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Environmental Risk Factors and Fall Incidence Among Older Adults: A Cross-Sectional Study

Sentosa Wijaya[1], Indriani[2]*, Siti Nadhir Ollin Norlinta[3]

[1,2,3]Undergraduate Program in Physiotherapy, Faculty of Health Sciences, Universitas 'Aisyiyah Yogyakarta, Yogyakarta, Indonesia

*Corresponding author:
E-mail: indriani@unisayogya.ac.id

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Abstract

Introduction: Falls represent a major public health concern among older adults, often leading to injuries, reduced independence, and decreased quality of life. While intrinsic factors contribute to fall risk, environmental hazards play a critical role and remain preventable through proper interventions.

Methods: This cross-sectional study included 33 older adults enrolled at the Gamol Elderly Integrated Health Post (Posyandu Lansia Gamol) in Sleman, Yogyakarta. Environmental risk factors were assessed using a standardized home safety checklist, while fall risk was measured with a validated fall risk questionnaire. Data were analyzed using the Kendall Tau correlation test to examine the association between environmental hazards and fall risk.

Results: Analysis revealed a significant positive correlation between environmental hazards and fall risk ($p < 0.05$). The most frequently identified hazards were poor lighting, slippery flooring, and unsafe bathroom conditions. No significant association was observed between fall risk and demographic variables, including age, sex, and occupation ($p > 0.05$).

Conclusion: Environmental hazards substantially contribute to fall risk among older adults. Preventive strategies should include home modifications, periodic safety assessments, and education for both families and community health workers. Coordinated efforts through government health initiatives and infrastructure development are essential to enhance safety and preserve independence among older adults.

Keywords

aged, accidental falls, risk factors, environment, home safety

Introduction

Individuals entering old age are more vulnerable to various health issues due to degenerative processes associated with aging. This process is characterized by the decline of multiple body systems, including the musculoskeletal, cardiovascular, neurological, and cognitive systems.[1] These changes increase the risk of falls, which can lead to injury or even death. Falls are classified among the "geriatric giants" due to their broad and significant impact on the elderly.[2]

Globally, the prevalence of falls among older adults reaches 26.5%, with the highest rates observed in Oceania (34.4%), followed by the Americas (27.9%) and Asia (25.8%).[3] In Indonesia, the prevalence of falls among older adults is also high and varies by region. A study in three major cities—Jakarta, Yogyakarta, and Bandung—showed that 21.8% of older adults in Jakarta had experienced a fall in the past year, with 35.3% at risk of falling. This figure was higher in Yogyakarta, where 24% of older adults reported falling, and 36.3% were at risk. Bandung recorded the highest numbers, with 40.5% having experienced a fall and 63.5% at risk. The risk was more prevalent among women than men.[4]

A variety of factors contribute to fall risk among the elderly. One primary intrinsic factor is the decline in muscle strength due to aging, which results in slower movement and impaired mobility, reducing independence in daily activities.[5] Muscle weakness as an intrinsic factor has been shown to significantly affect mobility and fall risk.[6] This condition worsens the quality of life by increasing dependency and the likelihood of recurrent falls.

In addition to intrinsic factors, extrinsic factors such as environmental conditions also contribute to fall risk. Unfortunately, environmental risks are often overlooked by older adults and their families. Research conducted at the Senja Cerah Manado Social Welfare Institution revealed that poor lighting, slippery or uneven floors, and the absence of handrails in bathrooms or stairways significantly increase the risk of falling among the elderly.[7]

Unsafe environmental conditions can lead to serious injuries from falls, such as head trauma resulting in skull fractures, intracranial bleeding, loss of consciousness, or open wounds requiring urgent medical attention. Hip injuries—ranging from dislocation to fractures—are also commonly reported.[8] A study by the Sleman Health and Demographic Surveillance System (HDSS) found that the lower extremities were the most commonly injured body parts following a fall (55.3% in pre-elderly and 54.2% in elderly individuals), followed by upper extremities and the upper back.[9]

Numerous preventive strategies can be implemented to reduce fall risk, including physical exercises such as resistance, endurance, and balance training, as well as environmental modifications. Measures such as installing

handrails, improving lighting, and using textured flooring are recommended to create a safer living environment for older adults.[10,11]

A preliminary study conducted at the Elderly Health Post (Posyandu Lansia) in Balecatur Village found that 7 to 10 individuals in each elderly community group reported a history of falls, typically from slipping. Most older adults paid little attention to environmental conditions that could contribute to falls. However, data on the specific influence of environmental factors on fall risk among community-dwelling elderly in Yogyakarta—particularly at the primary care level, such as Posyandu Lansia—remain limited.

