-sectionally with a descriptive focus on exploring factors that influence balance and fall risk among elderly people in Palestine who are aged 60 years and above in Hebron. A cross-sectional method suitable to gather data at a single time that enables the determination of any possible associations between demographic, clinical, psychological, and cognitive and physical variables and falls risk.

No comparable alternative is more cost-effective or more time-efficient, notably when it comes to public health and community-based research, since the latter does not necessitate long-term follow-ups. It does not determine causality yet, which is appropriate when determining prevalence rates, correlations, and possible predictors of the risk of falls among the older individual populations.

3.2 Study Setting

This analysis was done in Hebron, which is situated in the southern West Bank-Palestine. Hebron is one of the biggest Palestinian cities where a high percentage of aged people can be found, both in rural and urban areas.

It has gathered information in various community- and health-based areas that are open to the elderly, such as:

- Nursing homes and adult retirement home facilities
- Physiotherapy clinics, which are members of the local health organizations, e.g. the Rehabilitation and Care Society (RCS)
- UNRWAP physiotherapy unit to aged Palestinian refugees at Hebron

These locations were chosen because of their ease of access, presence of the elderly customers and the presence of the trained personnel to facilitate the process of hiring and the data collection. Variety of settings helps to increase representativeness of the sample in the context of socioeconomic, and health services settings.

3.3 Population and Sampling

The intended participants in this study are elderly population in the Hebron region (age 60 years and older). Such individuals can be living individually, with family or in institutional settings.

3.3.1 Sampling Method

Convenience sampling methodology was used based on the lack of a centralized database or the official list of the aged persons in the Hebron governorate. In convenience sampling, the researchers can use available people on the basis of willingness and accessibility especially in social forums such as community centers, clinics, and social outreach networks.

Although such an approach can create impositions in terms of generability, it is suitable to conduct exploratory cross-sectional surveys and this approach offers practicability to research in resource-constrained environments where field-based research is practical.

3.3.2 Sample Size

A total of 323 participants were recruited. To calculate the sample size for a cross-sectional study on elderly balance in Hebron, with the following data:

- Population size (N) = 250,000
- Proportion of elderly (≥60 years) = 6% → Target population (N_e) = 250,000 × 0.06 = 15,000
- Confidence level (Z) = 95% → Z = 1.96
- Margin of error (d) = commonly 5% → d = 0.05
- Estimated prevalence (p) = if unknown, use p = 0.5 (maximizes sample size)
- Complement of prevalence (q) = 1 - p = 0.5

Total population	250,000
Elderly population (≥60)	15,000
Confidence level	95% (Z=1.96)
Estimated prevalence (p)	0.5
Margin of error (d)	0.05
Initial sample size (n_0)	384
Adjusted sample size (n)	375

3.4 Inclusion and Exclusion Criteria

Certain inclusion and exclusion criteria have been identified in order to make the choice of a representative and appropriate sample certain. These inclusion/exclusion criteria are geared towards selecting participants that are likely to fulfil the study aims and would be in a good position to take part in all the assessments without putting themselves at any danger and with minimal confounders that would lead to any other factors excluding validity of the findings.

3.4.1 Inclusion Criteria

The inclusion criteria to be subjected to the study included the following:

- Aged 60 years and above
- The individual lived in the Hebron governorate
- Capable of talking and obeying simple commands
- Being willing to participate and sign the informed consent form

3.4.2 Exclusion Criteria

The participants who had any of the following were excluded in the study:

- Stroke history
- Diagnosis of Parkinson's disease
- Multiple Sclerosis (MS)
- Any other neurological or cognitive disorder that has a considerable impact on motor control, balance or mobility (e.g. advanced dementia, severe vestibular disorders)
- Extreme sense of sight or hearing, where communication or taking part in a test might be difficult

The purpose of the following criteria is to be sure that the participants can serve in the study to adequately, reliably complete physical and cognitive tests, and the outcome is fall risk associated with, and not with any other complex neurological disorders.

3.5 Methods of data collection

3.5.1 Questionnaire Design and Components

To understand the different factors involved in both balance impairments and the risk of fall in elderly people of 60 years and older, a specific, structured, Arabic structured questionnaire was formulated. It administered the questionnaire through the face-to-face approach to clarify that the participant understands and accuracy is maintained when it comes to answers. It was formulated with ten significant sections, each focusing on a particular area that falls in line with the following goals of the study.

3.5.1.1 Demographic Information

This section collected basic personal information including age (in years), sex (male or female), height (cm), weight (kg), educational level (no formal education, primary, secondary, or university level), and living arrangement (living alone, with family, or in a care home). These variables are essential for identifying population characteristics and potential sociodemographic influences on balance and fall risk.

3.5.1.2 Comorbidities and General Health Status

The participants were also asked to indicate whether they had any chronic diseases like hypertension, diabetes, cardiovascular diseases, stroke, arthritis, neurological ailments (e.g. Parkinson or multiple sclerosis), and respiratory diseases. They were also requested of the indication of whether they were under regular medication and also to provide names of the medications. This section assisted to determine the effects of multimorbidity on the stability and mobility.

3.5.1.3 Vision Problems

The section was specifically concerned with the presence of visual impairments, which are identified accountable factors of falling. Specifically, participants were questioned on whether they were the users of glasses or contact lenses and whether they had been diagnosed with conditions of the eyes such as cataracts, glaucoma, macular degeneration, or diabetic retinopathy. In the everyday activities (e.g., reading, walking, driving), self-perceived visual ability was measured on the four-point scale, as excellent to poor. Each of the eyes was done individually, and the two eyes together, on visual acuity using a Fischer chart.

3.5.1.4 Balance and Mobility

The participants meant whether they had the feeling of unsteadiness when walking or when standing up, and how often they had that feeling. Assistive devices (e.g., cane, walker, wheelchair) use was documented. In this section specific functional tests were included such as:

- **Single-leg stance test** with eyes closed to evaluate proprioception and static balance.
- **Timed Up and Go (TUG) test:** to assess dynamic balance and functional mobility.

The participants were instructed to rise out of a chair, walk three meters and turnaround and do it back and sit back in the chair. The duration that one took to do the task was noted.

- o Validity: High correlation to fall risk (Podsiadlo & Richardson, 1991)
- o Reliability: ICC = 0.92
- o Cut off: >12 seconds- greater fall risk

- **Berg Balance Scale (BBS)** comprising 14 items, each scored from 0 to 4, assessing activities such as transferring, standing, reaching, and turning.

Scale evaluating both static and dynamic balance in the performance of daily activities, such as standing, reaching, and turning.

- o Validity: high predictive validity (Berg et al., 1992)
- o Reliability ICC = 0.98
- o Score interval: 056; scores BT45 indicated increased risk of falling

3.5.1.5 Cognitive Abilities

A mini-mental state examination (MMSE) was modified and used as a measure of cognitive ability. These were tested in the areas of orientation (time and place), short-term memory, attention and calculation (e.g. serial sevens), recall, language (naming, repetition, following commands), reading, writing and visuoconstructive abilities. There was a maximum of 30 points. Introspective levels were also detected (e.g., alert, drowsy, comatose).

The cognitive functioning can be evaluated through a 30-point questionnaire that covers the following areas such as orientation, attention, memory, language, and visual-spatial skills **(Tombaugh & McIntyre, 1992).**

- o Validity: Correlated strongly with the degree of cognitive impairment
- o Reliability: Cronbach, alpha = 0.78
- o 19-23 suggests cognitive impairment

3.5.1.6 Physical Activity and Lifestyle

Respondents were inquired on how regularly they do physical activity like walking or swimming and more. The possible answers included the choices between the daily and rarely or never. This part was used in evaluating the importance of physical activities in ascertaining balance and overall functionality.

3.5.1.7 Fall Risk and Fear of Falling

Participants gave information on whether they fell in the previous year, how many and when these falls occurred. They were questioned whether they avoided some activities due to fear of falls and whether they were exercising any balance or rehabilitation sessions. The amount of concern over falling was ranked between 1 (not so concerned) to 10 (very concerned).

Evaluates the fear of falling involved in daily activities.

- o High predictive validity of avoidance of activities (Delbaere et al., 2010)
- o Reliability: ICC = 0.88
- o Score range: 16-64; scores above 28 mean that the person is afraid of falling considerably

3.5.1.8 Quality of Life

- In this section, the dimensions of quality of life (QoL) were measured through a scale that entailed a Likert-type format which took the following format: (1 = very dissatisfied, 5 = very satisfied). Those were satisfaction with health, ability to have fun in life, interference of pain, concentration, energy levels, body image, access to healthcare and transportation, and social relationships. It gave a comprehensive picture of how balance and health condition can affect everyday life and affect the state of emotions.

- The 26-Item Short Form Health Survey (SF-26):

Assesses eight areas in physical and mental health.

- o Reliability: Cronbach alpha 0.78-0.93 (Burholt & Nash, 2011)
- o Validity: Generally accepted and applied in clinical studies
- o Offers a general perspective of the impact of health status on the general well-being

3.5.1.9 Nottingham Extended Activities of Daily Living (NEADL)

The participants were supposed to rate how they could carry out 22 daily activities independently, with difficulty, with assistance or not at all. Walking outside, climbing stairs, cooking, cleaning up dishes, financial management, traveling through a bus and engaging in social gatherings involved in the range of activities. This questionnaire detected the level of functional autonomy in the elderly population.

- Nottingham Extended Activities of Daily Living (NEADL) Scale: Functional scales of independence is measured in minimum basic areas including mobility, leisure, domestic activities and communication.

o Validity: shows a close relationship with the ability to live independently (Nouri & Lincoln, 1987)

o Reliability: Cronbach alpha 0.93

o range of scores: 0-66; scores less than 44 indicate functional dependence

3.5.1.10 Social Participation

This final section examined the participants' involvement in social and community activities both before and after the age of 60. Activities included visiting or receiving visits from friends and relatives, attending religious gatherings, volunteering, engaging in hobbies, and handling family responsibilities. The score was calculated before and after age 60, and the change was used to estimate the impact of aging on social integration.

3.6 Data Collection Procedure

Data collection was conducted during a predetermined study period of about 2-3 months after obtaining ethical approval by the concerned institutional review board. Recruitment occurred in local clinics, elder centers, physiotherapy units, and online resources including professional networks of therapists and social media.

The possible participants were contacted face-to-face or over-the-phone and asked to participate. Individuals who show interest received detailed information on the study which entails its objective, procedure, risks, and rights as participants. Before participation, written informed consent was obtained.

All the tests were done in a quiet and well-lit room/ a quiet and well-lit home of the participant or a clinic or specifically at an assessment site. The study was carried out through collection of data by either trained physiotherapists or research assistants that have had prior training on the administration of all the standardized tests in a prescribed and ethical manner.

Every assessment session was about 45 to 60 minutes and the participants were expected to:

- Fill in the data questionnaire on the demographics and health data
- Physically test (e.g. Single-Leg Stance, TUG, BBS)
- Carry out full cognitive and psychometric tests (e.g., MMSE, Fear of Falling)
- Maintenance of Vision, proprioceptive, functional activity, and Quality-of-life tests

The data collected were entered into a password secure digital database and the identity of participants was coded and anonymized to promote confidentiality.

3.7 Statistical Analysis

Statistical data analysis is conducted via Statistical Package for the Social Science (SPSS) version 28.0. Statistical processing was done after screening all data on completeness and correctness.

The following steps were undertaken:

• **Descriptive statistics** were used to summarize participant characteristics, including age, gender, education, comorbidities, and test scores. Means, standard deviations, frequencies, and percentages were reported as appropriate.

• **Inferential statistics** was conducted to examine associations between variables.

o Pearson or Spearman correlation coefficient helped investigate the relationships among continuous variables, namely, balance scores, cognitive functioning, and quality of life.

o ANOVA or independent t-tests can be used to compare balance or functional outcomes among categorical variables (e.g., gender, degree of physical activity).

o Categorical associations (e.g., fear of falling vs. history of falls) were tested with chi-square tests.

• **A multivariate regression** was carried out to detect important predictors of the risk of falls including age, proprioception, cognitive performance, and psychological parameter, whereas the confounders were removed.

The statistical significance is set at p -value < 0.05. Where warranted, there are also confidence intervals. The findings shall be presented in tables and graphs, facilitating easy interpretation and comparisons.

3.8 Ethical Considerations

All ethical standards for research involving human participants were adhered to in this study. The study received ethical approval from the Institutional Review Board (IRB) of Al-Quds University prior to data collection (Approval No: 524/REC/2025).

All the participants were informed in detail and clearly the nature of the study, the purpose, the procedures to be carried out, any possible risk or benefits, that they were signing up to the study voluntarily and had the right to withdraw, without any consequences. Participation was informed consent in writing.

The privacy of the participants and confidentiality are strictly preserved. All the information is kept safely in the password-protected files of the computer. Data were anonymized by using the unique code instead of identifying data and only research team had access.

There was no physical or mental harm involved through participation. When any participant was identified to experience severe impairment of balance or psychological distress, she or he was referred to relevant medical care providers to undergo further assessment or assistive care.

Chapter Four

Results

4.1 Results presentation and analysis

4.1.1 Demographic and Baseline Characteristics

Table 4.1 delineates the demographic characteristics of the geriatric participants in our study. The mean age (SD) was 67.8 (6.54) years, with 56.0% of participants identifying as female. Seventy percent of individuals reside with family, whereas around one-third has a university degree or higher. The average weight was 75.5 kg (SD = 12.15 kg), the average height was 164.9 cm (SD = 8.98 cm), and the average BMI was 27.9 (SD = 4.7) (kg/m^2). For more about the demographic of the sample see table 4-1 and Fig 1.

