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ORIGINAL RESEARCH

Multisite Pain and Intensity were Associated with History Fall among Older Adults: A Cross-Sectional Study

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Purpose: This study examined the independent associations among multisite pain, pain intensity, and the risk of falls, including a history of falls in the previous 12 months and frequent falls (≥ two falls vs one or two falls) among community-dwelling older adults.

Methods: A cross-sectional design from Wave 2 of the National Social Life, Health, and Aging Project was used. Data on pain intensity and location (45 sites) over the past 4 weeks were collected. Multisite pain was categorized into four groups: none, one, two, and three or more sites. The main outcomes of falls were a history of falls and frequent falls. The covariates included age, sex, race, body mass index, education, medications, and comorbidities.

Results: Among 3,196 participants in Wave 2, 2,697 were included because of missing key variables related to pain and fall history. The prevalence of falls and frequent falls were 30.3% (n = 817) and 12.6% (n = 339), respectively. Multisite pain at ≥ three sites (odds ratio (OR) 2.04, confidence interval (CI) [1.62, 2.57]; p < 0.001) and two sites (OR 1.72, 95% CI [1.30, 2.27]; p < 0.001) was significantly associated with an increased risk of falls. An increase in pain intensity was significantly associated with an increased risk of fall (OR 1.28, 95% CI [1.15, 1.44], p < 0.001), independent of multisite pain. Multisite pain at ≥3 sites (OR 2.19, 95% CI [1.56, 3.07], p < 0.001) and 2 sites (OR 1.54, 95% CI [1.01, 2.34], p = 0.045) was associated with an increased risk of frequent falls. An increase in pain intensity was associated with risk of frequent falls (OR 1.64, 95% CI [1.40, 1.91], p < 0.001), independent of multisite pain.

Conclusion: Multisite pain and pain intensity were associated with a history of falls and frequent falls among older adults, emphasizing the need for routine pain evaluation to develop fall prevention strategies in this population.

Keywords: falling, recurrent falls, multiple sites pain, pain severity, painful

Introduction

Falls are the second leading cause of death due to unintentional injuries.[1] The World Health Organization (WHO) estimates that almost 684,000 fatal falls occur annually worldwide, with death rates being the highest among adults aged over 60 years.[2] According to WHO, a fall is an event that causes individuals to accidentally descend to a lower level on the ground or floor.[3] Falls are associated with an increased risk of morbidity, mortality, and quality of life.[1,4] Frequent falls, defined as two or more falls over 12 months, are associated with more serious morbidities, such as mobility limitation and mortality, than single fall events.[5]

Several risk factors for falls have been established, including older age, female sex, fear of falling, comorbidities, certain medications, vision and hearing impairment, balance disorders, and a previous history of falls.[6,7] Despite growing scientific research identifying the risk factors that may increase the occurrence of falls, multifactorial interventions to reduce falls need to be implemented. However, standard multifactorial interventions have only a modest impact on reducing falls, suggesting that some major causes of falls in older adults remain elusive,[8] such as having pain.

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Pain is an independent risk factor for falls in the older population and appears to be continuously overlooked.[9] However, the association between pain and the occurrence of falls remains unclear. Evidence suggests that the pain-fall relationship can be explained by pain contributing to functional decline and muscle weakness, thereby predisposing patients to falls.[10,11] A recent systematic review and meta-analysis suggested that older adults reporting multisite pain (pain in more than one area of the body) have a higher risk of future falls than their pain-free counterparts.[12] Several studies have examined chronic pain and multisite pain as a risk for falls in older adults living in the community.[5,9–11,13,14] A recent study on community-dwelling older adults aged ≥70 years found that lower back or lower limb pain was associated with an increased risk of frequent falls and fall-related injuries.[14] The context of related injuries involves not only the site of pain in the body but also the severity of pain. A population-based cohort study examined the relationship between severity of chronic pain and risk for injurious falls in older adults aged ≥70 years.[13] The findings showed that moderate-to-severe pain in a given month was associated with an increased risk of injurious falls in the subsequent months.