Balecatur was chosen as the study site due to its relatively large elderly population and the lack of community-based fall risk data in the area. This study aims to identify the relationship between environmental risk factors and the risk of falling among older adults at the Elderly Health Post in Balecatur Village, Sleman, Yogyakarta.

Methods

This study employed an analytical survey design with a cross-sectional approach to examine the association between environmental risk factors and fall risk among older adults. The research was conducted at three community-based elderly health posts (Posyandu Lansia) located in Gamol, Pasekan Lor, and Sumber in Balecatur, Sleman, Yogyakarta. These locations were purposively selected based on their active status, substantial membership base (totaling 339 older adults), and strong cooperation from community health cadres throughout the research process. Data collection was carried out between April 1 and April 30, 2025, aligned with the scheduled activities of the elderly health posts.

The study population included all active older adults registered in the selected health posts. The sample was drawn using proportional random sampling among participants who were present during data collection and met the inclusion criteria. The sample size was determined using the Slovin formula: $n = N / (1 + Ne^2)$, where N = 339 and e = 0.10 (margin of error), resulting in a final sample of 157 older adults. Inclusion criteria were men and women aged 60 to 75 years, actively participating in one of the three selected health posts, and willing to provide informed consent. Exclusion criteria included individuals aged below 60 or above 75 years, those who failed to comply with the study procedures, or participants who withdrew during the process.

Data were collected by the principal investigator and trained research team members, with assistance from community health cadres who had received prior instruction to avoid influencing participant responses during questionnaire administration. The research instruments consisted of two main tools. First, an environmental risk questionnaire comprising 10 items assessed aspects such as home lighting, floor conditions, room layout, and toilet design. Responses were recorded as “yes” (score = 1) or “no” (score = 0), with total scores ≤5 categorized as “low-risk environment” and scores >5 as “high-risk environment”. [12]

This questionnaire was adapted from previous studies and developed through direct field observation. Second, the Morse Fall Scale (MFS), an internationally recognized screening tool, was used to assess fall risk through six items: history of falling, mobility impairments, use of assistive devices, mental status, and general health status. The total score was classified as low risk (<26), moderate risk (26–50), or high risk (>50).[13]

Demographic variables were also collected, including age, which was categorized into three groups (60–65, 66–70, and 71–75 years), and occupational status, classified as employed or unemployed. Prior to data collection, participants and community cadres received a full explanation of the study’s objectives, benefits, and procedures. Written informed consent was obtained from each participant. Data were gathered through direct interviews conducted by trained interviewers to ensure accuracy and comprehension.

After data collection, responses were reviewed for completeness and consistency. Incomplete responses were excluded from the analysis. The data were analyzed using IBM SPSS Statistics version 27, employing both univariate and bivariate techniques. Univariate analysis was used to describe the frequency distribution of variables, while bivariate analysis employed the Kendall’s Tau correlation test to assess the association between environmental factors and fall risk. A p-value < 0.05 was considered statistically significant. No multivariate analysis was conducted, as the study aimed solely to identify direct associations between variables.

Results

A total of 180 older adults met the inclusion criteria; however, 20 were absent during data collection, and 3 declined to provide written informed consent. As a result, the final sample included 157 participants, with no missing data identified for the analyzed variables.

The demographic and general characteristics of the participants are summarized in Table 1**.** The majority were in the 66–70 age group (52.3%), followed by the 61–65 age group (42.0%), and only 5.7% were exactly 60 years old. Most participants were female (56.7%). Regarding employment status, 38.2% were retired, unemployed, or housewives, while the remainder were either self-employed (24.8%) or engaged in other occupations (36.9%). In terms of residential environment, 50.3% lived in areas categorized as low-risk, and 49.7% in high-risk areas. Based on the Morse Fall Scale (MFS), 41.4% were at low risk (scores 26–50), 38.9% at high risk (>50), and 19.7% were not at risk (<26).