Table 4.1: Demographic characteristics of the participants (N=323)

Characteristics		N	%	M(SD)
Age				67.8(6.54)
Height (CM)				164.9(8.98)
Weight (Kg)				75.5(12.15)
BMI (kg/m^2)				27.9(4.7)
Gender	Male	142	44.0	
	Female	181	56.0	
Education Level	No formal education	30	9.3	
	Primary	64	19.8	
	Secondary	126	39.0	
	University or above	103	31.9	
Living Status	Living alone	94	29.1	
	With family	229	70.9	

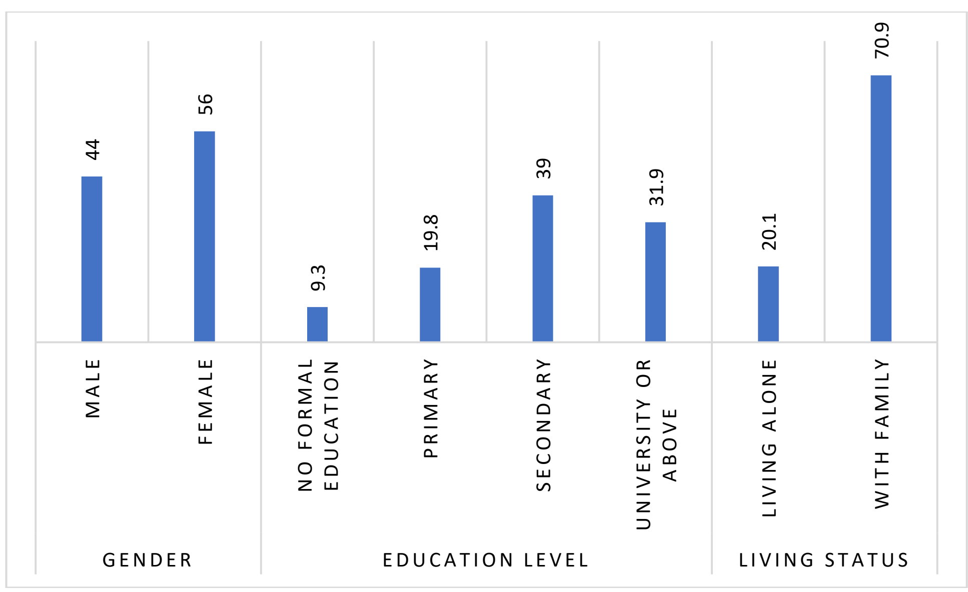


Figure 4.1: Demographic profile of the study participants.

4.1.2 Physical, Cognitive, and Psychological Factors

4.1.2.1 Physical Factors

According to table 4.2, Physical health and mobility assessments revealed that the majority of participants (67.8%) were on regular medications. Factors related to vision showed that 50.2% of people used corrective glasses and 64.4% of people said their vision was "good" or "excellent." A lot of people had problems with their balance and movement. For example, 52.9% said their balance had gotten worse in the last year, 58.8% said they had trouble walking on uneven ground, and 37.8% said they couldn't stand on one leg for 10 seconds. Levels of physical movement were different; 42.4% of people rarely or never exercised. 24.1% said they used an assistive device, mostly a cane (11.5%) or a walker (6.2%) (see Fig 2). Single-leg stance times averaged 10.83(13.1)

Table 4.2*:* Physical Factors: Health, Vision, Balance, Mobility, and Activity Levels (N=323)

Characteristics		**N**	**%**	**M(SD)**
	Health Status			
Regular Medications	Yes	219	67.8	
	No	104	32.2	
	Vision			
Wearing glasses or contact lenses	Yes	162	50.2	
	No	161	49.8	
Self-rated vision during daily activities	Excellent	97	30.0	
	Good	111	34.4	
	Fair	79	24.5	
	Poor	36	11.1	
Fisher score				4.8(1.1)
	Balance & Mobility			
Feeling unsteady while standing or walking	Never	120	37.2	
	Rarely	72	22.3	
	Sometimes	95	29.4	
	Often	36	11.1	
Ability to stand on one leg for at least 10 seconds	Yes	201	62.2	
	No	122	37.8	
Difficulty walking uneven surfaces	Yes	190	58.8	
	No	133	41.2	
Balance deterioration during the past year	Yes	171	52.9	
	No	152	47.1	
Frequency of dizziness or vertigo	Never	83	25.7	
	Rarely	109	33.7	
	Sometimes	97	30.0	
	Often	34	10.5	
Physical Activity Frequency	Rarely\never	137	42.4	
	1-2 weeks	76	23.5	
	3-5 weeks	110	34.1	
Use of assistive device	None	245	75.9	
	Cane	37	11.5	
	Walker	20	6.2	
	Wheelchair	16	5.0	
	Other	5	1.5	
Single Leg Stance Time				10.83(13.1)

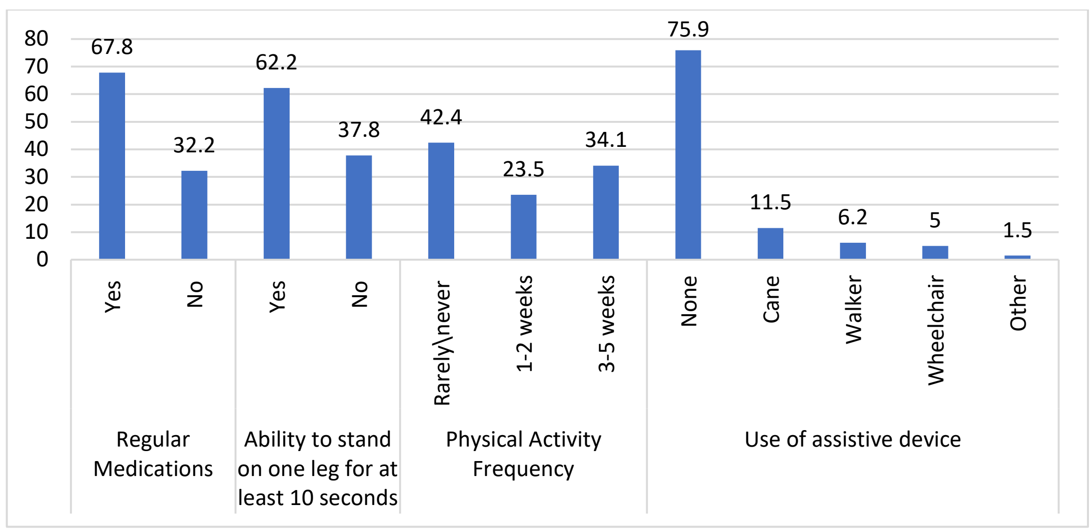


Figure 4.2: Percentage distribution of physical factors (health, vision, balance, mobility, and activity levels).

4.1.2.2 Cognitive Factors

A cognitive test showed that 73.7% of the participants had a cognitive impairment that had been identified. People often said they had memory problems; 28.8% said they had problems "sometimes" and 4.3% said they had problems "often." Rarely did people have trouble concentrating—87.9% said they "never" had problems. The average MMSE score was 26.07 with a standard deviation of 5.2. This showed that cognitive function was usually fine, though there was a lot of variation, for more details see table 4.3 and Fig 3.

Table 4.3. Cognitive Factors: Memory, Concentration, Diagnosis, and MMSE Scores (N=323)

Characteristics		N	%	M(SD)
Memory problems	Never	150	46.4	
	Rarely	66	20.4	
	Sometimes	93	28.8	
	Often	14	4.3	
Concentration difficulty	Never	39	12.1	
	Rarely	284	87.9	
Diagnosed cognitive impairment	Yes	238	73.7	
	No	85	26.3	
Manage Daily Tasks Independently	Yes	238	73.7	
	No	85	26.3	
MMSE				26.07(5.2)

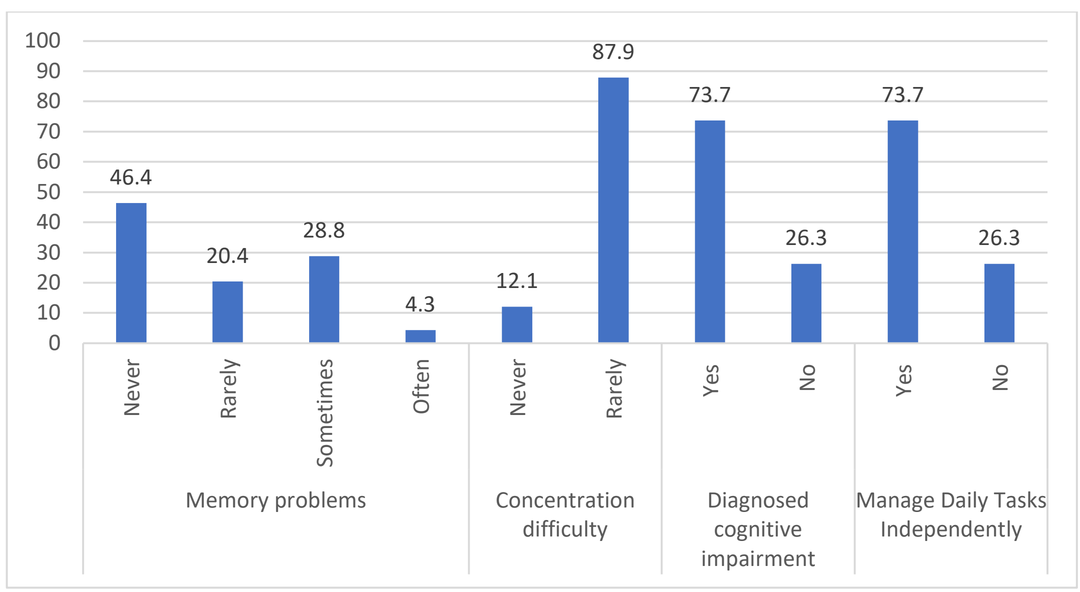


Figure 4.3: Percentage distribution of cognitive factors, including memory, concentration, and diagnosis.

4.1.2.3 Psychological, Social & Participation Factors

The findings in table 4.4 and Fig 4 reveal that the fear of falling was clear, with 67.8% refraining from activities due to this apprehension. 67.8% of people avoided tasks because they were afraid of falling. It was 4.84 ± 3.2 on a scale of 1 to 10 for worry about falling. Only a small percentage (22.9%) were in classes for balance or recovery. 16.1% of people had a fall in the last year, and each person had an average of 0.91 ± 1.6 falls. The average score on the FES-i for falls was 32.5 ± 16.0, which means that people were somewhat afraid of falling. This group of older people was only 28.4% involved in their communities on average, which is 22.3% less than the national average. The participants reported moderate quality of life across all domains. Mean scores were 54.7 for physical, 56.1 for psychological, 58.9 for social, and 58.1 for environmental well-being, with social and environmental domains slightly higher than physical and psychological., these findings indicate that the elderly participants reported moderate levels of QOL across physical, psychological, social, and environmental aspects, with social and environmental domains slightly higher than physical and psychological domains, table 4-4.

Table 4.4: Psychological, Social, and Participation Factors: Fear, Falls, and Community Engagement (N=323)

Characteristics		N	%	M(SD)
Avoid Activities Due to Fear	Yes	219	67.8	
	No	104	32.2	
In Balance/Rehab Program	Yes	74	22.9	
	No	249	77.1	
Worry About Falling (1–10)				4.84(3.2)
Fall in Past Year	Yes	52	16.1	
	No	271	83.9	
Number of Falls				0.91(1.6)
FES-i Total Score				32.5(16.0)
Community Participation (%)				28.4(22.3)
QOL – physical				54.72(15.7)
QOL – psychological				56.05(16.3)
QOL – Social				58.90(23.9)
QOL – Environmental				58.13(19.8)

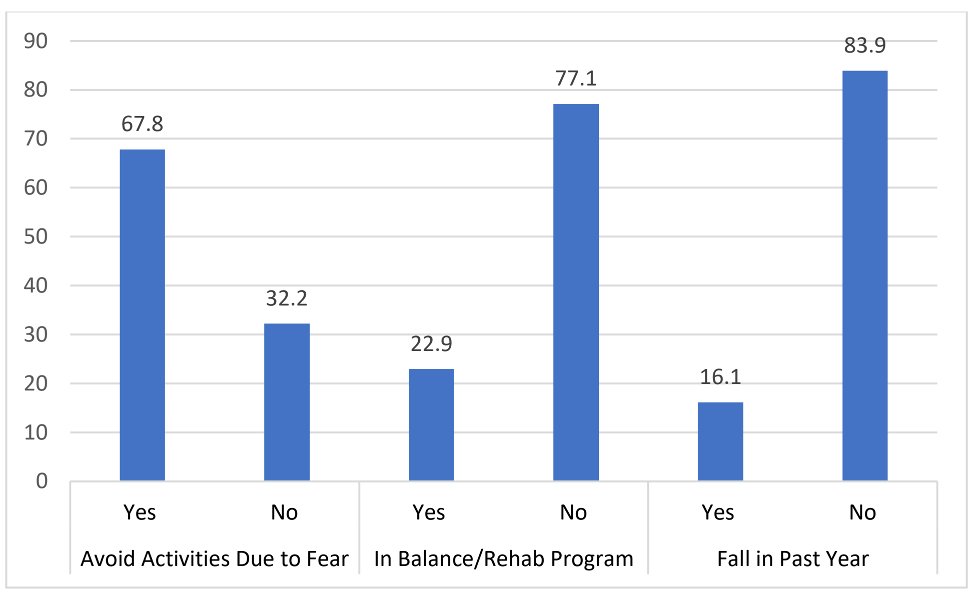


Figure 4.4: Percentage distribution of psychological, social, and participation factors, including fear, falls, and community engagement.

