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Trunk Flexibility and Postural Balance in Older Adults: A Cross-Sectional Study

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Abstract
Introduction: Aging is associated with physiological changes such as decreased muscle mass and reduced connective tissue elasticity, which may impair trunk flexibility and postural balance. Declines in these physical functions are linked to a higher risk of falls and loss of independence in older adults.
Methods: This analytical cross-sectional study included 88 older adults aged 60 years and above from the Tamalanrea Community Health Center, Makassar. Participants were recruited using purposive sampling according to predefined inclusion criteria. Trunk flexibility was measured using the Chair Sit-and-Reach Test, while postural balance was assessed with the Berg Balance Scale. Data were analyzed with Somers' D test to determine the strength and significance of the relationship between trunk flexibility and balance.
Results: Most participants demonstrated poor trunk flexibility and impaired postural balance requiring walking assistance (66.7%). Somers' D analysis revealed a statistically significant correlation between trunk flexibility and postural balance ($p = 0.000$; $p < 0.05$), with a correlation coefficient (r) of 0.649, indicating a strong positive association.
Conclusion: There is a strong relationship between trunk flexibility and postural balance in older adults. Enhancing trunk flexibility may improve postural control and help reduce fall risk in the elderly population.

Keywords
aging, trunk flexibility, postural balance, fall prevention, cross-sectional studies

Introduction

According to the World Health Organization (WHO), older adults are individuals aged 60 years and above. Aging is a natural process characterized by changes in physical, psychological, and social functions that can affect interactions with others. Older adults are particularly vulnerable to various challenges, including physical decline, reduced activity levels, limited mobility, lower household income, loneliness due to the loss of a spouse, and decreased contact with adult children. Socially, their roles and interactions may diminish significantly.[1]

Data from the Indonesian Central Bureau of Statistics (Badan Pusat Statistik, BPS) in 2022 show that older women make up a larger proportion of the elderly population, with females comprising 51.81% and males 48.19%. A region is classified as having an aging population if the proportion of individuals aged 60 years or older reaches 10% or more. South Sulawesi meets this criterion, with 10.65% of its population aged 60 years and above. The old-age dependency ratio—comparing the number of older adults to those in the productive age group—is 16.09%, meaning that for every 100 working-age individuals, there are 16 older adults depending on them.[1]

Physiologically, aging causes substantial decline in body functions, including a reduction in cross-sectional muscle area and connective tissue volume. Degeneration primarily affects fast-twitch type II muscle fibers, resulting in decreased capacity for strong and rapid contractions, which in turn lowers trunk flexibility.[2] Flexibility is defined as the ability of a joint to move through its full range of motion without pain or restriction. Flexibility is influenced by factors such as gender, occupation, and age. Aging affects body structure, reducing tissue elasticity.[2] Studies indicate that a 50% decline in trunk flexor and extensor flexibility can shift the body's center of mass posteriorly toward the heels, significantly increasing fall risk in older adults.[3]

Weakness and imbalance in the core muscles, including the *rectus abdominis*, *external oblique*, *longissimus thoracis*, and *lumbar multifidus*, may contribute to spinal issues. This is linked to poor coordination between isometric strength of the trunk flexors and extensors, particularly affecting gait and daily activities.[4]

According to WHO, 4.6% to 8% of older adults with poor flexibility also exhibit impaired balance.[5] Balance involves complex interactions between sensory systems—visual, vestibular, somatosensory, and proprioceptive—and the musculoskeletal system. In older adults, balance refers to the ability to maintain the center of mass within the base of support. It depends on neuromuscular coordination to maintain posture and execute movements efficiently. Degenerative changes related to aging are among the major factors that impair balance.[6]

A previous study conducted by Rosanti et al. in Bajar Tainsiat, Dangin Puri Kaja, North Denpasar found a significant relationship between trunk flexibility and postural balance in older adults.[2] Better trunk flexibility was associated with improved balance, while decreased flexibility led to a forward shift of the center of gravity toward the

toes, altering the base of support.[2] However, few studies have explored this topic, and relying on a single study does not adequately represent elderly populations in other regions due to demographic and lifestyle differences.