Table 1. Characteristics of Elderly Respondents in Yogyakarta (n = 157)

Characteristics	n	%
Age		
60 years old	9	5.7
61–65 years old	66	42.0
66–70 years old	82	52.3
Sex		
Male	68	43.3
Female	89	56.7
Occupation		
Retired/Unemployed/Housewife	60	38.2
Entrepreneur	39	24.8
Others	58	36.9
Residential Environment		
Low-risk	79	50.3
High-risk	78	49.7
Fall Risk (Morse Fall Scale)		
No Risk (<26)	31	19.7
Low Risk (26–50)	65	41.4
High Risk (>50)	61	38.9

To better understand the extrinsic factors that may contribute to fall risk, an environmental assessment of participants' homes was conducted. The results are detailed in Table 2**.** The most prevalent environmental risks included a lack of sunlight exposure indoors (66.9%) and inadequate lighting (66.2%). Other significant hazards included the use of stairs (65.0%), squat toilets (58.0%), and toilets located far from the bedroom (57.3%). Additionally, 54.1% of homes had slippery floor surfaces, 49.0% had slippery bathroom floors, and nearly half of the participants (47.8%) slept on high beds without guardrails. High seating furniture was present in 43.9% of homes.

Table 2. Environmental Risk Factors in Elderly Homes (n = 157)

Risk Factors in the Home	n	%
No sunlight entering the house	105	66.9
Inadequate lighting	104	66.2
Presence of stairs	102	65.0
Use of squat toilet	91	58.0
Toilet located far from the bedroom	90	57.3
Slippery floor	85	54.1
Slippery bathroom floor	77	49.0
High bed without side rails	75	47.8
High chairs or seating furniture	69	43.9

To evaluate intrinsic factors, clinical assessments were performed based on Morse Fall Scale components. As shown in Table 3, 66.2% of participants used walking aids, 59.2% had gait disturbances, and 42.0% reported a history of falls within the past six months. Furthermore, 43.9% had secondary diagnoses, 7.6% were receiving intravenous (IV) therapy, and 35.7% lacked awareness of their health condition.

Table 3. Clinical Conditions of Older Adults Based on Morse Fall Scale Components (n = 157)

Clinical Condition	n	%
Use of walking aids	104	66.2
Gait disturbance	93	59.2
History of falls (past 6 months)	66	42.0
Secondary diagnosis present	69	43.9
Currently on IV therapy	12	7.6
Lack of awareness of condition	56	35.7

The associations between selected participant characteristics—age, sex, occupation, and residential environment—and fall risk were analyzed using Kendall's Tau-b correlation, as presented in Table 4**.** The results indicate that only the residential environment was significantly associated with fall risk ($p = 0.031$). Age ($p = 0.743$), sex ($p = 0.697$), and occupation ($p = 0.753$) showed no significant associations. These findings are based on bivariate analysis and do not account for potential confounders. No confidence intervals, subgroup analyses, or sensitivity analyses were conducted.

Table 4. Associations Between Participant Characteristics and Fall Risk

Variable	Correlation Coefficient	p-value
Age	0.027	0.743
Sex	0.032	0.697
Occupation	0.026	0.753
Residential Environment	0.174	0.031*

*Significant at $p < 0.05$

Discussion

This study aimed to examine the association between age, sex, occupation, and environmental factors with the risk of falls among older adults. The findings revealed that 41.4% of older adults in Balecatur Village had a low risk of falls. This condition may be attributed to the high proportion of participants with a history of falls (42.0%), gait disturbances (59.2%), use of assistive devices (66.2%), and living in high-risk environments (49.7%). Fall risk is a common health problem among older adults, as aging naturally leads to declines in bodily functions such as balance, vision, and mobility.

A multinational study conducted across 18 European countries reported that 3,370 out of 41,098 participants experienced a fall within the previous six months, with the highest prevalence found in Portugal (16.3%), the Czech Republic (11.6%), France (11.3%), and Spain (11%).[14] In Portugal, 45.6% of older adults were found to be at high risk of falls due to mobility limitations and sensory impairments, including vision and hearing loss. In contrast, research in India identified alcohol consumption as a key risk factor, increasing fall risk by 97% compared to non-drinkers.[15] Several studies in Indonesia have also indicated that advanced age, female sex, and comorbidities such as hypertension, vertigo, and balance disorders significantly contribute to fall risk.[16]

In terms of age, the majority of participants aged 66–70 years exhibited a low fall risk (23.6%). However, statistical testing showed no significant association between age and fall risk ($p = 0.743$). This may be explained by the fact that 61.8% of participants remained active in the workforce, which likely reflects better physical health and quality of life. A study by Rahmawati et al. reported similar findings, showing that physically active older adults tend to have better balance, thereby reducing fall risk.[17]

