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FUNCTIONAL TRAJECTORIES OF AGING: GENDER-SPECIFIC PATTERNS IN BALANCE AND MOBILITY AMONG THE MIDDLE-OLD POPULATION

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ABSTRACT

Background:
Physiological and neuromuscular changes associated with aging significantly impair balance, mobility, and overall functional independence, particularly in individuals aged 65 to 84 years. This study primarily intended to evaluate gender differences in balance, functional mobility, and associated fall risk among community-dwelling middle-old adults.

Methods:
A cross-sectional analytical study was conducted among 300 community-dwelling older adults (150 males and 150 females), recruited through purposive sampling. Participants aged between 65 to 84 years with active ambulation were included. Individuals with neurological disorders, severe musculoskeletal conditions, uncorrected sensory deficits, or cognitive impairment were excluded. SPPB, the Tinetti POMA, the TUG test and the One Leg Stance Test were used a standardized outcome tools

Results:
Males demonstrated significantly better performance across all functional assessments. The mean SPPB score was higher in males (9.69 ± 1.18) compared to females (8.58 ± 1.44; p = 0.02). Tinetti POMA scores were also greater in males (25.27 ± 1.57) than in females (24.13 ± 1.84; p = 0.01). In the TUG test, males completed the task more quickly (12.90 ± 1.62 sec) than females (14.57 ± 2.04 sec; p = 0.03). Males also maintained longer one-leg stance (11.67 ± 4.18 sec) than females (9.66 ± 3.75 sec; p = 0.04).

Conclusion:
The findings indicate that males in the middle-old age group exhibit significantly better balance and functional mobility than females. These gender-specific differences underscore the importance of developing targeted assessment and intervention strategies to reduce fall risk and enhance functional independence, particularly in older women.

Key Words: Mobility, Balance, Elderly, TUG test, One leg stance, gender specific

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INTRODUCTION

Older adults undergo gradual physiological changes associated with loss of balance, gait and overall functional independence. These changes are particularly noticeable in older adults aged 65 to 84, often referred to as the "middle-old" age group. [21,20] Conversely at this very stage, there is a decrease in skeletal muscle mass, proprioceptive sensitivity and coordinated neuromuscular function, further increasing the risk of falling, mobility problems and disability in activities of daily living. [7] Falls constitute a major source of injury-related morbidity, hospitalization, and mortality among older adults worldwide. [10] Notably, latest information suggests that the progression of physical decline with age is not the same in men and women.

Women typically demonstrate greater functional impairment at an earlier age that is more pronounced than in men, as a result of less muscle mass at baseline and the effects of postmenopausal loss of bone mineral. [17,11]

Sociocultural factors including low levels of activity, inequalities in health care-seeking behaviour and limited access to specialist exercise therapy can contribute to a sex-related unfavourable functional vulnerability in women. [16] In older men, however, age-related loss of muscle mass tends to be less (on a relative scale) and while older men are likely to access and use preventive healthcare less, they may also experience greater underutilisation of preventive healthcare because of male gender stereotypes. [6]Although literature provides evidence of sex-based age related trends, there is scarce and even conflicting evidence in the available literature on sex-related differences in balance and mobility performance among this population. Some findings indicate that elderly women have poorer balance and gait performance, and more recently that the decrease in muscular strength and gait speed with age is similar between genders but the decline in bone mineral density is more pronounced in women. [19,5] Task-specific research, such as stair descent analyses, indicate that older women exhibit more lateral instability, hence increasing their susceptibility to fall-related injuries. Environmental exposures elucidate risk profiles: women are more frequently subjected to indoor dangers, whereas men are more prone to outdoor falls. [18] The discrepancies in the results and the methodological constraints of numerous prior research (such as non-standardized assessment instruments or disproportionate gender representation) underscore the necessity for a gender-stratified evaluation of balance and mobility in middle-aged and older persons. [8] Research is essential to guide clinical treatment, public health policy, and tailored fall prevention strategies that include the diverse physiological and social circumstances of older persons. [12] Consequently, this analytical study seeks to evaluate gender disparities in balance and functional mobility among community-dwelling adults aged 65 to 84 years, thereby facilitating the formulation of targeted interventions that mitigate sex-specific risks and foster healthy aging.