4.1.3 Analysis of factors, associations, and predictors of balance outcomes

4.1.3.1 Analysis of factors associated with berg balance score

4.1.3.1.1 Descriptive statistics for Berge balance score

Table 4.5 illustrates the distribution of balance performance across the individuals. The average BBS score was 41.15 (16.3), signifying that participant exhibited intermediate balancing capability. A majority of individuals (64.4%) were classified as low risk, whereas 20.7% were categorized as medium risk, and 14.9% were identified as high risk for falls (Fig 5). These findings demonstrate that while many people had reasonably decent balance, a considerable number nevertheless suffers from clinically relevant balance deficits.

Table 4.5: Descriptive Statistics of Berg Balance Score (BBS)

	Min	Max	Mean (SD)	BBS level	N	%
Berge balance score	.00	56	41.15(16.3)	Low risk (41-56)	208	64.4
				Medium risk (21-40)	67	20.7
				High risk (0-20)	48	14.9

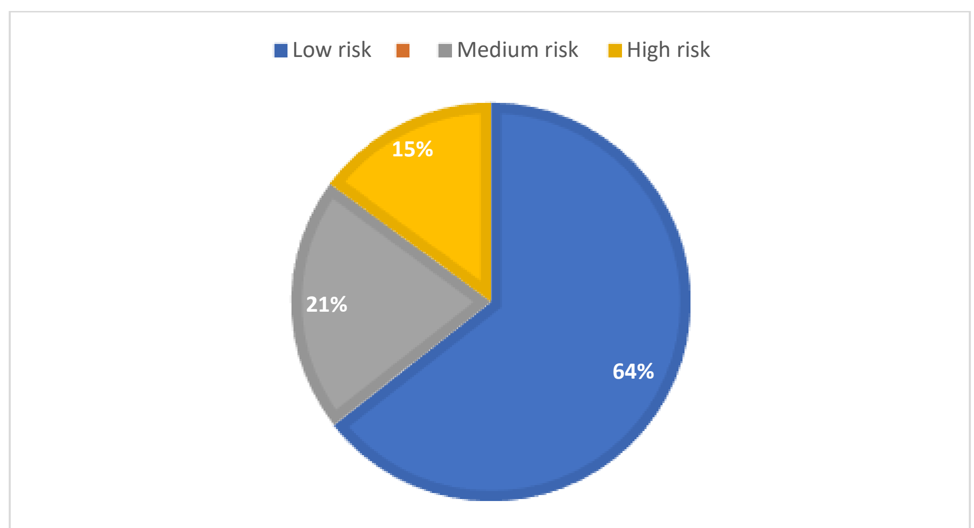


Figure 4.5: Percentages of Berg Balance Score level**.**

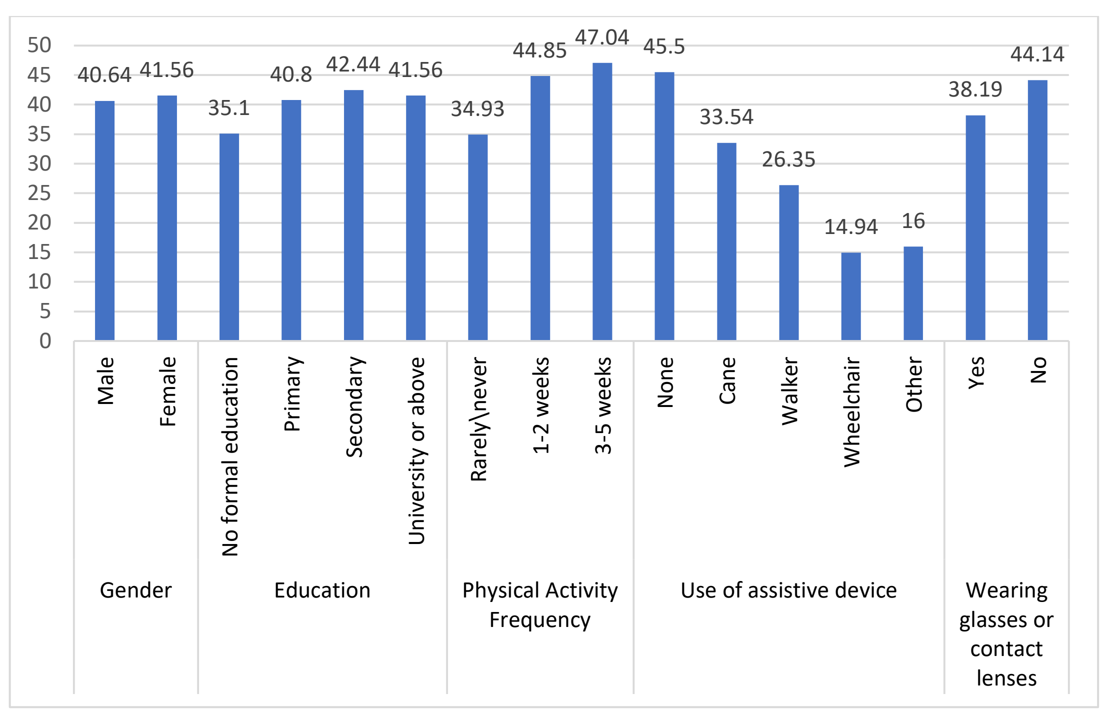
4.1.3.1.2 Difference in Berge balance score across participant factors

Table 4.6 compares BBS scores across various demographic and health-related categories. No notable disparities were observed regarding gender, education, or medication usage. However, numerous factors indicated strong relationships. Who occasionally participated in physical activity, utilized assistance aids, experienced challenges walking on irregular flooring, demonstrated cognitive impairments, or were unable to balance on one leg obtained markedly lower scores on the BBS ($p < 0.001$). These findings underscore that physical ability, cognitive condition, critical factors, and mobility constraints and

influence balancing performance measured by BBS. Fig. 6 and Fig. 7 present the *Mean BBS scores across participant factors*

Table 4.6: Differences in BBS Across Participant Factors

Variable		Mean	SD	Test statistics	p-value	Test type
Gender	Male	40.64	15.94	-0.5	0.61	Independent t test
	Female	41.56	16.67			
Education	No formal education	35.10	17.35	1.68	0.17	One way ANOVA
	Primary	40.80	16.64			
	Secondary	42.44	15.43			
	University or above	41.56	16.73			
Physical Activity Frequency	Rarely\never	34.93	17.47	19.77	<0.001	One way ANOVA
	1-2 weeks	44.85	13.21			
	3-5 weeks	47.04	14.55			
Use of assistive device	None	45.50	14.56	31.0	<0.001	One way ANOVA
	Cane	33.54	9.72			
	Walker	26.35	11.45			
	Wheelchair	14.94	15.75			
	Other	16.00	0.21			
Wearing glasses or contact lenses	Yes	38.19	17.45	-3.3	0.001	Independent t test
	No	44.14	14.57			
Regular Medications	Yes	40.40	17.00	-1.2	0.23	Independent t test
	No	42.74	14.77			
Ability to stand on one leg for at least 10 seconds	Yes	45.80	15.00	7.03	<0.001	Independent t test
	No	33.51	15.59			
Difficulty walking uneven surfaces	Yes	35.88	15.92	-7.15	<0.001	Independent t test
	No	48.69	13.79			
Diagnosed cognitive impairment	Yes	36.63	16.44	-5.50	<0.001	Independent t test
	No	46.24	14.66			
Manage Daily Tasks Independently	Yes	44.37	14.50	6.25	<0.001	Independent t test
	No	32.16	17.83			



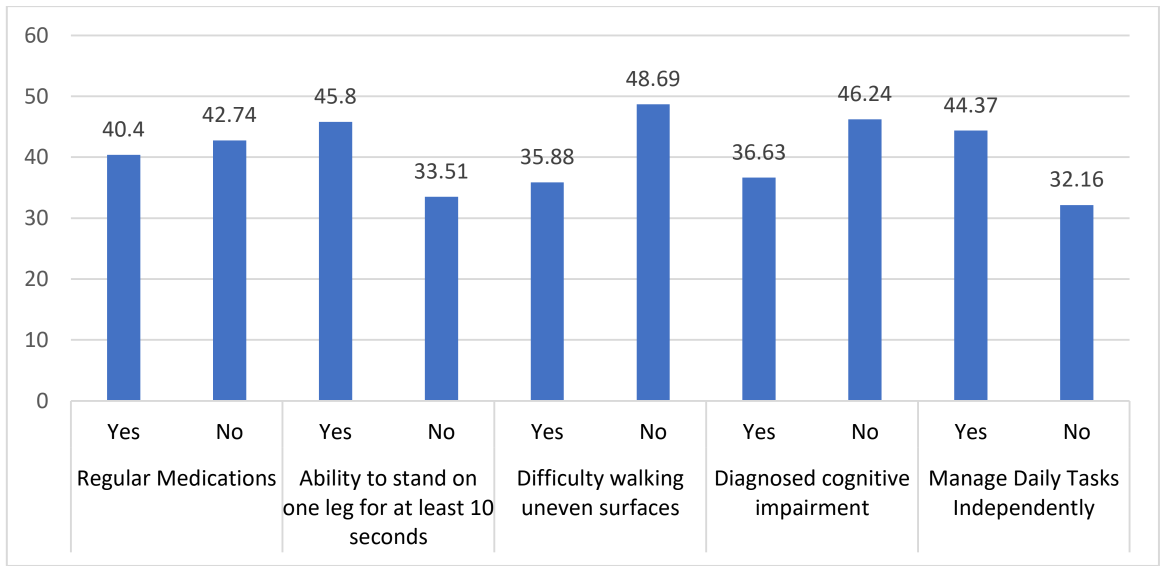


Figure 4.6: Mean Berg Balance Scale (BBS) scores across participant factors

4.1.3.1.3 Association between Berg score and study variable

The correlation analysis presented in table 4.7 shows that BBS scores were significantly related to several factors. Better balance was moderately associated with higher MMSE cognitive scores (r = 0.502) and better functional performance (ADL, Fisher score). On the other hand, lower BBS scores were linked with more falls, unsteadiness, memory problems, eye problems, and dizziness in the past year. These correlations show that balance ability goes down when people have sensory or cognitive issues or a fear of falling. Fig. 7 presents the *correlations of BBS with Balance, Health, Function, and Psychosocial Factors*

Table 4.7: Bivariate Correlations of BBS: Balance, Health, Function, and Psychosocial Factors

Variable	Pearson Correlation (r)	p-value	Variable	Spearman Correlation (r)	p-value
Age	-0.103	<0.001	Dizziness	-0.472	<0.001
BMI	-0.105	0.059	Self-related vision	-0.334	<0.001
Comorbidities	0.05	0.37	Memory problem	-0.411	<0.001
Fisher score	0.320	<0.001	Concentration difficulty	0.212	0.001
MMSE	0.502	<0.001	Feeling unsteady while standing or waking	0.356	<0.001
The number of falls last year	-0.307	<0.001			
FES-i	-0.007	0.901			
ADL	0.214	<0.001			
Participation	-0.191	0.001			
QOL	0.025	0.065			

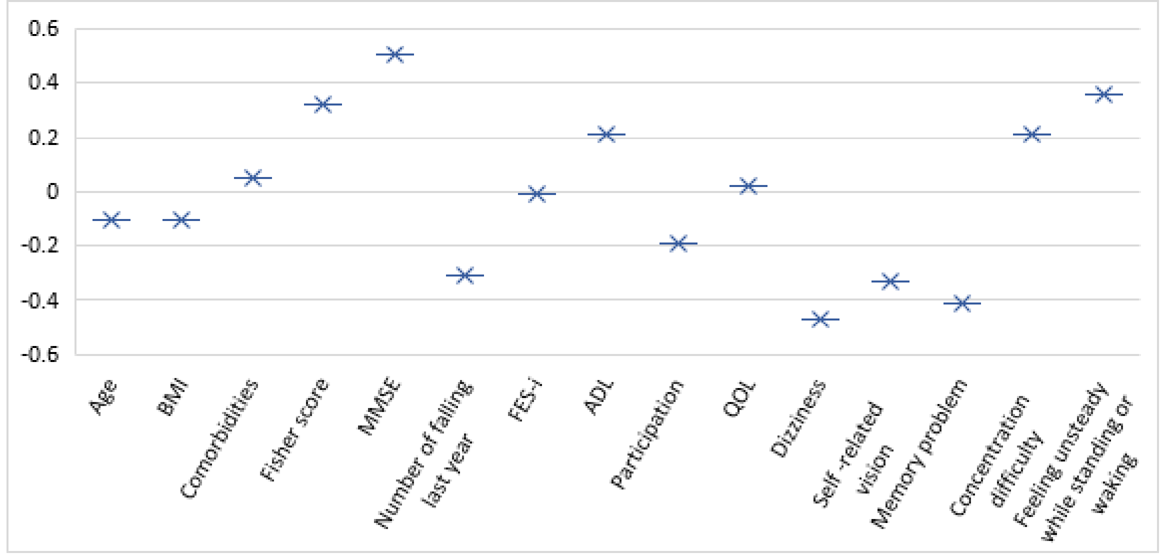


Figure 4.7: Correlations of BBS with Balance, Health, Function, and Psychosocial Factors

4.1.3.1.4 Predictor of berg score

The regression model explains 35.2% of the variance in BBS scores ($R^2 = 0.352$). Three significant predictors remained in the final model: use of assistive devices**,** memory problems, and Fisher score. Using an assistive device and reporting memory problems predicted lower BBS scores, while higher functional ability (Fisher score) predicted better balance. This indicates that both physical and cognitive factors contribute meaningfully to balance performance (see table 4.8 and Fig. 4.8).