This study aims to provide more region-specific evidence by investigating older adults at Tamalanrea Community Health Center in Makassar. The novelty of this research lies in its specific location and combined use of two assessment tools rarely studied together in Indonesia's elderly context: the Chair Sit and Reach Test for trunk flexibility and the Berg Balance Scale for postural balance. This approach offers a more comprehensive understanding of physical condition and fall risk among older adults.

The objective of this study is to analyze the relationship between trunk flexibility and postural balance in older adults at Tamalanrea Community Health Center, Makassar. Specifically, it aims to examine the distribution of trunk flexibility, postural balance levels, and their correlation in the local elderly population.

Methods

This study employed a quantitative analytical descriptive design with a cross-sectional approach. Participants were selected through non-probability purposive sampling. Descriptive research aims to depict phenomena or conditions as they exist, while a cross-sectional approach involves observing and measuring variables at a single point in time. The study aimed to examine the relationship between trunk flexibility and postural balance among older adults at the Tamalanrea Community Health Center.

The study was conducted at Tamalanrea Community Health Center, located on Kesejahteraan Timur I Street, Block B, Makassar, South Sulawesi. Recruitment and data collection took place from March to April 2024. Quantitative data were obtained directly from measurements performed on elderly participants who met the inclusion criteria. A total of 88 participants were selected from a population of 112 older adults using purposive sampling, guided by specific inclusion and exclusion criteria.

The inclusion criteria were as follows: (1) aged 60 years and above; (2) willingness to participate as indicated by signing informed consent; (3) cooperative during the assessment; and (4) free from conditions affecting brain structure and function, such as stroke, head trauma, or vertigo. The exclusion criteria included: (1) use of a wheelchair; (2) history of spinal injury or surgery; and (3) presence of visual or hearing impairments.

Data collection involved direct measurement of trunk flexibility using the Chair Sit and Reach Test and postural balance using the Berg Balance Scale. Trunk flexibility was measured in inches, while postural balance was scored based on performance in 14 functional tasks outlined in the Berg Balance Scale.

Occupational history and Body Mass Index (BMI) were considered as potential confounding variables, as both may influence trunk flexibility and balance. Physically demanding work or prolonged static postures may affect musculoskeletal function, while high BMI may restrict movement and impair balance. Conversely, low BMI may reduce postural stability due to decreased muscle mass.

Descriptive analysis was conducted to describe the distribution of trunk flexibility and postural balance. Normality of data was assessed using the Shapiro-Wilk test. Depending on the results, correlations were analyzed using Spearman's rank correlation (for non-normally distributed data) or Pearson's correlation (for normally distributed data). To minimize measurement bias, all assessments were performed by a single examiner. This approach ensured consistency in measurement techniques and reduced inter-rater variability, thereby enhancing the accuracy and reliability of the data collected.

Results

This study was conducted directly in the working area of Tamalanrea Community Health Center, Makassar City, from March to April 2024. A total of 88 respondents aged 60 years and above participated. Primary data were collected directly from respondents through the measurement of trunk flexibility using the Chair Sit and Reach Test and postural balance using the Berg Balance Scale. The demographic characteristics of the respondents are presented in Table 1.

Table 1. Respondent Characteristics

Respondent Characteristics	Category	n (%)
Age	60–64	38 (43.2)
	65–69	22 (25.0)
	70–74	19 (21.6)
	75–79	6 (6.8)
	80–84	2 (2.3)
	85–89	1 (1.1)
	Total	88 (100)
Sex	Male	40 (45.5)
	Female	48 (54.5)
	Total	88 (100)
Occupation	Retired	41 (46.6)
	Housewife	33 (37.5)
	Entrepreneur	6 (6.8)
	Others*	8 (9.1)
	Total	88 (100)

*Others include security guards, religious teachers, motorcycle taxi drivers, farmers, laborers, tailors, drivers, and Hajj assistants.

Table 1 presents the characteristics of the respondents from the Tamalanrea Community Health Center area in Makassar. The table categorizes respondents by age, sex, and occupation. The majority were aged 60–64 years

(43.2%), predominantly female (54.5%), and most were retired (46.6%). No missing data were encountered during collection or analysis. The distribution of trunk flexibility among older adults participating in this study is presented in Table 2.