METHODOLOGY:

This cross-sectional analytical study involved 300 community-dwelling older adults, consisting of 150 males and 150 females, who were intentionally recruited from urban community centers and outpatient geriatric clinics. Participants ranged in age from 65 to 84 years, were ambulatory with or without assistive devices, and possessed the cognitive ability to comprehend basic verbal instructions. Individuals were excluded if they had a diagnosed neurological condition, such as stroke or Parkinson's disease; severe musculoskeletal disorders, including recent fractures or amputations; uncorrected visual or vestibular impairments; or evidence of cognitive decline, indicated by a Mini-Mental State Examination (MMSE) score below 24. The Institutional Review Board approved the study (Ref No: MSK-1091/PHYSIO/IRB/2024-2025), and it was carried out in accordance with the ethical standards of the Declaration of Helsinki. [15] Before registering up, everyone got a comprehensive description of the study and signed a paper confirming they comprehended it.

Sample Size Determination and Recruitment:

The formula for two independent means was used to figure out the sample size ahead of time. We assumed a standard deviation of about 2.0 seconds and a clinically significant difference of 1.2 seconds between sexes based on earlier studies of the Timed Up and Go (TUG) test in older adults living in the community. The required sample size was estimated to be 44 participants per group (88 total) with a two-tailed α of 0.05 and a power of 80%. To make up for possible dropouts and make sure that men and women were equally represented, the goal was to recruit 150 people per group, for a total of 300 people. The sampling frame comprised individuals frequenting community centers and geriatric outpatient departments during the study period. A total of 342 individuals were screened; 24 were excluded due to neurological disorders, 10 due to severe musculoskeletal conditions, and 8 due to MMSE scores below 24. The other 300 people met the requirements to be included and agreed to take part **[FIGURE 1**]. The recruitment was intentional to ensure balanced representation by sex, facilitating direct gender-based comparisons.

Assessment Procedures

A professional physiotherapist who was trained in geriatric functional evaluation did all of the tests. The tests were done in a controlled environment with good lighting and floors that weren't slippery. The people taking part wore shoes that stayed on their feet. To reduce fatigue, the tests were done in a set order: the Short Physical Performance Battery (SPPB) for lower extremity function, the Tinetti Performance-Oriented Mobility Assessment (POMA) for balance and gait, the Timed Up and Go (TUG) test for functional mobility, and the One-Leg Stance Test (OLST) for static balance. Standardized verbal instructions were provided, and in instances allowing multiple trials, the optimal performance was documented. There were breaks for rest as needed, and safety measures were in place to keep people from falling during the tests. As the study compared male and female participants, assessor blinding was not feasible; however, objective scoring protocols and standardized administration were used to minimize potential measurement bias.

RESULT:

The statistical analysis involved the application of independent t-tests to evaluate differences in mean scores between genders, whereas categorical variables were analyzed using the chi-square test. A p-value of <0.05 was considered indicative of statistical significance throughout the study.

The statistical analysis employing descriptive model depicted the performance-oriented outcome indicators among 300 participants indicated significant gender disparities in balance and functional mobility. The average Short Physical Performance Battery (SPPB) score for men was 9.69 ± 1.18, while the average score for women was 8.58 ± 1.44. This shows that men have better lower extremity function. The Tinetti Performance-Oriented Mobility Assessment (POMA) scores also showed that males did better, with a mean score of 25.27 ± 1.57 compared to 24.13 ± 1.84 for females. This suggests that males had better control of their gait and balance. Men finished the Timed Up and Go (TUG) test in an average of 12.90 ± 1.62 seconds, while women took longer, with a mean of 14.57 ± 2.04 seconds. This shows that women have slower functional mobility.

