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Hamstring Muscle Flexibility and Dynamic Balance in Elderly Residents of Bagendang Hulu Village: A Cross-Sectional Study

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ABSTRACT

Introduction: Aging brings about notable changes in the musculoskeletal system, affecting muscle flexibility and dynamic balance among the elderly. This study explores the correlation between hamstring muscle flexibility and dynamic balance in elderly residents of Bagendang Hulu Village, Central Kalimantan. Decreasing flexibility with age can lead to stiffness and reduced mobility, impacting daily activities. Hamstring muscles, crucial for tasks like standing and walking, contribute significantly to balance despite their decreased flexibility in older adults. Dynamic balance, essential for mobility and fall prevention, integrates sensory, motor, and cognitive functions influenced by muscle strength and joint functionality.

Method: This cross-sectional study involved 66 participants aged 60-94 from Elderly Integrated Health Posts. Hamstring flexibility was assessed using the Chair Sit and Reach Test, and dynamic balance was measured with the Timed Up and Go Test.

Results: The study found no significant correlation ($p > 0.05$) between hamstring muscle flexibility and dynamic balance in this population.

Conclusion: Active engagement in senior gymnastics is recommended to enhance physical fitness and overall quality of life, addressing cardiovascular health, hypertension risk, blood sugar regulation, flexibility, and balance maintenance. Future research should focus on larger sample sizes, controlling for medical histories, and balancing participant demographics to provide deeper insights. Understanding these relationships can inform interventions aimed at enhancing musculoskeletal health and reducing fall risks among elderly populations.

Keywords: Aging, hamstring muscle flexibility, dynamic balance, elderly, physical activity

INTRODUCTION

Every human will experience the aging process in their lifetime.[1] Aging is synonymous with becoming elderly. The elderly experience a decline in the quality of the musculoskeletal system. This decline reduces muscle and joint flexibility, cartilage function, bone density, and muscle strength, particularly in the lower extremities.[2]

Flexibility is the ability of a muscle to stretch to its maximum limit, allowing the body to move within a range of motion (ROM) without discomfort or pain. Flexibility is related to joints, ligaments, tendons, muscles, bones, age, gender, body temperature, fatigue, and emotions. Muscle flexibility plays a crucial role for the elderly. As age increases, flexibility can decrease by 20-30%, potentially causing stiffness and pain during activities and daily routines.[3–5] In the lower extremities, muscles lose 14-16% of their strength due to aging.[6] The hamstring muscles are involved in major daily movements, such as standing and walking.[7] The hamstring muscles are important contributors to maintaining standing balance in the elderly.[8]

Balance is a state of equilibrium and is a crucial component of motor skills. It is achieved when an individual can maintain their center of gravity.[9] In the elderly, dynamic balance is a crucial component of their physical health. Various physiological systems must collaborate to establish dynamic balance, starting with sensory receptors in the skin, muscles, and joints. The somatosensory system provides information about body position and movement. The visual system also contributes input about the environment and helps adapt movements based on visual cues. The vestibular system in the inner ear provides information regarding head movement and direction, playing a critical role in maintaining balance. Additionally, motor output is essential for achieving dynamic balance. The musculoskeletal system must generate appropriate force and torque to control movements and maintain postural stability. This requires coordinated activation of multiple muscle groups and the ability to adjust movements based on feedback from sensory systems.[10]

On the other hand, cognitive processes also play a significant role in dynamic balance. Attention, memory, and decision-making are all involved in planning and executing movements. The ability to anticipate and respond to environmental cues is vital for successful dynamic balance. Age-related declines in sensory, motor, and cognitive

functions can all contribute to the loss of dynamic balance. Interventions aimed at improving these functions are crucial for maintaining independence and quality of life in the elderly.[10]

The decline in hamstring flexibility can lead to a decrease in balance. The hamstring muscles, which are predominantly composed of type II muscle fibers, are responsible for knee flexion and hip extension, making them prone to tightness. Additionally, limited extensibility of the hamstring muscles results in changes to dynamic range of motion. As a result, hamstring muscle tension becomes a factor affecting dynamic balance because the muscles lose their ability to change shape when stretched. This leads to reduced physical activity over time, accompanied by shortening of soft tissues such as ligaments. Loss of balance control increases the risk of falls in the elderly.[11,12]