The limitation of the current available evidence in investigating the association between fall occurrence and pain is that the comparison of different pain severity in different body sites within one study remains limited.[14] Another limitation is the definition of multisite pain, as previous studies have been limited to two or more sites. However, this might reflect the bilateral involvement of sites, such as bilateral knee pain, which might not be related to multisite and widespread pain. Studies on three or more sites have shown the complexity of chronic and widespread pain.[15,16] The number of included painful sites varies across studies, with huge variations ranging from 6 sites[17] to 44 sites.[9] Therefore, it is necessary to examine multisite pain at all possible locations to determine the associated risk of falls. Limited studies have included pain severity and multisite pain in the same studies. Furthermore, the analysis did not account for both variables to understand the independent association among pain severity, multisite pain, and fall risk. Furthermore, the age of the population in the most studies was limited to the community of older adults aged ≥70 years.[13,14] Further research is required to explore the independent relationship between multisite pain severity and fall occurrence in older adults to inform and update fall prevention strategies internationally. Therefore, the present study aimed to examine the independent association among multisite pain, pain intensity, and the risk of falls, including 1) a history of falls in the previous 12 months and 2) frequent falls (≥ two falls vs one or two falls) among community-dwelling older adults (aged ≥ 60 years).

Materials and Methods

Study Design and Participants

A cross-sectional design from wave 2 of the National Social Life, Health, and Aging Project (NSHAP) was used in the current study. The NSHAP is a longitudinal survey nationally representative of older adults in the United States, which is designed to evaluate the influence of social, biological, emotional, and environmental factors on health and aging.[18] Each participant signed an informed consent form before enrollment in the study. Data from the current analysis used deidentified data. Research Ethics Committee at Prince Sattam Bin Abdulaziz University considered this study to be exempt from review since we used publicly available deidentified data.

Community-dwelling adults aged 57–85 years who were cognitively intact to complete interviews and testing were included in Wave 1. This study involved three waves of data collection. However, we selected Wave 2 with data collected in 2010 and 2011 with an age range of 62–91 years in the current study because we targeted older adults aged ≥60 years in this wave and to decrease the missing variables and participants, as Wave 3 (2015, 2016) had a new cohort. Wave 1 (2005, 2006) was excluded because the main predictor variable (number of painful sites) was not included. The data collection process in the NSHAP included three components: (a) face-to-face interviews conducted in the participant's home, (b) collection of biomeasures, and (c) a leave-behind self-reported questionnaire that included items and questions about the number of falls during the past 12 months.

Outcome Measures and Covariates

Risk of Fall

According to the traditional definition, "a fall is an event that causes a person to unintentionally come to rest on the ground, floor, or other lower level." This study had two main outcomes related to falls. The primary outcome was a history of fall (one or more vs no fall). The secondary outcome was frequent falls (two or more falls in the past year) versus no frequent falls (one or no falls in the past year).

Multisite Pain

All participants were asked questions about pain to help differentiate between acute and persistent pain by assessing the presence, location, and severity of pain in the past 4 weeks. Participants were asked to locate the pain sites by indicating where they felt the most pain using a body map[19,20] divided into 45 locations, including the anterior and posterior parts of the body and the right and left sides, as shown in Figure 1, during the past 4 weeks.[21] In the current study, we categorized the pain locations (multisite categories) into four groups: none, one site, two sites, and three or more sites.

Pain intensity was described as the level of pain in the past four weeks using the Verbal Descriptor Scale (VDS). This scale shows good validity and reliability for measuring pain intensity among older adults as the most preferred unidimensional pain measure.[22–24] VDS categorized pain intensity into the most intense pain imaginable, extreme pain, severe pain, moderate pain, mild pain, slight pain, and no pain. The VDS for pain showed superior reliability and validity compared with other unidimensional pain measures, especially in older adults of different ethnicities and cognitive abilities.[25–27] Pain intensity using the VDS was translated into a numeric format: 0, no pain, 1 = slight pain, 2 = mild pain, 3 = moderate pain, 4 = severe pain, 5 = extreme pain, and 6 = most intense pain imaginable.[28,29]

Covariates

Different covariates can be considered established risk factors for falls among older adults. Therefore, we included demographics (age, sex, and race), body mass index (BMI), education level, total number of medications, and number of comorbidities in the data analysis.