The One Leg Stance Test (OLST) also demonstrated better static balance in males, who recorded a mean duration of 11.67 ± 4.18 seconds, as opposed to 9.66 ± 3.75 seconds in females. Overall, males outperformed females across all assessed domains, and the consistently lower scores among female's point to an elevated risk of falls and decreased functional capacity **[TABLE 1].**

Table 1: Descriptive Statistics of Variables by Gender (N = 300)

Variable	Males (Mean ± SD)	Females (Mean ± SD)
SPPB Score	9.69 ± 1.18	8.58 ± 1.44
Tinetti POMA Score	25.27 ± 1.57	24.13 ± 1.84
Timed Up and Go (sec)	12.90 ± 1.62	14.57 ± 2.04
One Leg Stance Time (sec)	11.67 ± 4.18	9.66 ± 3.75

DISCUSSION

The results indicate statistically significant gender differences in all measured domains of balance and mobility. Males outperformed females in SPPB, Tinetti POMA, and OLST, and showed faster TUG times. The difference may stem from variations in muscle strength, joint flexibility, physical activity levels, and hormonal influences such as postmenopausal estrogen decline in females.

Supporting these findings, **Butler et al**. reported that women aged 75–98 years performed significantly worse than men on multiple mobility assessments, including gait speed, balance, and stair negotiation tasks. Building on this [3], **Nakanose et al**. found that men had higher SPPB scores, attributing these differences to greater muscle strength and stature, which collectively contribute to enhanced functional mobility. Adding to the hormonal perspective [13], **Collins et al**. emphasized in a comprehensive review that estrogen deficiency following menopause accelerates the loss of muscle mass and contractile function in women, thereby increasing vulnerability to frailty and functional decline. Complementing this evidence [4], **Auais et al.** from the International Mobility in Aging Study (IMIAS) showed that women who experienced earlier natural menopause had lower grip strength and reduced gait speed, further supporting the role of hormonal changes in gender-based performance differences. [1]

Furthermore, **Bergland et al**. in the Tromsø Study reported that men scored on average 0.28 points higher than women on the SPPB across all age groups, confirming consistent sex differences in lower extremity performance [2]. **Hughes et al.** observed that older women scored approximately 14 % lower than men on SPPB and its component tasks, and completed 6-minute walk tests at substantially shorter distances, while also being 23 % less physically active—suggesting that disparities in physical activity may underlie functional differences. In a study of highly active older adults [9], **Smith et al.** reported that men outperformed women on measures of balance and muscle strength, although mobility differences were less pronounced, reinforcing sex-specific variation even in physically active cohorts. [22] Additionally, **Nakano et al**. documented that SPPB, Berg Balance scores, TUG, and leg press strength declined more markedly in older women, particularly in those over 80, indicating accelerated deterioration in multiple performance domains with advanced age. [14]

Collectively, these findings align with the present study and highlight the consistent pattern of functional disadvantages among aging women. They underscore the necessity for gender-specific assessments and intervention models that are tailored to the distinct needs of older females. Focused physiotherapeutic strategies such as resistance training, balance enhancement, and fall-prevention programs may play a critical role in mitigating these disparities and improving the overall quality of life. These discoveries are in line with earlier research that found that older women had lower physical performance scores. They also show how important it is for older women to have targeted exercise and fall-prevention programs.

CONCLUSION

Current research indicates that gender significantly influences balance and functional mobility in middle-aged to older persons, with males outperforming females. This disparity necessitates gender-specific rehabilitative measures. Enhancing balance and mobility training for women is essential for mitigating fall risk, maintaining independence, and promoting healthy aging. Creating and executing tailored programs can significantly enhance quality of life and mitigate functional decline in this demographic.

LIMITATIONS OF THE STUDY

This study included certain drawbacks. The sample size comprised 300 individuals, potentially limiting its generalizability to other populations. The study was conducted exclusively in urban regions, excluding rural or institutional settings. The cross-sectional design also constrains causation. We excluded individuals' typical physical activity levels and comorbidities that potentially influence the outcome.

RECOMMENDATIONS FOR FUTURE RESEARCH

Future studies should overcome these limitations by involving larger and more heterogeneous samples, also including people from rural communities and specific institutions. Prospective study designs could make it possible to follow functional changes and have more evidence for associations among variables. Future research should investigate the impact of sex-specific interventions on mobility outcomes. Integrating more objective outcome measures, e.g. gait analysis and muscle strength measurement, could improve validity and therapeutical importance of findings.

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