Table 2. Distribution of Trunk Flexibility

Trunk Flexibility	n (%)
Poor	48 (54.5)
Normal	35 (39.8)
Good	5 (5.7)
Total	88 (100)

Table 2 shows the distribution of trunk flexibility as measured by the Chair Sit and Reach Test, divided into three categories. The largest proportion of older adults had poor trunk flexibility (54.5%). The classification of trunk flexibility based on sex among the study participants is presented in Table 3.

Table 3. Trunk Flexibility by Sex

Flexibility	Male n (%)	Female n (%)	Total n (%)
Poor	17 (42.5)	31 (64.6)	48 (54.5)
Normal	19 (47.5)	16 (33.3)	35 (39.8)
Good	4 (10.0)	1 (2.1)	5 (5.7)
Total	40 (100)	48 (100)	88 (100)

Table 3 indicates that females predominantly fell into the poor flexibility category (64.6%), while males were more represented in the normal (47.5%) and good (10.0%) flexibility categories. The classification of trunk flexibility based on different age groups among the study participants is shown in Table 4.

Table 4. Trunk Flexibility by Age

Age Group	Poor n (%)	Normal n (%)	Good n (%)	Total n (%)
60–64	17 (44.7)	17 (44.7)	4 (10.5)	38 (100)
65–69	12 (54.5)	9 (40.9)	1 (4.5)	22 (100)
70–74	12 (63.2)	7 (36.8)	0 (0.0)	19 (100)
75–79	4 (66.7)	2 (33.3)	0 (0.0)	6 (100)
80–84	2 (100.0)	0 (0.0)	0 (0.0)	2 (100)
85–89	1 (100.0)	0 (0.0)	0 (0.0)	1 (100)
Total	48 (54.5)	35 (39.8)	5 (5.7)	88 (100)

Table 4 presents trunk flexibility by age group. The 60–64 age group had the highest number of respondents across all categories, with 17 each in the poor and normal categories and 4 in the good category. The classification of trunk flexibility according to the participants' occupations is presented in Table 5.

Table 5. Trunk Flexibility by Occupation

Occupation	Poor n (%)	Normal n (%)	Good n (%)	Total n (%)
Retired	19 (46.3)	20 (48.8)	2 (4.9)	41 (100)
Housewife	23 (69.7)	9 (27.3)	1 (3.0)	33 (100)
Entrepreneur	3 (50.0)	3 (50.0)	0 (0.0)	6 (100)
Others	3 (37.5)	3 (37.5)	2 (25.0)	8 (100)
Total	48 (54.5)	35 (39.8)	5 (5.7)	88 (100)

Table 5 illustrates the distribution of trunk flexibility by occupation. Poor flexibility was most prevalent among housewives (69.7%), while normal and good flexibility were more common among retired individuals. The classification of postural balance levels among study participants is shown in Table 6.

Table 6. Distribution of Postural Balance

Postural Balance	n (%)
Requires wheelchair	3 (3.4)
Walks with assistance	33 (37.5)
Independent	52 (59.1)
Total	88 (100)

As shown in Table 6, most respondents were independently mobile (59.1%), with a smaller proportion requiring walking aids or a wheelchair. The classification of postural balance based on participants' sex is presented in Table 7.

Table 7. Postural Balance by Sex

Postural Balance	Male n (%)	Female n (%)	Total n (%)
Requires wheelchair	1 (2.5)	2 (4.2)	3 (3.4)
Walks with assistance	12 (30.0)	21 (43.8)	33 (37.5)
Independent	27 (67.5)	25 (52.1)	52 (59.1)
Total	40 (100)	48 (100)	88 (100)

Table 7 shows that males were more likely to be independently mobile (67.5%), while females had higher representation in the assisted walking and wheelchair categories. The variation in postural balance categories across different age groups is illustrated in Table 8.

Table 8. Postural Balance by Age Group

Age Group	Wheelchair n (%)	Assistance n (%)	Independent n (%)	Total n (%)
60–64	0 (0.0)	12 (31.6)	26 (68.4)	38 (100)
65–69	2 (9.1)	7 (31.8)	13 (59.1)	22 (100)
70–74	1 (5.3)	10 (52.6)	8 (42.1)	19 (100)
75–79	0 (0.0)	3 (50.0)	3 (50.0)	6 (100)
80–84	0 (0.0)	0 (0.0)	2 (100.0)	2 (100)
85–89	0 (0.0)	1 (100.0)	0 (0.0)	1 (100)
Total	3 (3.4)	33 (37.5)	52 (59.1)	88 (100)

Table 8 details postural balance by age. The 60–64 group had the highest proportion of independent individuals (68.4%). Wheelchair use was most frequent among those aged 65–69. The classification of postural balance based on participants' occupations is presented in Table 9.