Table 4.8*:* Regression Models Predicting Balance (BBS)

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
3	(Constant)	57.344	4.615		12.427	<.001
	Use of assistive device	-7.391	.883	-.402	-8.371	<.001
	Memory problems	-4.150	.833	-.244	-4.980	<.001
	Fisher score	1.996	.674	.142	2.963	.003

Dependent Variable: Berg score, R-square=0.352, F=57.71, p-value<0.001; method: Stepwise

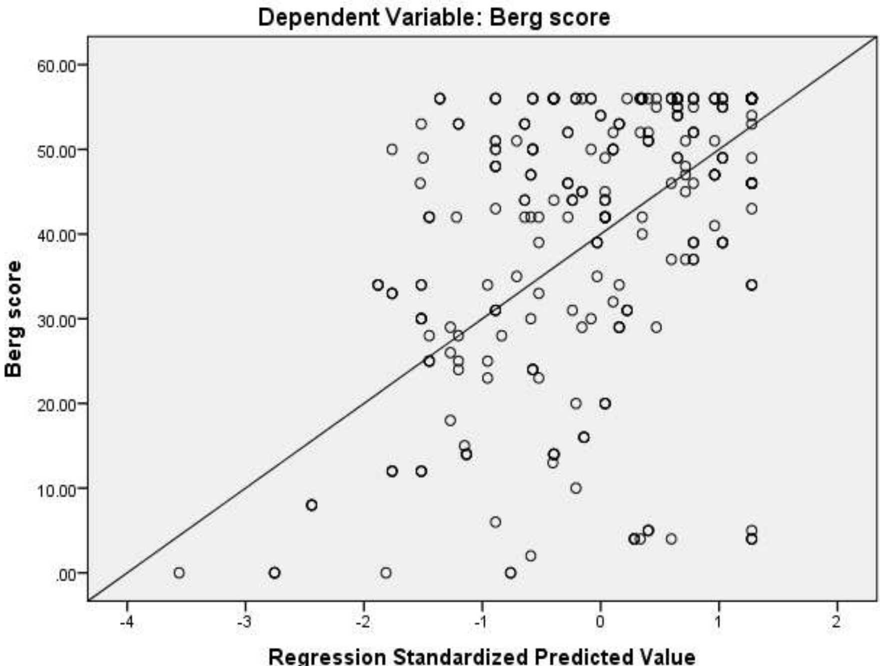


Figure 4.8: Scatterplot showing the relationship between standardized predicted values and observed Berg Balance Scale (BBS) scores.

4.1.3.2 Analysis of factors associated with TUG score

4.1.3.2.1 Descriptive statistics for TUG score

The mean TUG time was 9.0 (7.2) seconds, indicating generally normal mobility. About 38.7% of participants were within the normal range (<10 seconds), while 44.6% were at moderate risk and 16.7% at high risk of falls. These results suggest that although many participants have acceptable functional mobility, more than half demonstrate some degree of fall risk (table 4.9 and Fig. 4.9).

Table 4.9: Descriptive Statistics of TUG Score

	Min	Max	Mean (SD)	TUG level	N	%
TUG	.00	47.60	9.00(7.2)	Normal (<10s)	125	38.7
				At risk (10-13.5s)	144	44.6
				High risk (>13.5)	54	16.7

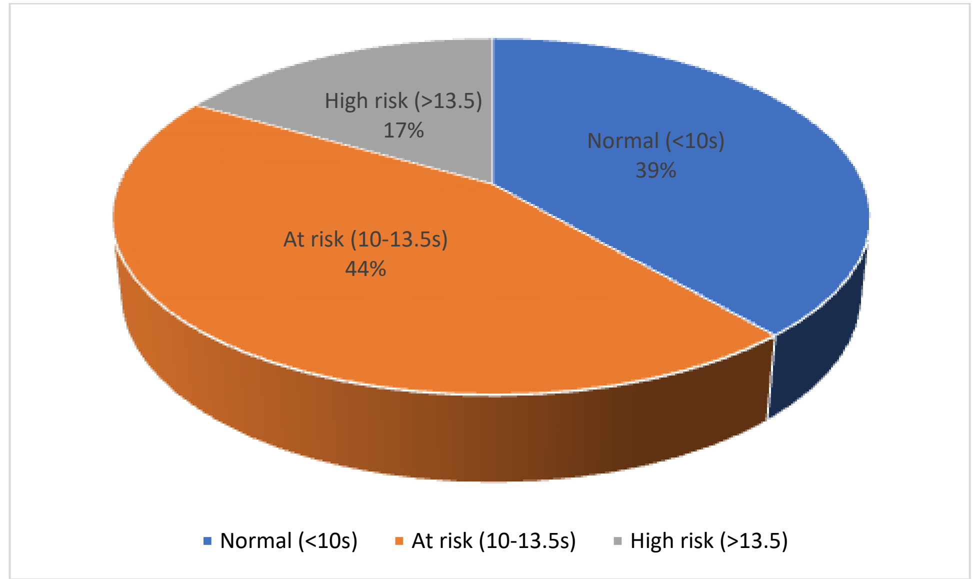


Figure 4.9: Percentages of TUG level.

4.1.3.2.2 Difference in TUG score across participant factors

Table 4.10, Fig. 4.10 indicate that the majority of sociodemographic characteristics (gender, education, medication use) did not significantly influence TUG results. Considerable disparities were noted in the utilization of assistive devices ($p < 0.001$) and cognitive impairment ($p < 0.001$). Individuals utilizing walkers or wheelchairs, as well as those diagnosed with cognitive impairment, exhibited diminished movement. Conversely, people capable of autonomously managing daily duties had quicker TUG times.

Table 4.10: Difference in TUG score across participant factors

Variable		Mean	SD	Test statistics	p-value	Test type
Gender	Male	9.7398	8.35489	1.6	0.10	Independent t test
	Female	8.4160	6.15051			
Education	No formal education	9.24	7.40	0.13	0.94	One- way ANOVA
	Primary	8.83	6.90			
	Secondary	8.76	8.00			
	University or above	9.32	6.41			
Physical Activity Frequency	Rarely\never	9.44	5.51	0.63	0.53	One- way ANOVA
	1-2 weeks	8.47	8.44			
	3-5 weeks	9.35	6.61			
Use of assistive device	None	9.07	6.03	9.98	<0.001	One- way ANOVA
	Cane	9.58	8.61			
	Walker	14.66	12.98			
	Wheelchair	1.13	2.68			
	Other	0.30	0.11			
Wearing glasses or contact lenses	Yes	9.30	8.36	0.76	0.45	Independent t test
	No	8.69	5.86			
Regular Medications	Yes	8.62	6.99	-1.38	0.34	Independent t test
	No	9.80	7.66			
Ability to stand on one leg for at least 10 seconds	Yes	9.33	5.87	1.60	0.28	Independent t test
	No	8.45	9.02			
Difficulty walking uneven surfaces	Yes	8.44	7.97	-1.7	0.097	Independent t test
	No	9.80	5.93			
Diagnosed cognitive impairment	Yes	7.23	6.63	-4.80	<0.001	Independent t test
	No	10.99	7.37			
Manage Daily Tasks Independently	Yes	9.57	6.09	2.14	0.016	Independent t test
	No	7.38	9.57			

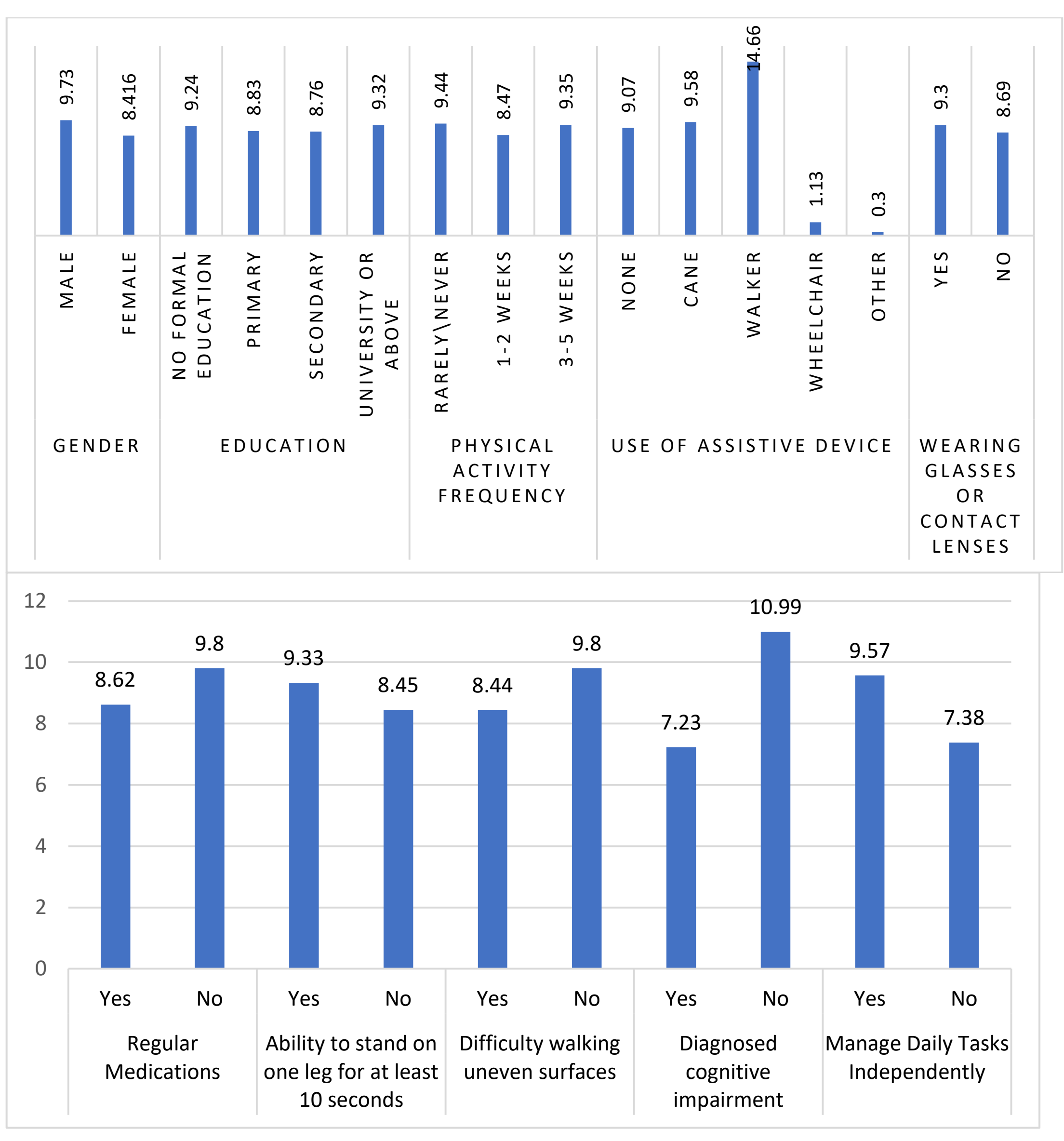


Figure 4.10: Mean TUG scores across participant factors

4.1.3.2.3 Association between TUG score and study variable

Several variables demonstrated significant correlations with TUG performance. Worse balance was associated with dizziness, concentration difficulty, unsteadiness, and history of falling. Better performance was associated with higher cognitive function (MMSE) and higher ADL scores. These findings emphasize the importance of cognitive and functional abilities in determining mobility speed, for more details see table 4.11 and Fig 11.

Table 4.11: Bivariate Correlations of TUG: Health, Function, and Psychosocial Factors

Variable	Pearson Correlation (r)	p-value	Variable	Spearman Correlation (r)	p-value
Age	-0.09	0.10	Dizziness	-0.235	<0.001
BMI	0.083	0.14	Self -related vision	0.062	0.26
Number of Comorbidities	-0.085	0.19	Memory problem	-0.101	0.071
MMSE	0.197	<0.001	Concentration difficulty	0.230	<0.001
Fisher score	-0.03	0.58	Feeling unsteady while standing or waking	0.280	<0.001
Number of falling last year	-0.166	0.003			
FES-i	0.09	0.1			
ADL	0.12	0.032			
Participation	-0.38	0.5			
QOL	-0.085	0.13			

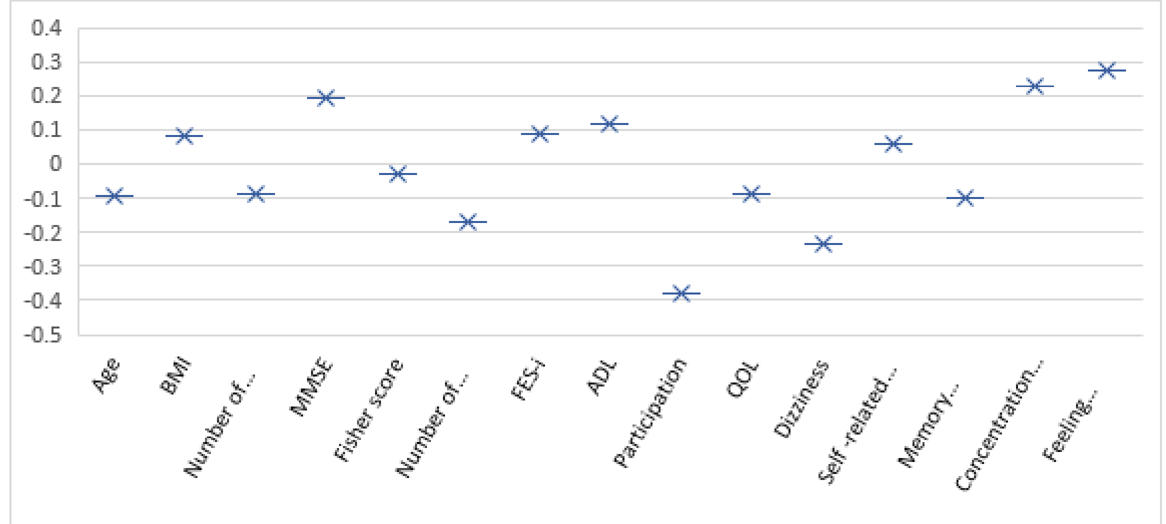


Figure 4.11*:* Correlations of TUG with Balance, Health, Function, and Psychosocial Factors

4.1.3.2.4 Predictor of TUG

The regression model presented in table 4.12 explained **7.1%** of the variance in TUG scores (R^2 = 0.071). Three factors predicted TUG time: feeling unsteady**,** memory problems**,** and Fisher score. Unsteadiness and memory problems were associated with slower TUG performance, while better functional ability predicted faster times. Although the model explains a modest proportion of variance, it shows that both physical stability and cognitive status influence mobility. The scatterplot in Fig. 4.12 show showing the relationship between standardized predicted values and observed TUG scores.