Research indicates that the strength of hip extension, hip abduction, quadriceps, ankle plantar flexion and dorsiflexion, and hamstrings significantly correlates with balance and the risk of falls in the elderly.[13] Other studies have noted that hamstring tightness increases with age compared to younger populations. Hamstring tightness elevates the risk of muscle strain during physical activities. Additionally, shortened hamstrings increase posterior pelvic tilt and reduce lumbar lordosis, resulting in a flat back and potentially leading to back pain in the future.[14]

On the other hand, sedentary behavior is another significant factor that can exacerbate these issues. Sedentary behavior can lead to decreased flexibility, muscle strength, joint function, and reduced mobility, thereby disrupting balance in the elderly. Physical activity plays a crucial role in maintaining joint and muscle function, which is essential for preserving balance in the elderly. Physiologically, aging leads to reduced physical activity, resulting in a decline in muscle fibers that impairs the muscle's ability to generate quick and strong contractions necessary for maintaining balance. [9,15,16]

Daily physical activities encompass various aspects such as work, sports, household chores, and more. Research results indicate that the more active elderly individuals are in participating in exercises tailored for their age group, the more independent and balanced they tend to be.[9,15,16]

Based on the preliminary study conducted in Bagendang Hulu Village, it is known that there are 2 Elderly Integrated Health Posts (Posyandu Lansia) in the village. Additionally, there is a Prolanis program held weekly, including senior exercises. It is noted that the elderly in Bagendang Hulu Village remain physically active and participate in senior exercises. However, there has been no previous research specifically on hamstring muscle flexibility and dynamic balance among the elderly in this village.[17]

The elderly were chosen as research subjects because they need to understand the function or usefulness of hamstring muscles in their bodies, especially hamstring flexibility, to enhance their quality of life. Despite their active lifestyle, maintaining optimal activity requires researchers to gather data on hamstring muscle flexibility and dynamic balance among the elderly. This is crucial because elderly individuals with decreased hamstring flexibility who engage in high-intensity activities are at risk of falling due to poor balance. Therefore, this research is essential as muscle strength tends to decrease with age.[17]

Moreover, based on a previous study by Amajida in 2021, there were limitations such as the age range of respondents being limited to 60-69 years, which resulted in less diverse measurement outcomes.[17] Therefore, the researcher has decided to conduct further research with the aim of understanding the relationship between hamstring muscle flexibility and dynamic balance in the elderly. This study also aims to determine whether there is a correlation between hamstring muscle flexibility and dynamic balance among the elderly at the Elderly Integrated Health Posts in Bagendang Hulu Village, Mentaya Hilir Utara, Kotawaringin Timur, Central Kalimantan.

METHOD

This study employed a cross-sectional design conducted at the Elderly Integrated Health Posts (Posyandu Lansia) in Bagendang Hulu Village, during the month of April 2024, coinciding with the schedule for senior exercises. The population consisted of elderly individuals attending the Elderly Integrated Health Posts. The respondents included elderly individuals who met the inclusion criteria: 1) aged 60-94 years and attending the Elderly Integrated Health Posts in Bagendang Hulu Village, 2) willing to participate in the study, 3) capable of following instructions well, and 4) able to communicate effectively. Exclusion criteria were: 1) elderly individuals under 60 years old, 2) history of osteoporosis and musculoskeletal injuries, 3) recent knee or hip arthroplasty surgery within the last month, 4) experiencing pain during forward bending movements, 5) cognitive impairments, and 6) use of walking aids.

Based on a preliminary study, 152 elderly individuals attended the Elderly Integrated Health Posts in 2022. Therefore, the sample size was determined using the Slovin's formula with a 10% tolerance for non-response, resulting in a minimum required sample size of 60 individuals. Purposive sampling technique was used.

Variables included in the study were: the independent variable, hamstring muscle flexibility measured using the Chair Sit and Reach Test (CSR); the dependent variable, dynamic balance measured using the Timed Up and Go Test (TUG); and covariates such as age, gender, and physical activity level involving participation in senior exercises. CSR demonstrated good reliability for males (R = 0.92) and females (R = 0.96) with criterion validity correlations of (r = 0.76) for males and (r = 0.81) for females. TUG was validated against standard measures such as DGI and showed strong correlations with other balance measures including the Berg Balance Scale, gait speed, and functional reach test. It exhibited good reliability with both intra-rater and inter-rater reliability.