Age was used as a continuous variable. Sex was dichotomized as male or female. Race was categorized as white, black, or other. For all participants, BMI was calculated by dividing body mass (in kilograms) by the square of height (in meters). Education was categorized into four levels: less than high school, high school, college, and bachelor's degree.

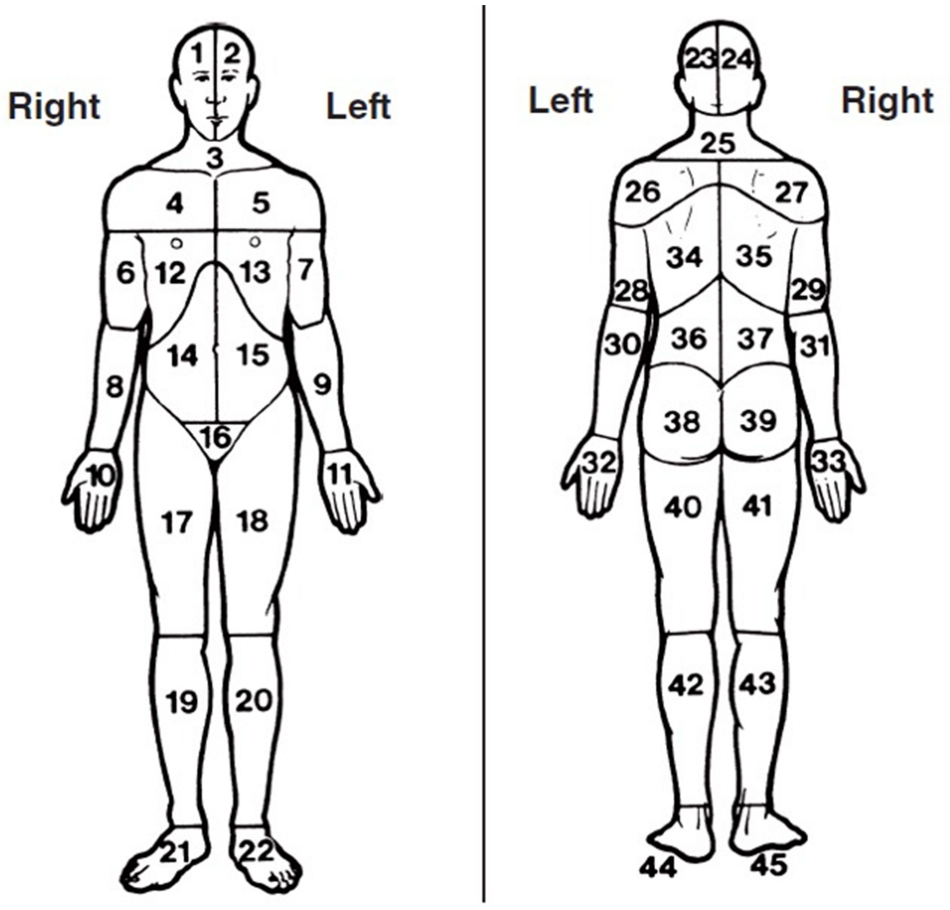

Figure 1 Pain map for all the 45 pain sites.

The total number of medications administered was considered as the current number. Finally, the number of comorbidities was calculated based on self-reported physician-diagnosed comorbidities, including hypertension, diabetes, arthritis, rheumatoid arthritis, heart disease, heart attack, coronary artery disease, congestive heart failure, lung disease, osteoporosis, hip fracture, Alzheimer's disease, dementia, Parkinson's disease, and stroke. Comorbidities were then calculated and categorized as (none, one, two, three, or more comorbidities).

Statistical Analysis

Descriptive statistics (mean, standard deviation, number, and percentage) were used to examine participants' demographics and clinical characteristics. Differences between groups (fallers vs non-fallers) were determined using independent sample t–tests for continuous variables and chi-squared tests for categorical variables.

Multiple binary logistic regression was used to examine the association between multisite pain and pain intensity and the risk of falls (fallers vs non-fallers) and frequent falls (frequent fallers vs non-frequent fallers). Results are presented as odds ratios (OR) with 95% confidence intervals (95% CI) after controlling for covariates, including age, sex, race, BMI, number of medications, number of comorbidities, multisite pain, and pain intensity. *P*-value was set at 0.05. All analyses were performed using IBM SPSS for Mac version 25.0 (SPSS Inc. Chicago, IL).