Table 4.12. Regression Model Predicting TUG Score

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
3	(Constant)	9.424	3.031		3.109	.002
	Feeling unsteady while standing or walking	-1.445	.395	-.216	-3.660	.000
	Memory problems	3.854	1.220	.174	3.160	.002
	Fisher Score	-.946	.372	-.152	-2.543	.011

Dependent Variable: TUG, R-square=0.071, F=8.1, p-value<0.001; method: Stepwise

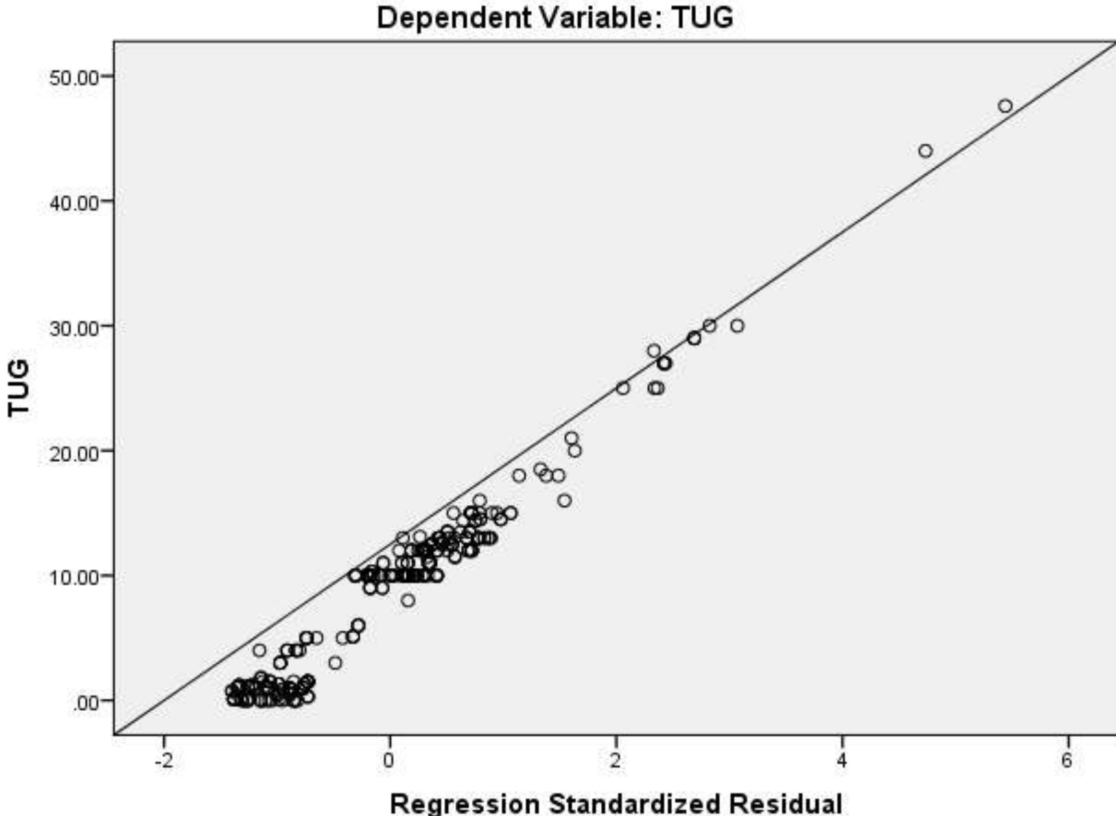


Figure 4.12: Scatterplot showing the relationship between standardized predicted values and observed TUG scores.

4.1.3.3 Analysis of factors associated with Single Leg stance (SLS) score

4.1.3.3.1 Descriptive statistics for SLS score

The Single Leg Stance time ranged from 0 to 110 seconds, with a mean of 10.83 ± 13.1 seconds. This suggests that overall, participants demonstrated reduced postural stability, as average SLS times were relatively low compared to normative values for older adults (table 4.13).

Table 4.13. Descriptive Statistics of SLS Score

Variable	min	Max	Mean	SD
Single Leg Stance Time	0	110	10.83	13.1

4.1.3.3.2 Difference in SLS across participant factors

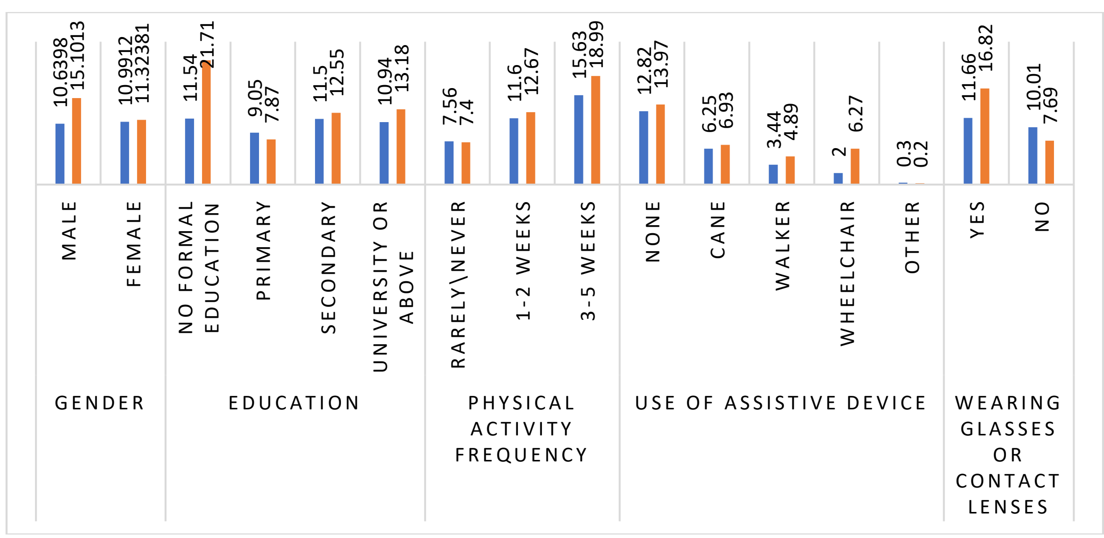
Table 4.14, Fig. 4.13 present the difference of SLS across several factors. Significant differences were observed across several categories. Individuals exhibiting elevated levels of physical activity, absence of assistive device utilization, no cognitive deficits, and no challenges in ambulating on irregular terrains demonstrated markedly extended SLS durations ($p < 0.001$). Individuals utilizing assistance devices or undergoing regular medication had inferior balance. The data indicate that levels of physical activity, cognitive health, and mobility status significantly affect static balance.

Table 4.14 -A: Difference in SLS score across participant factors

Variable		Mean	SD	Test statistics	p-value	Test type
Gender	Male	10.6398	15.10130	-0.24	0.81	Independent t test
	Female	10.9912	11.32381			
Education	No formal education	11.54	21.71	0.53	0.66	One way ANOVA
	Primary	9.05	7.87			
	Secondary	11.50	12.55			
	University or above	10.94	13.18			
Physical Activity Frequency	Rarely\never	7.56	7.40	10.1	<0.001	One way ANOVA
	1-2 weeks	11.60	12.67			
	3-5 weeks	15.63	18.99			
Use of assistive device	None	12.82	13.97	6.95	<0.001	One way ANOVA
	Cane	6.25	6.93			
	Walker	3.44	4.89			
	Wheelchair	2.0	6.27			
	Other	0.3	0.2			
Wearing glasses or contact lenses	Yes	11.66	16.82	1.13	0.25	Independent t test
	No	10.01	7.69			
Regular Medications	Yes	9.05	7.30	-3.6	<0.001	Independent t test
	No	14.61	20.06			

Table 4.14 -B: Difference in SLS score across participant factors

Ability to stand on one leg for at least 10 seconds	Yes	14.02	14.97	5.90	<0.001	Independent t test
	No	5.59	6.45			
Difficulty walking uneven surfaces	Yes	7.90	6.94	-5.00	<0.001	Independent t test
	No	15.04	17.87			
Diagnosed cognitive impairment	Yes	7.38	7.29	-5.2	<0.001	Independent t test
	No	14.72	16.65			
Manage Daily Tasks Independently	Yes	12.52	14.26	3.96	<0.001	Independent t test
	No	6.11	7.29			



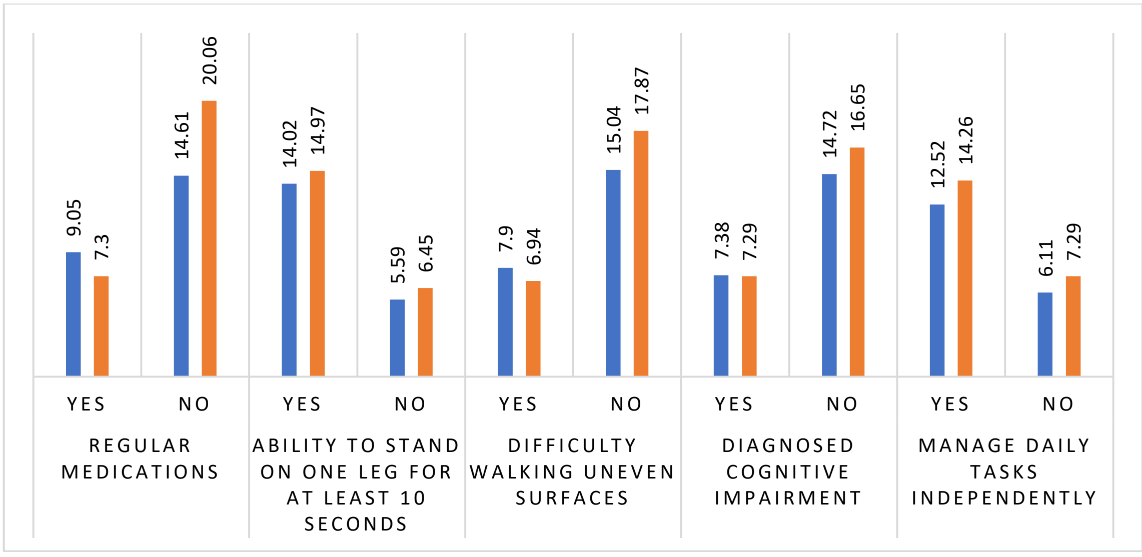


Figure 4.13: Mean SLS scores across participant factors.

4.1.3.3.3 Association between SLS score and study variable

SLS scores showed significant negative correlations with dizziness, poor vision, cognitive problems, concentration difficulty, unsteadiness, and fall history. Positive correlations were observed with Fisher score. This indicates that SLS is sensitive to sensory, cognitive, and functional limitations (table 4.15, Fig. 4.14).

Table 4.15: Bivariate Correlations of SLG: Balance, Health, Function, and Psychosocial Factors

Variable	Pearson Correlation (r)	p-value	Variable	Spearman Correlation (r)	p-value
Age	0.01	0.85	Dizziness	-0.330	<0.001
BMI	0.009	0.87	Self-related vision	-0.307	<0.001
Number of Comorbidities	0.065	0.24	Memory problem	-0.007	0.901
MMSE	-0.29	<0.001	Concentration difficulty	-0.191	0.001
Fisher score	0.122	0.028	Feeling unsteady while standing or waking	-0.26	<0.001
Number of falling	-0.176	<0.001			
FES-i	-0.025	0.66			
ADL	-0.07	0.21			
Participation	0.015	0.79			
QOL	0.003	0.96			

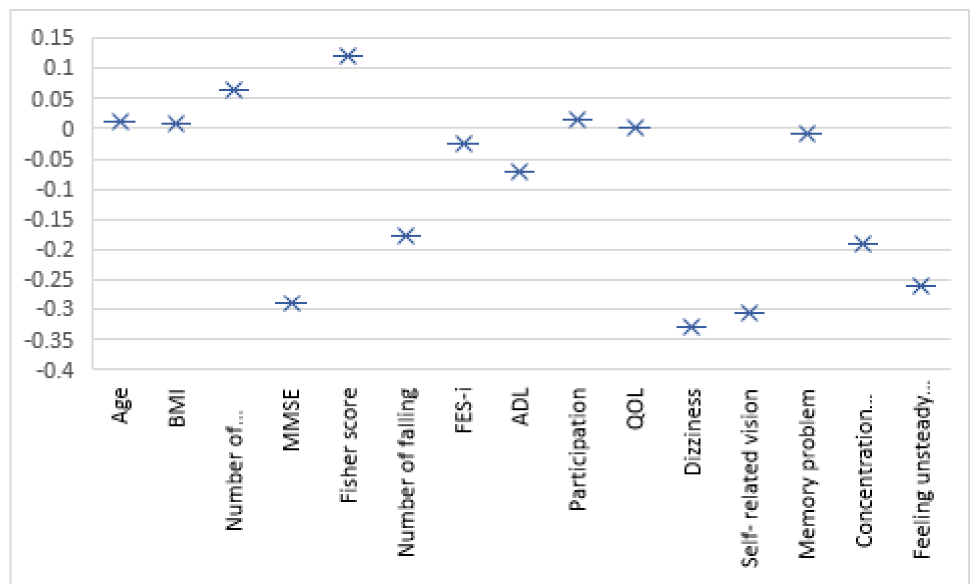


Figure 4.14: Correlations of SLS with Balance, Health, Function, and Psychosocial Factor

4.1.3.3.4 Predictor of SLS

The regression model presented in table 4.16 explained 15.8% of the variance in SLS performance (R^2 = 0.158). Significant predictors included memory problems, use of assistive device, regular medication use, and physical activity frequency. Memory

problems and assistive device use predicted poorer balance, while regular medication use and frequent physical activity predicted better balance performance. This suggests that static balance is influenced by a combination of physical, functional, and cognitive factors. The scatterplot in Fig. 4.15 show showing the relationship between standardized predicted values and observed SLS scores.