Before the study commenced, elderly participants were required to warm up to prevent injuries. The warm-up consisted of exercise routines as the study was conducted during the scheduled exercise sessions. Therefore, additional warm-up exercises were not administered by the researchers. Following the exercises, participants gathered for blood pressure checks conducted by Bagendang Health Center personnel, followed by data collection. A brief Q&A session related to filling out respondent characteristic forms and providing information regarding the study was conducted. Elderly individuals who agreed to participate then signed the provided informed consent form before proceeding to hamstring muscle flexibility and dynamic balance measurements.

Elderly individuals who met the inclusion criteria and were free from exclusion criteria but declined or did not wish to participate in the study were not coerced by the researchers to participate. A total of 66 respondents were obtained. Measurements were conducted individually. Data analyzed included respondent characteristic data, hamstring muscle flexibility measurements, and dynamic balance measurements. Normality testing was performed using the Kolmogorov-Smirnov test due to the sample size (>50 respondents), and correlation analysis utilized non-parametric Spearman Rank test as data were not normally distributed. All data were analyzed using SPSS version 26.

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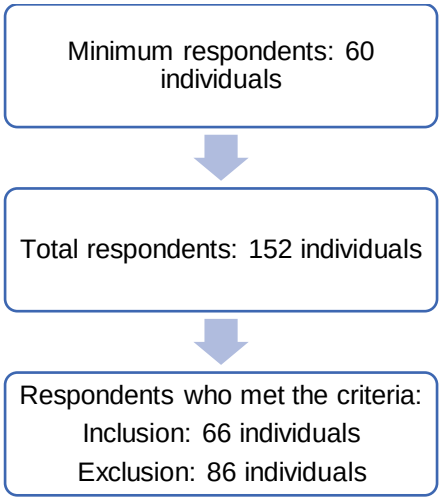

Figure 1. Process of Respondent Selection

Based on Figure 1 above, this study obtained a total of 66 respondents who met the inclusion criteria. Additionally, there were 86 individuals who did not meet the inclusion criteria because they were under 60 years old. Furthermore, some individuals experienced pain when bending forward, and there were individuals with a history of ankle injuries, as shown in Figure 1.

The respondents in this study consisted of 152 elderly individuals aged 60-94 years. After a brief interview conducted using a subject characteristics form to determine the respondents who met the inclusion criteria, the final result was 66 respondents. There were no missing data or values for any variables.The table below illustrates the frequency distribution of respondent characteristics, independent variables, and dependent variables among 66 elderly participants from Bagendang Hulu Village who met the inclusion criteria and were free from exclusion criteria.

Table 1. Distribution of Respondents Based on Gender

Gender	Frequency (n)	Percentage (%)
Male	15	22.7
Female	51	77.3
Total	66	100

Based on Table 1 above, it can be seen that out of 66 elderly respondents in Bagendang Hulu Village, females dominate with 51 individuals (77.3%). Meanwhile, males comprise only 15 individuals (22.7%).

Table 2. Distribution of Respondents Based on Age

Age	Frequency (n)	Percentage (%)
60-64 Years	30	45.5
65-69 Years	19	28.8
70-74 Years	10	15.2
75-79 Years	4	6.1
80-84 Years	1	1.5
85-89 Years	1	1.5
90-94 Years	1	1.5
Total	66	100

Based on Table 2 above, it can be observed that out of 66 elderly respondents in Bagendang Hulu Village, those aged 60-64 years dominate with 30 individuals (45.5%).

Table 3. Distribution of Respondents Based on Participation in Senior Exercises

Senior Exercises Activity	Frequency (n)	Percentage (%)
Active	57	86.4
Inactive	9	13.6
Total	66	100

Based on Table 3 above, it can be observed that out of 66 elderly respondents in Bagendang Hulu Village, the majority are actively participating in senior exercises, totaling 57 individuals (86.4%).