Results

A total of 3,196 older adults from Wave 2 of the NSHAP were included in this study. Owing to missing values for some variables, such as the risk of falls and multisite pain, other participants were excluded (n = 499). A total of 2,697 older adults were included in the analysis. Figure 2 shows the flowchart of included participants in the current analysis. The ages of the participants ranged from 62 to 91 years old in this wave. A total of 817 (30.3%) participants reported one fall in the past 12 months. A total of 399 (12.6%) participants reported frequent fall (having two or more falls) in the past 12 months. Table 1 shows the demographics and clinical variables of all included participants. In brief, the age, number of

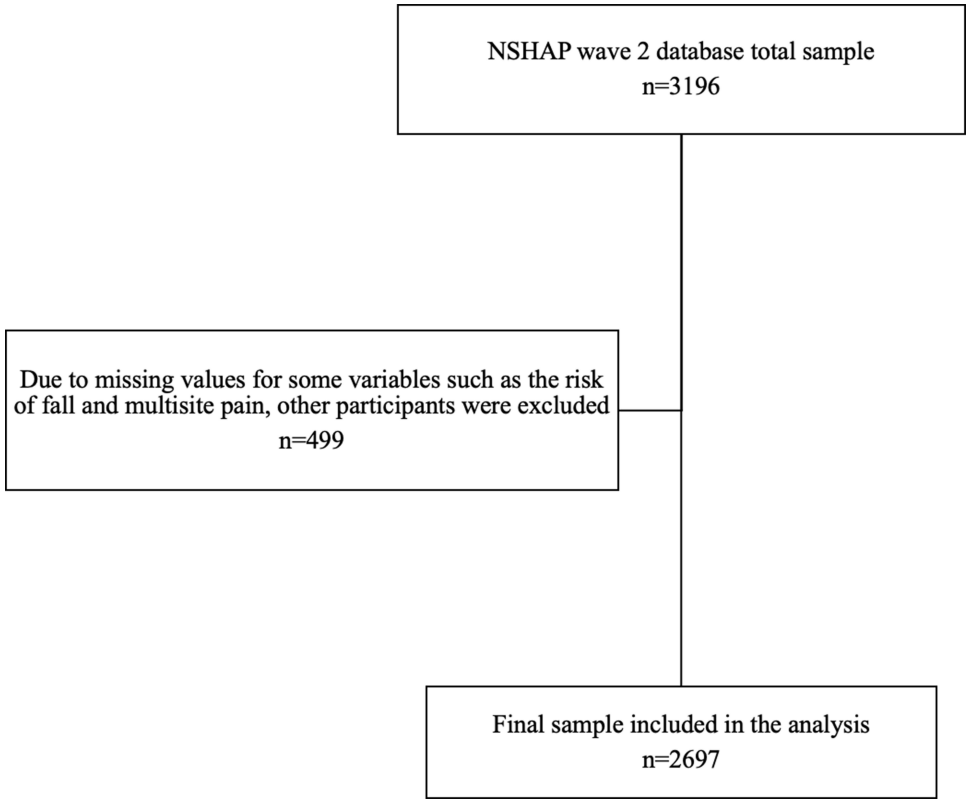

Figure 2 Flowchart for included participants.