Table 4.16. Regression Model Predicting SLS Score

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
4	(Constant)	22.871	3.669		6.234	<0.001
	Memory problem	-2.861	.756	-.210	-3.786	<0.001
	Use of an assistive device	-3.035	.799	-.206	-3.796	<0.001
	Regular Medications	4.237	1.475	.151	2.873	<0.001
	Physical Activity Frequency	-2.295	.901	-.132	-2.547	.011

Dependent Variable: SLS, R-square=0.158, F=14.96, p-value<0.001; method: Stepwise

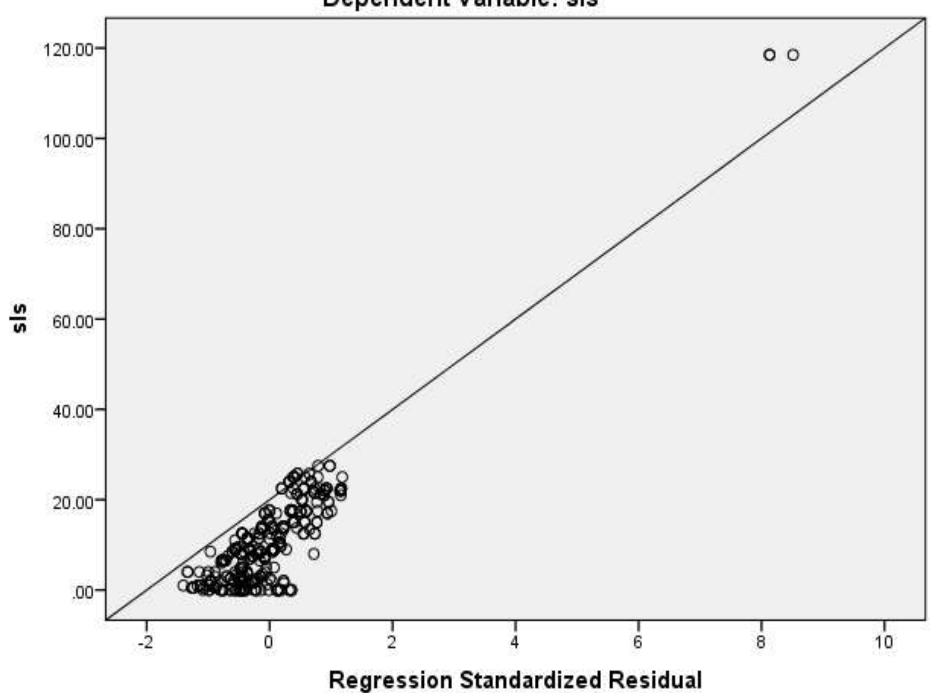


Figure 4.15: Scatterplot showing the relationship between standardized predicted values and observed SLS scores.

4.1.4 Effect of Balance Measures on Health, Psychological, and Functional Outcomes

This section examines how balance performance—measured using the Berg Balance Score (BBS), Timed Up and Go (TUG), and Single Leg Stance (SLS)—affects a range of physical, psychological, and functional variables among older adults. The models explore whether better balance predicts fewer falls, reduced fear of falling, better participation, higher quality of life, and less worry about falling.

4.1.4.1 Effect of Balance on Number of Falls

Table 4.17 reveals that the BBS was the most reliable and alone significant predictor of fall occurrences. Individuals exhibiting weaker BBS scores encountered a greater incidence of falls ($p < 0.001$), signifying that diminished balance is directly correlated with increased fall frequency. TUG and SLS were not substantial predictors. The model accounted for 15% of fall variability, affirming that balance capability significantly influences fall risk, but additional factors are also involved.

Table 4.17: Linear Regression Model Predicting number of falling

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig.
1	(Constant)	1.550	1.140		1.360	.175
	Age	.007	.014	.027	.505	.614
	Gender	-.107	.179	-.032	-.597	.551
	Education	.048	.094	.027	.510	.611
	BMI	.024	.019	.067	1.260	.209
	Berg score	-.034	.006	-.329	-5.678	.000
	TUG	-.024	.013	-.101	-1.880	.061
	SLS	-.007	.007	-.051	-.909	.364

Dependent Variable: number of fallings, R-square=0.15, F=7.90, p-value<0.001;

4.1.4.2 Effect of Balance on Fear of Falling (FES-I)

Balance measures did not significantly forecast FES-I scores. BBS, TUG, and SLS had no significant correlations with fear of falling, and the model lacked statistical significance ($p = 0.60$). This suggests that the fear of falling may be influenced more by psychological variables than by actual balance performance, indicating that individuals may experience dread while having good balance (more details presented in table 4.18).

Table 4-18: Linear Regression Model Predicting FES-I score (N=323)

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	10.487	12.109		.866	.387
	Age	.244	.144	.096	1.688	.092
	Gender	-.658	1.904	-.020	-.346	.730
	Education	-.506	1.000	-.029	-.506	.613
	BMI	.232	.199	.066	1.164	.245
	Berg score	-.002	.064	-.002	-.038	.970
	TUG	.122	.133	.053	.917	.360
	SLS	-.034	.077	-.026	-.437	.663

Dependent Variable: FES-! score, R-square=0.017, F=0.07, p-value=0.60;

4.1.4.3 Effect of Balance on Social Participation

Table 4.19 demonstrated that the BBS substantially predicted levels of participation (p = 0.001). Participants with worse BBS scores exhibited reduced social activity, indicating that compromised balance diminishes confidence and mobility, resulting in decreased participation in social or community endeavors. TUG and SLS were not substantial predictors. Despite the modest explained variance of 6%, the findings underscore the significance of balance in sustaining social engagement.

Table 4-19: Linear Regression Model Predicting Social Participation

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	44.266	15.894		2.785	.006
	Age	.095	.190	.028	.499	.618
	Gender	.994	2.499	.022	.398	.691
	Education	-1.740	1.313	-.073	-1.326	.186
	BMI	-.382	.261	-.081	-1.460	.145
	Berg score	-.292	.084	-.213	-3.495	.001
	TUG	.047	.175	.015	.269	.788
	SLS	.163	.101	.096	1.618	.107

Dependent Variable: participation, R-square=0.059, F=2.8, p-value=0.007;

4.1.4.4 Effect of Balance on Overall Quality of Life

According to the model presented in table 4.20, none of the balance measures significantly predicted overall quality of life, and the model was not statistically significant (p = 0.49). This suggests that quality of life is influenced by broader health, psychosocial, and environ mental factors, and is not solely determined by physical balance or mobility.

Table 4-20: Linear Regression Model Predicting Overall Quality of Life

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	38.234	9.959		3.839	.000
	Age	.129	.119	.061	1.081	.280
	gender	.265	1.566	.010	.169	.866
	educ	.580	.823	.040	.705	.481
	BMI	.303	.164	.105	1.849	.065
	Berg score	.028	.052	.033	.527	.599
	TUG	-.111	.110	-.058	-1.010	.313
	SLS	-.010	.063	-.010	-.161	.872

Dependent Variable: QOL, R-square=0.02, F=0.92, p-value=0.49;

4.1.4.5 Effect of Balance on Fall Occurrence (Logistic Regression) handsome

In the logistic regression model presented in table 4.21, the Berg Balance Score was the only balance variable approaching significance for predicting fall occurrence (p = 0.039). Lower BBS scores slightly increased the odds of falling, although the overall model explained a small proportion of the variance (3%). This further supports that balance contributes to fall risk, but falls are influenced by many additional factors.

Table 4.21: Logistic Regression Model for Variables Predicting Fall Occurrence (N=323)

		B	S.E.	Wald	df	Sig.	OR
Step 1[a]	Age	.018	.025	.519	1	.471	1.018
	Gender	-.091	.317	.083	1	.773	.913
	Educ	.124	.161	.586	1	.444	1.132
	BMI	-.038	.032	1.370	1	.242	.963
	Berg score	-.017	.010	2.720	1	.039	.856
	TUG	-.017	.021	.689	1	.407	.983
	SLS	.000	.014	.001	1	.981	1.000
	Constant	.901	2.008	.201	1	.654	2.463

R-square =0.029

4.1.4.6 Effect of Balance on Worry About Falling

The model predicting worry about falling showed strong and significant effects for BBS, TUG, and SLS. Poorer balance across all three measures was associated with greater worry about falling ($p < 0.05$). SLS and BBS showed the strongest effects. This indicates that worry about falling is closely linked to actual physical performance, unlike general fear of falling (FES-I), which was not related to balance (table 4.22).

Table 4.22: Linear Regression Model Predicting Worry About Falling

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.920	2.153		2.285	.023
	Age	.027	.026	.055	1.053	.293
	Gender	-.130	.339	-.020	-.383	.702
	Education	-.062	.178	-.018	-.348	.728
	BmI	.039	.035	.058	1.088	.277
	Berg score	-.038	.011	-.195	-3.372	.001
	TUG	-.054	.024	-.121	-2.262	.024
	SlS	-.056	.014	-.229	-4.100	.000

Dependent Variable: Worry About Falling, R-square=0.157, F=7.3, p-value<0.001;

4.1.5 Evidence-Based Balance factors

By concentrating on the factors identified in this study as significantly correlated, it may be feasible to enhance the equilibrium among the participants. Individuals who engage in regular exercise tend to have superior balance scores ($p < 0.001$). This indicates that increased frequency of exercise is crucial. In all models, cognitive impairments and the utilization of assistive devices were most significantly associated with poor balance ($p < 0.001$). This suggests that emotional support and strength training may enhance individuals' stability. Poor eyesight and dizziness, together with other sensory impairments, were associated with worse balance ($p < 0.001$). This makes it clear how important it is to treat vestibular and vision problems. People who could do their daily jobs on their own had a much better balance ($p < 0.001$), which shows that people need to train to improve their movement for their health. The main strategies of the study were to do more physical exercise, improve brain function, take care of sensory awareness, and learn how to be self-sufficient. The study's results support these strategies.

Table 4.23: Practical Strategies to Enhance Balance According to Study Findings

Improvement Strategy	Key Statistical Evidence
Increase physical activity	BBS & SLS $p < 0.001$
Reduce assistive device reliance	BBS $\beta = -0.402$, $p < 0.001$
Improve cognition/memory	Significant predictor in all models
Improve ADL independence	Significant across BBS, TUG, and SLS
Correct vision & reduce dizziness	Strong correlations ($p < 0.001$)
Train on uneven surfaces	BBS & SLS $p < 0.001$
Strengthen muscles	One-leg stance is strongly significant
Manage medications	SLS $p < 0.001$
Address unsteadiness	Significant correlations with all balance tests

4.2 Results Dıscussıon

The present study explored the multifactorial predictors of the risk of falls and balance in older adults who dwell in the community at 60 years and above in Hebron, Palestine. The test involved the functional tools with validated measures, the Berg Balance Scale (BBS) and the Timed Up and Go Test (TUG), to examine the correlations between demographic, physical activity, cognitive ability, psychological variables and chronic health, and balance performance.

The results indicate that the fall hazard is a multidimensional, complex phenomenon, which is triggered by a combination of physical, functional, psychological, and clinical factors. This is in line with global literature, which has underlined that falls in the elderly are hardly due to a single cause but an outcome of the combined stress of the numerous risk factors that interact (Shumway-Cook and Woollacott, 2017; World Falls Guidelines, 2022).

In this chapter, the interpretation of the study findings is provided in a comprehensive manner, compared to the previous research, discussing their clinical and public health implications, the strengths and limitations of the research, and directions of future research.

Interpretation of Main Findings

The participants exhibited moderate balance impairment with the average BBS score of 36.46 /SD 6.11 and fell in the medium fall-risk group. Shumway-Cook et al. (1997) note that a BBS score under 45 demonstrates greater risk of falls and a BBS score under 40 indicates greater vulnerability. On the same note, the average TUG time (13.12 + -4.34) was more than the normative value of properly functioning older adults (less than 10 seconds), which means that their functional mobility is impaired (Podsiadlo and Richardson, 1991).

The identified shortages indicate that a significant proportion of elderly people in Hebron can also be termed as being at moderate-high risks of falls. The physiological processes involve age-related losses in the strength of muscles, proprioception, reaction time, and the vestibular activity all of which are essential to keeping a balance and addressing postural challenges (Lord et al., 2007). Also, the contextual conditions like low access to preventive rehabilitation, high rates of chronic diseases, and low rates of organized physical activity may contribute to the severity of these impairments.