Table 4. Distribution of Respondents Based on Hamstring Muscle Flexibility

Hamstring Muscle Flexibility	Category	Frequency (N)	
		Frequency (N)	Percentage (%)
Male	Below Average	0	0
	Normal	4	26.7
	Above Average	11	73.3
Total		15	100
Female	Below Average	0	0
	Normal	16	31.4
	Above Average	35	68.6
Total		51	100

Based on Table 4 above, it is noted that the majority of hamstring muscle flexibility measurements among elderly respondents are categorized as above average. Among male elderly respondents, out of 15 individuals, 11 (73.3%) were categorized as above average and 4 (26.7%) as normal. Meanwhile, among female elderly respondents, out of 51 individuals, 35 (68.6%) were categorized as above average and 16 (31.4%) as normal. Therefore, a total of 66 elderly respondents were included in the study.

Table 5. Distribution of Respondents Based on Dynamic Balance

Dynamic Balance	Category	Frequency (N)	
		Frequency (N)	Percentage (%)
Male	Normal	1	6.7
	Low Fall Risk	13	86.7
	Moderate Fall Risk	1	6.7
	High Fall Risk	0	0
Total		15	100
Female	Normal	2	3.9
	Low Fall Risk	43	84.3
	Moderate Fall Risk	6	11.8
	High Fall Risk	0	0
Total		51	100

Based on Table 5 above, the results of dynamic balance measurements are predominantly categorized as low fall risk for both male and female elderly respondents. Among male elderly respondents, out of 15 individuals, 13 (86.7%) were categorized as low fall risk, with 1 individual (6.7%) each in the normal and moderate fall risk categories. Among female elderly respondents, out of 51 individuals, 43 (84.3%) were in the low fall risk category, 6 (11.8%) in the moderate fall risk category, and 2 (3.9%) in the normal category. Therefore, a total of 66 elderly respondents were included in the study.

Table 6. Normality Test of Hamstring Muscle Flexibility with Dynamic Balance

Variable	P Value
Hamstring Muscle Flexibility	0.200
Dynamic Balance	0.001

Based on Table 6 above, after conducting the normality test using Kolmogorov-Smirnov, it is found that the dynamic balance data are not normally distributed ($p<0.05$). Therefore, it is concluded that the overall data are not normally distributed, and the analysis proceeds with non-parametric testing using Spearman Rank.

Table 7. Correlation Analysis

Variable	P Value
Relationship: Hamstring Muscle Flexibility with Dynamic Balance	0.935

Based on Table 7 above, after conducting the correlation analysis using Spearman Rank, the results indicate that there is no significant correlation between hamstring muscle flexibility and dynamic balance in the elderly ($p>0.05$).

DISCUSSION

The Relationship Between Hamstring Muscle Flexibility and Dynamic Balance in the Elderly

The study results indicate that hamstring muscle flexibility does not significantly affect dynamic balance in the elderly, or in other words, there is no relationship between hamstring muscle flexibility and dynamic balance in the elderly in Bagendang Hulu Village. This finding contrasts with previous research by Rahayu et al. in 2019 and Amajida in 2021, where the studies showed a significant relationship between hamstring muscle flexibility and dynamic balance in the elderly.[11,17]

The specific conditions of the elderly respondents, such as those who engage extensively in standing or sitting positions or lead sedentary lifestyles, were not explicitly mentioned in this study. However, in Amajida's research in 2021, it was noted that elderly respondents were selected by visiting their homes directly.[17] In contrast, in this study, elderly participants gathered at the Elderly Integrated Health Posts (Posyandu Lansia) and participated in exercises beforehand, with the majority actively moving, especially during exercise sessions. This active engagement likely contributed to the absence of significant findings regarding hamstring muscle flexibility and dynamic balance. Other

factors such as age, physical activity involving exercise participation, and walking speed may have influenced the study's results.

The theory suggests that elderly individuals experience a decline in musculoskeletal system quality, leading to reduced flexibility. Additionally, aging is associated with a decline in dynamic balance. Based on the findings of Utami and Syah in 2022, age itself does not directly impact elderly balance. This is because with advancing age, increased physical activity or functional activity can help minimize the risk of falls among the elderly.[9] In addition, physical activity is a significant factor influencing both flexibility and dynamic balance, exemplified by activities such as gymnastics. Active participation in gymnastics among the elderly can enhance physical fitness and improve their quality of life. Theoretically, as aging occurs, muscle fibers shrink and muscle mass decreases, resulting in a decline in muscle strength. Approximately 10-15% of muscle strength can be lost each week if muscles are not used or fully rested. Furthermore, around 5.5% can be lost daily under conditions of complete rest and immobility. Therefore, engaging in physical activities helps elderly individuals maintain joint mobility, muscle tone, and reduce issues related to flexibility.[18]