Another study conducted at PPSLU Mappakasunggu in Parepare found that independent older adults aged 60–74 years had an 80% lower risk of falling compared to those dependent on others.[18] Nevertheless, Silva et al. noted that fall risk increases by 1.2 times at age 65 and doubles at age >85[1]. These findings align with research conducted at Leuwiliang Primary Health Center in Bogor, which reported that adults aged >75 years are at greater risk due to muscle weakness, joint stiffness, and impaired balance. [19]

Regarding sex, the present study found that older women had a lower risk of falling (24.2%) than men. Physiologically, women are more vulnerable to falls due to postmenopausal estrogen decline, which contributes to osteoporosis and changes in posture. Despite this, no significant relationship between sex and fall risk was found. A similar pattern was observed in a study at the Sinta Rangkang Nursing Home, where most participants were male, yet fall risk was more closely associated with obesity and fall history than with sex per se.[20] This suggests that physical condition and environmental factors may play a more critical role than biological sex in determining fall risk.

Occupational status was also analyzed, with findings showing that 29.2% of unemployed older adults were at greater risk of falling compared to those still working.[21] However, statistical analysis showed no significant relationship. Functional independence in daily activities is a key indicator of older adults' physical capability. Ikhsan et al. stated that routine activities, including employment, may enhance agility and physical health[8]. Supporting this, a study conducted at Panti Harapan Kita Palembang found that older adults with high activity levels were 125 times less likely to fall than those with low activity levels. [22] Conversely, research at Nusa Indah Health Center in Bengkulu reported a higher fall risk (47.4%) among older adults engaged in heavy physical activities, likely due to diminished physical capacity. [21]

Environmental factors demonstrated a statistically significant relationship with fall risk, with 22.9% of participants living in hazardous environments experiencing high fall risk. Contributing environmental hazards included poor lighting (66.2%), slippery floors (54.1%), the presence of stairs (65%), and the use of squat toilets (58%). A study by Sirisopha et al. in Thailand found that bathrooms with slippery surfaces were the most common fall location among older adults.[23] Other structural factors, such as poor home design, inadequate lighting, and excessive household clutter, were also associated with increased fall risk. Similarly, Wongthanasuporn et al. reported that disorganized home layouts and low visibility could impede mobility and elevate fall risk.[24] These results are in line with studies from elderly care homes in Surakarta and Manado, which indicated that unsafe home conditions—such as the absence of stair railings or uneven floors—significantly contribute to falls.[25]

This study has several limitations. The cross-sectional design precludes causal inference. Additionally, the use of questionnaires and interviews may have introduced information bias. Since the study was conducted in a single village, the generalizability of findings to the wider elderly population is limited. The relatively high level of independence and physical activity among participants may also have influenced the nonsignificant findings related to age, sex, and occupation. Future studies are warranted in areas with different geographical and sociocultural characteristics and should incorporate additional variables, such as medication use, cognitive status, and alcohol consumption.

Conclusion

Based on the results of the Kendall Tau statistical test, this study demonstrates a significant association between environmental factors and the risk of falls among older adults. However, no significant correlation was found between fall risk and age, sex, or occupation. This research was conducted at the Gamol Elderly Health Post (Posyandu Lansia) in Sleman, Yogyakarta, and therefore the findings may not be generalizable to the broader Yogyakarta region.

Older adults in this area face an increased risk of falling due to environmental hazards such as poor lighting and slippery floors. Reducing this risk requires improvements to the physical environment, routine evaluations of home conditions, and training for family members and community health volunteers (kader) to recognize and address fall-related risks. In addition, government support through health programs and the development of safer infrastructure for the elderly is essential. Cross-sectoral collaborative efforts are critical to enhancing safety and promoting sustainable independence among older adults.

Author Contribution

Sentosa Wijaya and Indriani conceived and designed the study. Sentosa Wijaya collected the data and performed the initial analysis. Indriani supervised the research process and verified the analytical methods. Siti Nadhir Ollin Norlinta contributed to data interpretation and drafting of the manuscript. All authors critically reviewed the manuscript, approved the final version, and agreed to be accountable for all aspects of the work.

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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 received ethical approval from the Health Research Ethics Committee of Universitas 'Aisyiyah Yogyakarta (Approval No. 2047/KEP-UNISA/II/2025). Participation was voluntary, and written informed consent was obtained from all participants. Respondent data were treated with strict confidentiality and handled in accordance with established ethical research principles.

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