An Asian, European, and North American literature indicates that moderate fall risk is observed in this paper. As an example, Turk and Saudi research studies found a median of 35 to 38 in terms of BBS scores in older adults living in the community and with chronic circumstances, which are similar to those with functional limitations (Değer et al., 2019; Alhwoaimel et al., 2024). Similar TUG times were also found in older adults with decreased mobility by Barry et al. (2014) and Gómez-Campos et al. (2023).

Factors Associated with Balance and Fall Risk

Balance and mobility (BBS: $r = 0.66$; TUG: $r = 0.70$; $p = 0.001$) showed a significant correlation with age, which proves the statement that advancing age is a leading predictor of reduced functional performance. Old age causes sarcopenia, loss of control of the vestibular apparatus, slow reflexes, lower gait velocity and loss of postural control, which are direct effects of age on the stability maintenance and post-perturbation recovery capabilities (Cruz-Jentoft et al., 2019). Also, there is a decline in neuromuscular response time, which minimizes compensatory movements in cases of slips or falls.

It has been argued that age-related physiological fall is a universal determinant of falls, which has been confirmed to be true in Turkey, Saudi Arabia, and Europe (Granacher et al., 2012; Alhwoaimel et al., 2024). The size of the age-related risk, however, may be amplified because of environmental and lifestyle factors, including the availability of exercise facilities or social support.

The BMI was not significantly correlated with the BBS or TUG scores in this study. Although obesity is commonly linked with the lack of mobility and the increased risk of falls (Vincent et al., 2010), the data is not unanimous. It is postulated in some studies that fat people can use a broader support base which makes up the instability of postures.

Others emphasize that sarcopenic obesity, which is the decrease in muscle mass with excess fat, is a better predictor of impaired balance than BMI is (Pasco et al., 2018). The non-significant result could be indicative of the heterogeneity in body composition, whereby BMI could not be an adequate measure of the obesity-related fall risk among older adults.

Balance and mobility had a strong correlation with cognitive performance (BBS: $r =.65$, $p <.001$, TUG: $r =-60$, $p <.001$). Individuals that had higher cognitive scores had better balance and functional mobility. The cognitive domains especially the executive functioning, attention, and planning are important in gait control, obstacle avoidance, and splitting attention.

The cognitive impairment decreases awareness of hazards, the speed of the reaction, and the flexibility, which elevates the risk of falls (Mirelman et al., 2012; Sturnieks et al., 2025). Canadian and European studies have shown that cognition has been a determinant of mobility and falls, and therefore integrated cognitive screening must be incorporated in the fall prevention initiatives.

BS and TUG had a significant fear of falling ($r = .47$, $p < .01$ and $r = .52$, $p < .01$ respectively). The subjects who had poorer balance and slower mobility were the ones with poorer fall efficacy. The fear of falling may result in restrictions of activities, physical unfitness, and muscle deconditioning, in a vicious circle, which increases the risk of falls (Donoghue et al., 2013; Lenouvel et al., 2023; Mullen et al., 2012). Fear of falling can be dealt with by cognitive-behavioral therapies and confidence-building interventions to ensure functional independence.

Exercise was positively correlated with BBS ($r = .55$, $p = .01$) and negatively correlated with TUG ($r = -.50$, $p = .01$). Exercise will increase muscle strength, neuromuscular coordination, proprioception, cardiovascular fitness, and reaction time all of which are paramount to postural stability and prevention of falls (Arnold et al., 2011). The beneficial impact of physical activity is reported worldwide, and Korea, Canada, and the USA are not an exception (Sun et al., 2021; Sherrington et al., 2019).

The existence of chronic conditions (hypertension, diabetes, musculoskeletal disorders) was related to a decrease in balance score and a reduction in mobility. Neuropathy, orthostatic hypotension, joint stiffness, polypharmacy, and pain are some of the ways in which chronic diseases could result in impaired postural control predisposing patients to falls (Tinetti et al., 1988; Ambrose et al., 2013).

Canes or walkers used poor balance and slow mobility, and this was the indication of the underlying gait instability or weakness in lower limbs (Bateni & Maki, 2005). The use of the device can act as a compensatory factor and indication of risk of falls.

Regression Analysis: Predictors of Balance and Fall Risk

Findings obtained from multiple regression analysis conducted for this study revealed that age, cognitive functions, physical activity levels, and fall efficacy were found to be the most influential factors associated with balance and mobility, as determined by BBS and TUG test scores. Together, these variables were seen to contribute significantly towards understanding fall risk factors among elderly individuals.

Age appeared as a prominent predictor, which cannot be changed. The negative relationship between age and performance on balance functions and the relationship with

times on TUG would accentuate the progressive effects associated with aging on stability functions, muscle strength, and reaction-time functions. Biological changes associated with aging, like muscle wasting, loss of proprioception, loss of vestibular function, and delayed reaction times, reduce older people's capacity for balancing recovery and stability functions in relation to daily activities.

In addition, cognitive function turned out to be a strong predictor of both balance and mobility. The association of high cognitive ability, especially in the areas of executive function, attention, and planning, with higher BBS scores and quicker TUG performance can be easily discerned. On the other hand, cognitive impairment can lower the perception of hazards, increase the time taken in making a decision when walking under bifurcated circumstances, and slow down dual-task performance - all of which contribute to higher fall risk. These findings are consistent with earlier studies that have identified cognitive decline as the main cause of falls (Sturnieks et al., 2025; Mirelman et al., 2012). Thus, incorporating cognitive screening and cognitive training into fall-prevention programs could be of great help in reducing the mentioned risk and improving functional independence.

Physical activity emerged as a protective factor, as it showed a positive effect on balance and mobility. The elderly individuals who exercised regularly had better postural control and TUG performance, and scored higher on the BBS. Mechanistically, physical activity enhances muscle strength, neuromuscular coordination, proprioceptive feedback, cardiovascular fitness, and reaction time, all critical to maintaining stability. These findings confirm prior investigations that indicate organized physical activity programs can mitigate fall risk significantly in older adults (Sherrington et al., 2019; Sun et al., 2021). It adds weight to the implication that widely accessible, culturally appropriate exercise interventions in community settings provide an opportunity for great improvement in functional outcomes and reduction of falls.

The fear of falling, as measured by FES, was yet another significant predictor. Those who had less confidence in their abilities to avoid falls showed not only poorer balance but also slower mobility, suggesting that psychological factors are paramount in determining fall risk. Alongside the restriction of activities, fear of falling may cause a decrease in physical fitness, and thus make a person less able to move around—this can actually lead to a situation in which one is more likely falls. The result has been corroborated with the international research, which show that the fear of falling when treated by means of psychological interventions, such as cognitive behavioral therapy, can lead to better performance in confidence and function (Donoghue et al., 2013; Lenouvel et al., 2023).

Although comorbid status was recognized as not being among the most significant predictors within the regression equation, it still plays an essential role within fall risk.

Conditions like hypertension, diabetes, and musculoskeletal disease affect balance and generalized mobility because of neuropathy, orthostatic hypertension, joint stiffness, polypharmacy, and pain (Ambrose et al., 2013; Tinetti et al., 1988). The control of these comorbid conditions should thus form an essential component within fall prevention.

Overall, these results are consistent with the guidelines on falls worldwide in 2022, and emphasize the key role that needs to be played in addressing physical, cognitive, as well as psychological aspects with a focus on preventing falls. Similar regressions have been seen elsewhere, for instance, Korea (Park, 2020), Thailand (Hiengkaew et al., 2012), and USA (Muir et al., 2013).

Implications for Clinical Practice and Public Health

The implications of this research are several and very significant with regards to practice and a strategy that would be applicable in preventing falls among older people within the region of Hebron, Palestine. Because falls have multiple risk factors, interventions should also be multi-modal.

1. Community-Based Fall Prevention Programs:

The moderate imbalance deficits seen among the participants emphasize the pressing need for targeted community-based intervention programs for fall prevention. These should include a balanced mix of exercises related to muscle strengthening, functionality, and maintaining posture control, as applicable to seniors. Thus, for instance, there could be group exercises for balancing as well as chair exercises at senior community centers and senior citizen clubs. According to global research, there are 30–50% fewer chances of falling as a result of structured exercise programs (Sherrington, 2019; Sherrington et al., 2019). In a Palestinian scenario, there would be a pressing need for addressing factors like accessibility and cultural receptivity as well.

2. Cognitive Screening and Interventions:

Cognitive function showed up as a strong predictor of balance and mobility, pointing out the need for regular cognitive screening through routine MMSE or MMEC during clinical consultation in older adults. Since early detection of impaired cognition may enable specific interventions, such as dual-task training, memory exercises, or cognitive-motor exercises, which improve executive function, attention, and gait performance in older adults with cognitive impairment (Sturnieks et al., 2025; Mirelman et al., 2012), integrating cognitive stimulation in fall prevention programs would significantly reduce the risk of falls by improving hazard perception, decision-making capability, and adaptive response against complex tasks.

3. Addressing Fear of Falling:

Fear of falling significantly impacts mobility and confidence in balance, causing restriction of activities and functional decline. This calls for clinicians to assess fall efficacy and apply appropriate psychological treatments, such as CBT, confidence exercises, or graded exposure to functional activities. Indeed, some studies have reported that fear of falling can be reduced, activity levels improved, and balance enhanced by avoiding the vicious circle of deconditioning. Donoghue et al. (2013); Lenouvel et al. (2023) Group sessions are also held within the community programs to help stimulate social support and alleviate anxiety with movement.

4. Promotion of Physical Activity:

Regular physical activity has been shown to be a protective element against falls. These should focus on regular structured classes involving aerobic, strengthening, flexibility, and balancing activities suited for older people. Examples include walking classes, Tai Chi, band exercises, and multi-component classes. Aside from developing muscle strength, neuromuscular control, and cardiovascular function, regular physical activity also boosts confidence and reduces fear of falling, thus promoting independence (Arnold et al., 2011; Sun et al., 2021).

5. Management of Chronic Diseases:

Although it did not appear as a predictor with a prominent role within the regression variable, it still plays an important role as a risk factor for falls. Its impacts might be reduced with optimum control and management of hypertension, diabetes, musculoskeletal conditions, and neuropathies. A number of medical approaches might be involved, such as optimizing drug therapies and disease education and understanding. Monitoring and tracking changes in blood pressure, glucose, and pain might prevent unexpected declines that could result in falls (Ambrose et al., 2013; Tinetti et al., 1988).

6. Integration of Multidimensional Interventions:

The importance of incorporating multiple interventions and not relying on a single strategy for preventing falls cannot be overstated. The strategy suggested here uses a combination of physical exercise, cognitive stimulation, psychological support, and medical follow-up. For example, a program conducted within a community setting can include sessions on group balance and strength exercises conducted once a week, cognitive-motor exercises, workshops on psychological support, and regular health follow-up for patients with chronic illnesses. Findings have shown that these multiple-component intervention programs are more effective than single-component interventions for preventing falls (Sherrington et al., 2019; World Falls Guidelines, 2022).

7. Public Health Strategies and Policy Implications:

At a population level, it is recommended that preventing falls should be made a prominent health goal for people within Palestine. Raising awareness and educating healthcare practitioners on identifying people at risk for falls and making physically safe environments, including sidewalk and home safety, should be implemented. At a health policy level, it should be ensured that there is allocation to elderly care centers and exercise classes. The implementation of these measures should have a positive impact on improving the life and safety of older people within Palestinian society.

These findings highlight the importance of multi-dimensional and culturally and community-based interventions. Physically, cognitively, and psychologically based measures should be holistically integrated with medical factors so as to optimize balance and movement as well as overall functionality.

Strengths and Limitations

Strengths

- Large community-based sample (N = 323) enabling robust multivariable modeling.
- Comprehensive assessment across cognitive, physical, psychological, and functional domains.
- Use of both linear and logistic regression to isolate independent predictors.
- Findings are aligned with and supported by recent international research, enhancing external validity.

Limitations (expanded & specific)

1. Cross-sectional design, cannot establish temporal causation (e.g., whether cognitive decline preceded balance deterioration or vice versa). Prospective designs are required.

2. Use of MMSE as primary cognitive measure, MMSE is a global screen and less sensitive to executive dysfunction, which is particularly relevant to gait/balance and fall risk; future studies should add domain-specific tests (Trail Making Test, Stroop, verbal fluency).

3. Self-reported falls and recall bias, retrospective fall history (last year) may be inaccurate; prospective fall diaries or wearable detection are preferable (Koh et al., 2024).

4. Limited environmental/medication data, comorbidity count lacks granularity (types/severity), and polypharmacy or psychotropic medication classes were not modeled; these are known, often strong contributors to falls.

5. Cultural/contextual factors, social participation measures may behave differently across cultural settings; qualitative follow-up would clarify paradoxical findings.

6. Potential selection bias, participants able/willing to attend assessment may differ from home-bound older adults.

Chapter five:

Conclusion and Recommendations

5.1 Conclusions

- Despite low fall-risk classification by the Berg Balance Scale, many older adults demonstrated impaired balance and postural stability.
- Cognitive impairment was highly prevalent and emerged as the strongest predictor of balance performance and fall risk.
- Physical performance and fear of falling were associated with poorer balance but did not independently predict falls after accounting for cognitive factors.
- These findings indicate that falls are primarily driven by cognitive dysfunction, with physical impairments acting as contributing comorbidities.
- Contextual and environmental factors in Palestine may further exacerbate balance deficits and fear of falling.
- Early cognitive screening and multidimensional fall-prevention strategies, integrating physical, cognitive, and psychosocial interventions, are essential to maintain function and independence in older adults.

5.2 Recommendations for future research

The results of this study recommend:

1. Prospective cohort with a detailed neuropsychological battery (executive function, attention, visuospatial) and prospective fall capture (diaries + wearables).