Table 1 Demographics and Clinical Characteristics for All Participants

Factors	Non-fallers n=1880	Fallers n=817	*p**
Age, years (mean±SD)	72.54±7.05	74.02±7.5	<0.001
Sex, females, n (%)	979 (52.1)	444 (54.3)	0.27
Race, n, (%)			<0.001
White/Caucasian	1477 (78.7)	682 (84.0)	
Black/African American	269 (14.3)	72 (8.9)	
Others	130 (6.9)	58 (7.1)	
BMI, Kg/m^2 (mean±SD)	29.26±6.3	29.48±6.6	0.43
Education, n, (%)			0.25
Less than high school	335 (17.8)	153 (18.7)	
High school	486 (25.9)	196 (24.0)	
Some college	568 (30.2)	273 (33.4)	
Bachelors or more	491 (26.1)	195 (23.9)	
Total number of medications (mean±SD)	6.5±4.2	7.73±4.6	<0.001
Number of comorbidities, n, (%)			<0.001
None	139 (7.4)	40 (4.9)	
One	318 (16.9)	108 (13.2)	
Two	411 (21.9)	129 (15.8)	
Three or more	1012 (53.8)	540 (66.1)	
Number of painful sites, n, (%)			<0.001
None	628 (35.4)	165 (21.3)	
One site	188 (10.6)	68 (8.8)	
Two sites	291 (16.4)	141 (18.2)	
Three or more	665 (37.5)	400 (51.7)	
Pain intensity in the past 4 weeks (mean±SD)	2.85±1.04	3.12±1.02	<0.001

Notes: *p indicates the p-value that was based on Chi square for categorical variables or independent t-test for continuous variables.
Abbreviations: %, Percent within fallers; BMI, Body Mass Index; SD, standard deviation.

medications, and pain intensity were significantly higher in fallers than in non-fallers. The race, number of comorbidities, and number of painful joints were significantly different between the faller and non-faller groups.

The results of the binary logistic regression analysis examining the association between multisite pain, pain intensity, and a history of falls (fallers with one or more falls versus non-fallers) are shown in Table 2. Multisite pain with three or more sites was significantly associated with history of fall (odds ratio (OR) 2.04, 95% confidence interval (CI) [1.62, 2.57], $p < 0.001$) after adjustments for age, sex, race, education, BMI, number of comorbidities, and number of medications. In addition, two sites were significantly associated with history of fall (OR 1.72, 95% CI [1.30, 2.27], $p<0.001$) after adjustments for covariates. An increase in pain intensity in the past 4 weeks was significantly associated

Table 2 Binary Logistic Regression for the Association Between Multisite Pain and Pain Intensity with Risk of Fall (Fallers Vs Non-Fallers)

	OR [95% CI]	*p*-value
Multisite Pain Categories (n=2394)		
Three painful sites or more	2.04 [1.62, 2.57]	<0.001
Two painful sites	1.72 [1.30, 2.27]	<0.001
One painful site	1.31 [0.93, 1.85]	0.12
No painful site	Ref	Ref
Pain intensity in the past 4 weeks* (n=1597)	1.28 [1.15, 1.44]	<0.001

Notes: The model was adjusted for age, sex, race, education, BMI, number of comorbidities, and number of medications. *The model was further adjusted for multisite pain.
Abbreviations: OR, odds ratio; CI, confidence interval.

Table 3 Binary Logistic Regression for the Association Between Multisite Pain and Pain Intensity with Frequent Falls (Frequent Fallers Vs Non-Frequent Fallers)

	OR [95% CI]	*p*-value
Multisite Pain Categories (n=2394)		
Three painful sites or more	2.19 [1.56, 3.07]	<0.001
Two painful sites	1.54 [1.01, 2.34]	0.045
One painful site	1.12 [0.65, 1.93]	0.68
No painful site	Ref	Ref
Pain intensity in the past 4 weeks*(n=1597)	1.64 [1.40, 1.91]	<0.001

Notes: The model was adjusted for age, sex, race, education, BMI, number of comorbidities, and number of medications. *The model was further adjusted for multisite pain.
Abbreviations: OR, odds ratio; CI, confidence interval.

with history of fall (OR 1.28, 95% CI [1.15, 1.44], $p<0.001$) after adjustments for age, sex, race, education, BMI, number of comorbidities, and number of medications, independent of multisite pain.

The results of the binary logistic regression analysis investigating the association between multisite pain and pain intensity and the risk of frequent falls (frequent fallers with two or more falls vs non-frequent fallers in the past 12 months) are shown in Table 3. Multisite pain with three or more sites was significantly associated with history of frequent falls OR 2.19, 95% CI [1.56, 3.07], $p < 0.001$) after adjustments for age, sex, race, education, BMI, number of comorbidities, and number of medications. In addition, two sites were significantly associated with history of frequent falls (OR 1.54, 95% CI [1.01, 2.34], $p=0.045$) after adjustments for covariates. An increase in pain intensity was associated with history of frequent falls (OR 1.64, 95% CI [1.40, 1.91], $p<0.001$) after adjustments for age, sex, race, education, BMI, number of comorbidities, and number of medications, independent of multisite pain.