Table 9. Postural Balance by Occupation

Occupation	Wheelchair n (%)	Assistance n (%)	Independent n (%)	Total n (%)
Retired	2 (4.9)	14 (34.1)	25 (61.0)	41 (100)
Housewife	1 (3.0)	16 (48.5)	16 (48.5)	33 (100)
Entrepreneur	0 (0.0)	2 (33.3)	4 (66.7)	6 (100)
Others	0 (0.0)	1 (12.5)	7 (87.5)	8 (100)
Total	3 (3.4)	33 (37.5)	52 (59.1)	88 (100)

Table 9 shows postural balance across occupations. The retired group had the highest proportion of independent individuals, while housewives represented the majority needing walking assistance. The outcome of the statistical correlation test examining the relationship between trunk flexibility and postural balance is shown in Table 10.

Table 10. Correlation Test Result

Variable	n	r	p-value
Trunk Flexibility	88	0.649	0.000

Table 10 presents the correlation test using Somers' D, revealing a statistically significant relationship ($p < 0.05$) between trunk flexibility and postural balance. The correlation coefficient ($r = 0.649$) indicates a strong positive correlation between the two variables.a

Discussion

This study demonstrates a strong and significant relationship between trunk flexibility and postural balance in older adults in the working area of Tamalanrea Public Health Center. The majority of respondents exhibited low trunk flexibility yet maintained independent postural balance. As a cross-sectional study, the results are associative rather than causal.

General Characteristics of Respondents

The research was conducted among elderly individuals aged over 60 years in the working area of the Tamalanrea Public Health Center, Makassar City. A total of 88 respondents met the inclusion criteria. Respondents were categorized by age, sex, and occupation, as summarized in the frequency distribution tables. Most participants (n=38) were in the 60–64 age category, followed by 22 participants aged 65–69, 19 aged 70–74, 6 aged 75–79, 2 aged 80–84, and 1 participant aged 85–89. These findings align with data from the Central Statistics Agency, which indicate that individuals aged 60–69 years constitute the largest proportion of the elderly population in Indonesia.[6]

The majority of respondents were female (n=48), compared to males (n=40), which is consistent with BPS data reporting a higher proportion of elderly women than men (52.82% vs. 47.72%).[6] In terms of occupation, most respondents were retired civil servants (n=41), housewives (n=33), self-employed individuals (n=6), and others (n=8), including security guards, religious teachers, motorcycle taxi drivers, farmers, laborers, tailors, drivers, and pilgrimage organizers.

Trunk Flexibility in Older Adults at Tamalanrea Public Health Center

Trunk flexibility assessments revealed that 54.5% of older adults had poor trunk flexibility, 39.8% had normal flexibility, and only 5.7% had good trunk flexibility. These results support previous findings showing a 20%–30% decline in flexibility between the ages of 30 and 70, which may increase injury risk, restrict daily movements, and negatively affect overall quality of life.[7]

When analyzed by sex, poor trunk flexibility was more prevalent among women (64.6%). This supports findings that hormonal and anatomical differences between men and women affect flexibility.[8] Hormonal changes, such as decreased estrogen and increased testosterone in older women, may influence muscle and vascular flexibility. Additionally, anatomical differences like wider pelvic structures and increased thoracic kyphosis with age may limit movement and trunk flexibility.

In terms of age, the 60–64 age group showed the highest prevalence (44.7%) of poor trunk flexibility. This may reflect the early aging stage where physiological changes and decreased body function begin to accumulate. Factors such as hormonal decline, reduced physical activity due to health issues or mobility limitations, and anatomical changes contribute to reduced flexibility in this age group. These findings are consistent with previous research reporting a gradual decline in upper and lower limb joint flexibility starting after age 55.[9] Specifically, hip flexion flexibility decreases by 0.60 per year in men and 0.70 per year in women.