2. Randomized controlled trials testing combined cognitive + balance training (dual-task programs) versus standard balance training, with falls, ADL and QOL outcomes.

3. Sensor-augmented assessment studies: include IMU features during TUG and daily life to improve prediction and to identify near-fall signatures.

4. Medication and environmental risk modeling: gather polypharmacy and home hazard metrics to build more comprehensive prediction models.

5. Qualitative studies exploring fear of falling, cultural patterns of participation and device acceptance to design culturally appropriate interventions.

Recommendations for therapists and clinicians

1. Considering balance in an elderly care program, as it has been shown in this study that there is a high prevalence of poor balance among the elderly
2. Considering visual impairments management as part of fall-preventing and risk mitigation measures
3. Integrating cognitive screening in balance training and failing risk assessment
4. Implementation of a community -based multifactorial balance training programs
5. Target fear of falling through education and graded exposure

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APPENDICES

Participant Information and Consent Form

Introduction Dear Participant,

You are invited to participate in a research study titled "Determinants of Balance in Older Adults Over 60 Years," conducted as part of the Master's research by student Safaa Al-Batsh at Al-Quds University. This study aims to explore factors affecting balance in older adults, including comorbidities, vision problems, balance, and cognitive abilities.

Participation in this study is completely voluntary, and you have the right to withdraw at any time without any consequences. Completing this questionnaire will take approximately 10–15 minutes.

Ethical Considerations and Confidentiality:

All information collected will be treated with strict confidentiality.

- Your responses will be anonymous, and no identifying information will be recorded.
- Data will be used solely for research purposes, and results may be published in journals or presented at conferences, but without revealing any personal identity.
- If you have any questions about this study, you can contact the researcher at ( ).

By agreeing to participate, you confirm the following:

✓ I have read and understood the purpose of the study.

✓ I voluntarily agree to participate.

✓ I understand that I have the right to withdraw at any time without any consequences.

Instructions for Completing the Questionnaire:

1. Answer each question honestly based on your personal experience.
2. Some questions require selecting a checkbox (☐), while others require short written answers.
3. If you do not wish to answer a particular question, you may leave it blank.
4. There are no right or wrong answers – we want to understand your personal experience.

If you agree to participate, please proceed to the next section:

☐ Agree ☐ Disagree Signature ______________________

Section 1: Demographic Information

1. Age: ___ years

2. Gender: ☐ Male ☐ Female

3. Height (cm): ___

4. Weight (kg): ___

5. Education Level: ☐ No formal education ☐ Primary ☐ Secondary ☐ University or higher

6. Living Situation: ☐ Living alone ☐ Living with family ☐ Living in a care home

Section 2: Comorbidities and Health Status

7. Do you have any of the following medical conditions? (Select all that apply)

☐ Hypertension

☐ Diabetes

☐ cardiovascular diseases

☐ Stroke

☐ Arthritis

☐ Neurological disorders (e.g., Parkinson's, Multiple Sclerosis)

☐ respiratory diseases

☐ Other (please specify) _______

8. Do you take any medications regularly? ☐ Yes ☐ No

If yes, please specify: _______

Section 3: Vision Problems

9. Do you wear glasses or contact lenses? ☐ Yes ☐ No

10. Have you been diagnosed with any of the following?

☐ Cataract

☐ Glaucoma

☐ Macular degeneration

☐ Diabetic retinopathy

☐ Other (please specify) ________

11. How would you rate your vision during daily activities (e.g., reading, walking, driving)?

☐ Excellent ☐ Good ☐ Fair ☐ Poor

12. Fischer Chart

Right Eye	Left Eye	Both Eyes

Section 4: Balance and Mobility

13. Do you feel unsteady when standing or walking? ☐ Never ☐ Rarely ☐ Sometimes ☐ Often

14. Do you use any mobility aids? ☐ None ☐ Cane ☐ Walker ☐ Wheelchair ☐ Other ________

15. Can you stand on one leg for at least 10 seconds? ☐ Yes ☐ No

16. Do you have difficulty walking on uneven surfaces (e.g., grass, gravel, stairs)? ☐ Yes ☐ No

17. Do you feel your balance has declined over the past year? ☐ Yes ☐ No

18. Do you experience dizziness or vertigo? ☐ Never ☐ Rarely ☐ Sometimes ☐ Often

19. Berg Balance Scale

Item	**Description**	**Score (0-4)**
1	Sit-to-stand	
2	Stand without support	
3	Sit without support	
4	Stand-to-sit	
5	Transfers	
6	Stand with eyes closed	
7	Stand with feet together	
8	Forward reach with arms	

	extended	
9	Pick object from floor	
10	Look behind	
11	Turn 360°	
12	Alternate foot on stool	
13	Tandem standing	
14	Stand on one leg	
	Total	

Timed Up and Go (TUG) Test

Average	3	2	1	
				Steps
				Time (seconds)

Single Leg Stance with Eyes Closed

LT Open (s) C	RT Open (s) C	LT Open (s)	RT Open (s)	Trial
				1
				2
				Average

Section 5: Cognitive Abilities

20. Do you have memory problems? ☐ Never ☐ Rarely ☐ Sometimes ☐ Often

21. Do you have difficulty concentrating or paying attention? ☐ Never ☐ Rarely ☐ Sometimes ☐ Often

22. Have you been diagnosed with cognitive impairment? ☐ Yes ☐ No

23. Can you manage daily tasks independently (e.g., cooking, shopping, handling money)? ☐ Yes ☐ No

Mini-Mental State Examination (MMSE)

Domain	Question	Maximum Score
Orientation (5 points)	What is: the year? semester? date? day? month?	5
	Where are we: country? town? city? hospital? floor?	5
Registration (3 points)	Name 3 objects (e.g., apple, table, ball) and ask the patient to repeat them.	3
	Number of attempts to learn the words: ________	
Attention and Calculation (5 points)	Subtract 7 from 100 repeatedly up to five times, or ask the patient to spell "world" backwards.	5
Recall (3 points)	Ask the patient to repeat the three previously mentioned objects.	3

Language (9 points)	- Name the following objects.	2
	- Repeat the sentence: "No if, and, or but".	1
	- Perform a three-step command: "Take this paper in your hand, fold it in half, and place it on the floor."	3
	- Read the following and perform the written instruction: "Close your eyes."	1
	- Using a noun and a verb, write a meaningful complete sentence.	1
	- Copy this figure (simple geometric shape).	1
Total Score	_____ out of 30 points	
Level of Consciousness	Alert / Drowsy / Semi-coma / Coma	

Section 6: Physical Activity and Lifestyle

24. How often do you perform physical activities (e.g., walking, running, exercise, swimming)?

☐ Daily ☐ 3–5 times/week ☐ 1–2 times/week ☐ Rarely/Never

Section 7: Fall Risk and Fear of Falling

25. Do you avoid certain activities due to fear of falling? ☐ Yes ☐ No

26. Do you participate in any balance training or rehabilitation programs? ☐ Yes ☐ No

27. On a scale from 1 to 10, how concerned are you about falling?

(1 = Not concerned at all, 10 = Very concerned) _______

28. Have you experienced any falls in the past year? ☐ Yes ☐ No If yes, when was the last fall? _______

29. If yes, how many times? _______

Section 8: Quality of Life

Rate each statement from 1–5: 1 = Very dissatisfied, 2 = Dissatisfied, 3 = Neutral, 4 = Satisfied, 5 = Very satisfied

No.	Question	1	2	3	4	5
1	How would you rate your overall quality of life?					
2	How satisfied are you with your health?					
3	To what extent does pain prevent you from doing what you want?					
4	How much medical care do you need to perform daily activities?					
5	To what extent do you enjoy life?					
6	To what extent do you feel your life is meaningful?					
7	How capable are you of concentrating?					
8	How safe do you feel in your daily life?					
9	To what extent do you consider your surrounding environment healthy?					
10	Do you have enough energy to carry out your daily activities?					
11	Are you able to accept your physical appearance?					
12	Do you have enough money to meet your needs?					
13	How available is the information you need in your daily life?					
14	To what extent do you have opportunities for recreational activities?					
15	How capable are you of moving around easily?					
16	How satisfied are you with your sleep?					
17	To what extent are you satisfied with your ability to perform daily activities?					
18	How satisfied are you with your work abilities?					
19	How satisfied are you with yourself?					
20	How satisfied are you with your personal relationships?					
21	How satisfied are you with your sexual life?					

22	How satisfied are you with support or help from friends?					
23	How satisfied are you with your living conditions?					
24	How satisfied are you with available healthcare services?					
25	How satisfied are you with your transportation?					
26	How often have you experienced negative feelings (e.g., sadness, hopelessness, anxiety, or depression)?					

Section 9: Nottingham Extended Activities of Daily Living (NEADL)

No.	Activity	Never did it	With help	Independently without difficulty	Independently with difficulty
1	Walking outdoors				
2	Climbing stairs				
3	Getting in and out of a car				
4	Walking on uneven surfaces				
5	Crossing roads				
6	Using public transportation				
7	Eating by yourself				
8	Preparing a hot drink for yourself				
9	Carrying a hot drink from one room to another				
10	Washing dishes				
11	Preparing a hot snack for yourself				
12	Managing your money when going out				
13	Washing small clothing items				
14	Performing household tasks by yourself				
15	Shopping by yourself				
16	Washing all clothes				
17	Reading newspapers or books				
18	Using the telephone				

19	Writing letters				
20	Going out for social purposes				
21	Taking care of your garden				
22	Driving a car				

Section 10: Social Participation

No.	Participation Item	Participation Before 60	Participation After 60
1	Visiting friends and relatives		
2	Being visited by friends and relatives		
3	Managing your financial affairs		
4	Going to paid work		
5	Voluntary activities (unions, associations, charity…)		
6	Attending general social gatherings (mosques…)		
7	Engaging in physical hobbies (gardening, sports…)		
8	Caring for family in any form (cooking, shopping, repairing things…)		
9	Participating in social events (celebrations, condolences…)		
10	Spending leisure time during the day (TV, social media…)		
	Total participation before and after	Total A ___/100	Total B ___/100

Thank you! Your responses will help us understand factors affecting balance in older adults and contribute to improving fall prevention and rehabilitation strategies.

العوامل المؤثرة على التوازن وخطر السقوط لدى كبار السن فوق 60 عامًا في محافظة الخليل – فلسطين: دراسة مقطعية

إعداد: صفاء عرفات عيسى البطش
إشراف: د. أكرم عمرو

الملخص

الخلفية : تُعدّ حالات السقوط بين كبار السن مشكلة صحية خطيرة، إذ ترتبط بالإصابات، والإعاقة، وتدهور جودة الحياة. ومن الضروري تبنّي نظرة شمولية للعوامل المؤثرة في الجوانب الجسدية والمعرفية والنفسية والاجتماعية المرتبطة بالتوازن وخطر السقوط.

الهدف : استكشاف العوامل التي تؤثر في التوازن وخطر السقوط لدى كبار السن بعمر 60 عامًا فأكثر، المقيمين في المجتمع المحلي بمدينة الخليل، فلسطين.

المنهجية : شملت الدراسة 323 مشاركًا، تم جمع البيانات الديموغرافية الخاصة بهم، إضافة إلى تقييمهم جسديًا ومعرفيًا باستخدام مقاييس التوازن (مقياس بيرغ للتوازن[BBS] ، اختبار النهوض والمشي الموقّت[TUG] ، واختبار الوقوف على ساق واحدة([SLS] ، وأدوات قياس الوظائف المعرفية (اختبار الحالة العقلية المصغّر)، فضلًا عن أدوات نفسية اجتماعية (مقياس الخوف من السقوط، والمشاركة المجتمعية، ومجالات جودة الحياة).

النتائج : بلغ متوسط العمر 67.8 ± 6.54 سنة، وشكّلت الإناث 56% من العينة. وأظهرت اختبارات خطر السقوط أن 64.4%، و20.7%، و14.9% من المشاركين كانوا ضمن مستويات خطر منخفضة، ومتوسطة، وعالية على التوالي. وُجد ارتباط ذو دلالة إحصائية بين ضعف أداء التوازن وكل من القصور المعرفي، واستخدام الوسائل المساعدة، وقلة النشاط البدني، وصعوبة المشي على الأسطح غير المستوية، وفقدان الاستقلالية الوظيفية

كما تبيّن أن مقياس بيرغ للتوازن كان الأفضل في التنبؤ بخطر السقوط مقارنة ببقية المقاييس، وكان له تأثير على المشاركة الاجتماعية والقلق من السقوط، لكنه لم يؤثر على الرضا العام عن الحياة أو الخوف من السقوط وفق مقياس الكفاءة الدولية للسقوط .(FES–I) وأشارت تحليلات الانحدار إلى أن المتغيرات الجسدية والمعرفية، مثل مشكلات الذاكرة واستخدام الوسائل المساعدة، تُعد من المحددات الأساسية للتوازن. كما تنبأت التغيرات الوظيفية، المقاسة بدرجة فيشر، بشكل ملحوظ بمستوى التوازن.

الاستنتاج: يتطلب الحفاظ على التوازن لدى كبار السن مراعاة المتغيرات الجسدية والمعرفية والوظيفية. وينبغي تعزيز الاستراتيجيات التي تركز على زيادة مستويات النشاط البدني، وتحسين الوظائف المعرفية، والاستخدام المناسب للوسائل المساعدة، ومعالجة الاضطرابات الحسية، وتشجيع الاستقلالية في أنشطة الحياة اليومية لدى كبار السن في مدينة الخليل.

الكلمات المفتاحية : التوازن، خطر السقوط، كبار السن، الخليل، النشاط البدني، الوظيفة المعرفية، الاستقلالية الوظيفية.