Discussion

The findings of this study demonstrate a strong association between multisite pain and pain intensity and a history of falls and frequent falls in older adults. Specifically, the odds ratios indicated that individuals with three or more painful sites were more than twice as likely to experience a fall or frequent falls in the past 12 months than those without any painful sites after

controlling for potential confounding variables. This association was statistically significant and highlighted the importance of addressing multisite pain and pain intensity in fall risk assessments and prevention strategies for older adults.

Geriatric research has recently shown an interest in multisite pain because it is believed to be an indicator of widespread bodily pain or generalized pain syndrome.[29] Our findings suggest that older adults experiencing pain at three or more sites have a two-fold increased risk of falling compared with those without pain. This aligns with the broader understanding that pain can compromise postural stability and gait, which are integral factors in fall risk.[12,30] These findings concur with those of previous research, implying that pain can play a crucial role in the mobility and balance of older adults, potentially as a result of avoidance or distraction.[11] In agreement with these findings, the correlation between pain intensity and self-reported falls was the highest in individuals aged ≥65 years. This study found that participants with multisite pain were highly likely to experience falls and sustain future.[9] Pain at particular anatomical sites and several sites is linked to an increased risk of falling.[17] Pain is strongly associated with a risk of frequent falls among women.[31] In contrast, the relationship between back discomfort and the likelihood of falling among older men was not associated with age.[32] These pain variables (number of sites, severity, and pain-related impairment) were associated with injurious falls in older Australian men but not in women, and the probability of injurious falls resulting in emergency department visits or hospitalizations was substantially correlated with both pain severity and pain interference.[14] In another study, the prevalence of falls was less than 7% within 6 months, which is considered low compared to previous studies. Pain increases the risk of falls through various mechanisms. Pain can also be a sign of musculoskeletal conditions, such as rheumatoid arthritis, osteoarthritis, and fractures.[32] However, unlike other risk factors for falls, the number of pain sites is no longer a reliable indicator of self-reported falls.[9] Falls can result from multi-site pain in several ways. Pain can cause a fear of falling, avoidance of activities, and physical inactivity. In fact, older people with pain related to chronic muscular disorders are less active than those who are pain-free.[29]

The current study showed that approximately one-third of the study population experienced falls, and the prevalence of frequent falls was 12.6%. Moreover, fall prevalence increases with age. Similarly, older age was consistently associated with an increased risk of falls. As individuals age, their physical strength, balance, and coordination tend to decline, making them highly susceptible to falls.[17] In contrast, another study found that the risk of falls was more pronounced in younger female participants and frequent fallers who reported severe lower back or lower limb pain. This discrepancy may be attributed to factors, such as differences in muscle mass, bone density, and hormonal changes.[14] The presence of pain in older adults may cause them to alter their gait patterns or restrict their movement, thereby increasing the likelihood of imbalance or falls. Additionally, pain has been linked to the fear of falling, leading to reduced physical activity, which can further increase the risk of falls.[22]

In addition, pain intensity over the past 4 weeks has been found to be a significant predictor of fall risk. The findings of this study are consistent with those of previous studies and are of great importance. Pain and falls are significantly associated with each other. It was found that the pain intensity was significantly associated with falls and frequent falls among older adults aged ≥60 years.[33] Our findings, along with those of other studies, suggest that pain intensity should be considered when devising strategies to prevent falls. A significant positive relationship between pain and falls has also been reported in other populations, such as community-dwelling older adults in the US, Malaysia, China, and Australia.[30,33,34] Increased pain intensity is associated with a high likelihood of falling, which may be attributed to the impact of pain on an individual's physical activity level, gait pattern, impaired motor function and judgment, and overall functional status, all of which increase the susceptibility to falls.[14] Therefore, this raises an important question about how to motivate older adults experiencing pain to exercise to prevent falls.[33] Finally, it is important to address pain intensity in older adults to prevent falls and reduce the risk of injury.