Occupational analysis showed poor trunk flexibility was more prevalent among retirees (46.3%) and housewives (69.7%). Retirees tend to be physically inactive, while housewives reduce household activities with age-related limitations. This supports prior findings indicating that physical activity, especially aerobic exercise, is associated with better flexibility.[10] Regular activity enhances blood flow to muscles and joints, supports tissue repair, maintains muscle elasticity, promotes synovial fluid production, and contributes to collagen remodeling—all of which support joint and muscle flexibility.

Postural Balance in Older Adults at Tamalanrea Public Health Center

Regarding postural balance, 59.1% of respondents maintained independent balance, 37.5% required assistance while walking, and only 3.4% relied on wheelchairs. These findings contradict previous reports stating that age-related morphological changes such as sarcopenia reduce muscle strength and flexibility, thereby impairing postural balance.[11] Sensory-motor and visual declines also exacerbate balance instability and increase fall risk in the elderly.

Male respondents were more likely to have independent balance (67.5%) compared to females. This supports findings suggesting that postural balance control is generally better in older men than women.[12] Elderly women demonstrated lower performance in balance tests, and there is a negative correlation between postural control and gait parameters, indicating a connection between walking ability and postural balance.

Within the 60–64 age group, 68.4% had independent balance, while 31.6% required walking assistance. This suggests a transitional phase in aging, where physiological systems—including the nervous, muscular, and sensory systems—undergo natural decline. This includes neuronal loss, reduced muscle mass, and diminished sensory function, affecting balance. Previous studies also show that cognitive decline increases fall risk, as cognitive tasks performed concurrently with postural tasks can impair balance performance, particularly in older adults.[13] In addition, reduced lower limb strength can hinder the body's ability to respond to environmental changes requiring balance.

In terms of occupation, postural independence was higher among retirees (61%) and housewives (48.5%). Interviews indicated that these groups remain active through gardening, jogging, and social activities. This is consistent with findings showing that active older adults tend to have better postural balance.6 However, it contrasts with other studies reporting reduced activity among older adults, with many spending prolonged periods sitting improperly.[14] Prolonged sitting can stress the spinal musculoskeletal structure, increase intradiscal pressure, reduce muscle flexibility and joint mobility, and fatigue spinal extensor muscles—ultimately impairing postural balance.

Correlation Between Trunk Flexibility and Postural Balance in Older Adults

This study found a significant correlation between trunk flexibility and postural balance among older adults at Tamalanrea Public Health Center. Better trunk flexibility was associated with greater independence in postural balance. The statistical analysis yielded a low p-value (0.000) and a correlation coefficient (r) of 0.649, indicating a strong relationship. Therefore, trunk flexibility appears to play a critical role in postural balance in older adults. This supports findings that physiological changes in the musculoskeletal system—such as joint limitations, postural changes, reduced strength and endurance, and collagen and nutritional changes—contribute to decreased flexibility.2 In turn, this reduced flexibility impairs the body's ability to maintain balance.

Study Limitations

This study had several limitations. First, the cross-sectional design prevents inference of causal relationships between trunk flexibility and postural balance. Second, the use of purposive sampling limits the generalizability of the findings to the broader elderly population in Makassar or other regions.

Conclusion

Based on the results and discussion regarding the relationship between trunk flexibility and postural balance among older adults at the Tamalanrea Primary Health Center, Makassar, the following conclusions can be drawn: The distribution of trunk flexibility showed that the majority of elderly individuals exhibited low levels of trunk flexibility. The distribution of postural balance revealed that most older adults had an independent category of postural balance. A significant relationship was found between trunk flexibility and postural balance among the elderly in the Tamalanrea Health Center area. Therefore, it can be concluded that greater attention should be given to improving trunk flexibility in older adults, particularly in the working area of the Tamalanrea Primary Health Center in Makassar.

Author Contribution

Mutia Puspita Alman contributed to the study conception, data collection, and drafting of the manuscript. Ita Rini contributed to study design, data analysis, critical revision, and final approval of the manuscript. Both authors read and approved the final version of the manuscript.

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Conflict of Interest Statement

The authors declare that there are no conflicts of interest related to this study.

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Ethics Statement

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Ethical approval was not required as the study involved only non-invasive procedures (blood pressure measurement and questionnaire surveys) and posed minimal risk to participants. Informed consent was obtained from all participants prior to their inclusion in the study, and confidentiality was strictly maintained.

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