Generally, physical activity levels decline significantly with age. In the elderly, the loss of fitness in the musculoskeletal system, including muscle flexibility and balance, combined with reduced physical activity levels, is a strong contributing factor to the risk of falls, disability, decreased quality of life, and increased mortality rates.[19] If there is a decline in muscle function and strength, it can lead to reduced ability in older adults to maintain postural balance or body equilibrium. If balance disturbances are not controlled, the risk of falls and injuries among older adults increases.[15]

The research conducted by Yanti and Armayanti in 2016 indicates that the more active older adults are in participating in gymnastics, the better their body balance and independence. This is because gymnastics aims to strengthen, improve endurance, and enhance flexibility of bones and joints, thereby potentially improving the declining condition of the musculoskeletal system.[15] The elderly in Desa Bagendang Hulu always make time to participate in gymnastics to feel healthier. This study also found that there are elderly individuals who actively participate in gymnastics and have good hamstring muscle flexibility, but still have a moderate risk of falling. This finding aligns with similar research by Yanti and Armayanti in 2016, where it was noted that some elderly people actively engage in gymnastics but still require assistance when using chairs or walking. This is often due to conditions like gout or joint inflammation, causing discomfort when standing for prolonged periods. However, they continue to strive to actively participate in gymnastics to stay fit and socialize with other elderly individuals.[15]

The decline in lower limb muscles can result in slow movements, shorter steps, weakened ability to step firmly, increased instability, and reduced mobility in the elderly.[15] Walking is an activity of moving from one place to another by alternating steps between the right and left legs, involving the interaction of the nervous and musculoskeletal systems in a balanced or stable physiological body position.[20] On the other hand, according to a study conducted by Henriques et al. in 2021, the average walking speed of the elderly falls below average. Therefore, from this study, it can be concluded that there is no correlation between hamstring muscle flexibility and walking speed in the elderly.[21] Walking activity and balance are formed by the integration of components within the same neuromusculoskeletal system in the body. Therefore, walking speed can also be used to assess balance in the elderly. Decreased walking speed in the elderly may be due to reduced strength in the lower extremity muscles and slower information processing while walking.[22]

The limitation of this study is that the number of elderly individuals who attended could not be controlled and was only managed according to the inclusion and exclusion criteria. Consequently, this resulted in an uneven distribution of male and female elderly respondents. Additionally, the study did not control for other medical conditions, injuries, or the history of falls among the elderly participants.

This study provides insights into the potential influence of various factors on the relationship between hamstring muscle flexibility and dynamic balance, such as daily physical activity, additional health conditions, or environmental factors. Future research could benefit from deeper analyses of these factors to better understand their contributions to dynamic balance among the elderly.

Expanding the discussion on the practical implications of these findings in the context of care and interventions to improve dynamic balance and quality of life among the elderly is crucial. Interventions focused on enhancing physical activity and addressing musculoskeletal health could be explored further to mitigate the risk of falls and improve overall well-being in elderly populations.

Updating the literature used with recent studies can strengthen arguments about the relationship between hamstring muscle flexibility and dynamic balance in the elderly. This could involve incorporating recent findings and advancements in related fields to provide a comprehensive understanding of the topic.

CONCLUSION

This study concludes that there is no significant relationship between hamstring muscle flexibility and dynamic balance in the elderly in Bagendang Hulu Village ($p > 0.05$). Recommendations include encouraging elderly individuals to participate actively in senior gymnastics at the Elderly Integrated Health Posts (Posyandu Lansia), as it promotes physical fitness and improves quality of life. Gymnastics also enhances heart function, reduces hypertension risk, controls blood sugar levels, improves flexibility, and maintains balance. Elderly individuals experiencing balance issues or at risk of falling should consider using walking aids and undergo regular assessments of their dynamic balance. Future research should increase sample size, control for medical histories and fall incidents, and balance participant distribution by gender for more robust results.

This study highlights discrepancies between theoretical expectations and empirical findings influenced by research criteria and uncontrollable factors. These findings underscore the importance of further research to update knowledge and deepen understanding in this area.

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