Furthermore, our results showed that participants with higher medication consumption had a higher risk of falls. Older adults with moderate-to-severe pain have a greater likelihood of falling, falling in living/dining rooms, and falling due to feeling dizzy/faint.[35] Certain medications, especially those that affect the central nervous system or have side effects, such as dizziness or drowsiness, can increase the risk of falls.[36] In addition, the number of comorbidities can be considered a risk factor for falls, and various medical conditions are associated with an increased risk of falls. These diseases include osteoporosis, Parkinson's disease, arthritis, diabetes, and cardiovascular diseases. Chronic pain and cognitive impairments also contribute to the risk, and aging, being a woman, and a declining body mass index are the three factors that predict falls necessitating hospital admission.[9]

Clinical Implications

This study sheds light on demographic and clinical differences between fallers and non-fallers, including age, number of medications, race, number of comorbidities, and number of painful joints. The prevalence of multiple medications and comorbidities is common among older adults and is known to increase the likelihood of falls.[4,16] Therefore, the association between these factors and falls highlights the importance of comprehensive geriatric assessments to better understand individual fall risk. The findings of this study highlight the need for healthcare professionals to pay special attention to older adults who report multi-site pain and increased pain intensity. Reducing the number of painful sites and the pain intensity in older adults may prevent falls. Routine clinical visits should include screening for multisite pain to enable the early identification and management of individuals at a high risk of falls. Comprehensive pain assessment and management, including both pharmacological and nonpharmacological interventions, may help reduce the risk of falls. Interventions that focus on pain management, such as physiotherapy or occupational therapy, may provide dual benefits by alleviating pain and potentially reducing the risk of falls. Furthermore, a holistic approach for evaluating fall risk could lead to more tailored and effective preventive strategies. Healthcare professionals should provide educational sessions for older adults regarding the risk of falls associated with pain and the importance of timely reporting and pain management. Older adults must be gradually assessed for the risk of falls, and a routine schedule must be written to assess pain intensity and the presence of variables associated with an increased risk of falls. Patients with multisite pain must be aware of falls and repeated falls and try to use supporting devices to decrease the probability of falls. Caregivers or partners of older adults should receive attention in awareness programs regarding the factors associated with falls.

Limitations

This study has some limitations. This cross-sectional design prevents the establishment of causality, and longitudinal studies may offer more insights into the causative relationship among pain, risk of falls, and frequent falls. Furthermore, the study was conducted on a specific age group, which may have limited the generalizability of the findings. Using the NSHAP database has limitations, such as not including the comorbidity index (ie, the Charlson Comorbidity Index) and medication index. In addition, it is difficult to distinguish between the several elements that contribute to falls because they are complex. Future research should examine how different elements, such as mobility issues and psychological considerations, interact with one another in older adults experiencing pain. Further studies are needed to longitudinally examine clusters of multisite pain associated with the risk of falling.

Conclusion

This study showed a significant association between multisite pain and pain intensity and a history of falls and frequent falls in the past 12 months among older adults. These results emphasize the necessity for routine pain evaluation and comprehensive management as an integral part of fall prevention strategies in this population. Given the substantial health consequences of falls in older adults, addressing pain is a vital intervention for healthcare providers to improve patient safety and health. Further research is necessary to understand the mechanisms linking pain, falls, and frequent falls in older adults and to assess the effectiveness of pain management interventions in reducing fall risk.

Data Sharing Statement

The NSHAP data are publicly available through the National Archive of Computerized Data on Aging (NACDA, https://www.icpsr.umich.edu/icpsrweb/NACDA/).

Ethics Committee Approval Statement

The National Social Life, Health, and Aging Project study was approved by Institutional Review Board (IRB) for the Social and Behavioral Sciences at the University of Chicago (the Federal Wide Assurance [FWA] No. FWA00005565) and National Opinion Research Center (NORC) IRB (No. FWA00000142), and each participant signed an informed consent before to the enrolment to the study. Data from the current analysis used deidentified data. Research Ethics Committee at Prince Sattam Bin Abdulaziz University considered this study to be exempt from review since we used publicly available deidentified data.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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