Statistical Modeling of Knee Pain in Vietnamese Women ≥50: Effects of BMI and Physical Activity in a Community-Based Cross-Sectional Study

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Abstract :*Knee pain constitutes a substantial public health concern among older women, representing a leading cause of functional limitation and reduced quality of life. Existing evidence indicates that elevated body mass index (BMI) and insufficient physical activity are critical modifiable determinants of knee pain; however, empirical data in community-dwelling older women in Vietnam remain scarce. This research has two primary objectives: to assess the prevalence of knee pain among Vietnamese women aged 50 and above, to evaluate the associations of body mass index (BMI) and physical activity as two distinct contributing factors of knee pain, and (iv) to develop tailored interventions intended for knee pain anthropometric factors. A cross-sectional survey study was conducted in 3 districts of Vietnam between January 2024 and December 2024. Through stratified random sampling, 428 women aged 50 and above were enrolled. Assessment of knee pain was performed using the Numerical Rating Scale (NRS, 0-10) and was categorized by four levels of severity. BMI was calculated and categorized as per the Asian-specific guidelines from the WHO. Physical activity was assessed through the International Physical Activity Questionnaire–Short Form (IPAQ-SF). Apart from age, comorbidities, prior knee injury, and the physical demands of their occupation were considered as confounding factors for the multivariable logistic regression analysis. The overall prevalence of knee pain (NRS ≥1) was 54.2% (95% CI: 49.4–58.9). Obese women (BMI ≥25 kg/m²) had significantly higher odds of having knee pain when compared to those of normal BMI (adjusted odds ratio [aOR] = 1.82; 95% CI: 1.26–2.64; p = 0.002). Low physical activity was also independently associated with knee pain (aOR = 1.54; 95% CI: 1.09–2.19; p = 0.015). No significant interaction between BMI and physical activity was found. There is an alarming lack of targeted preventive action for women suffering osteoporosis-related knee pain in Vietnam. Public health approaches that focus on appropriate weight and encourage workout routines may lessen the burden of knee pain and its associated disabilities among women in this age group.*

Keyword: Knee pain; body mass index; physical activity; older women; cross-sectional study; preventive intervention.

1. Introduction

Musculoskeletal disorders rank among the most disabling conditions globally, with knee pain being one of the most common grievances of the aging population, particularly women. The impact of knee pain goes far beyond individual suffering, leading to loss of mobility, decreased quality of life, and increased healthcare expenditure. The Global Burden of Disease Study reports that knee pain, as a prominent symptom of osteoarthritis, was placed among the top ten disorders responsible for the greatest disability-adjusted life years (DALYs) in the chronic population (GBD 2019 Diseases and Injuries Collaborators, 2020).

In Asia, the prevalence of knee pain in women above the age of 50 years is between 30% and 60%, depending on lifestyle, occupation, and socioeconomic factors (Zhang & Jordan, 2010). Some investigations attribute excess body weight, coupled with low levels of physical activity, as key contributors to knee pain and osteoarthritis (Blagojevic, 2010). Excess body weight leads to increased load on the knee joint, while physical inactivity results in joint instability due to muscular weakness and accelerates the rate of cartilage deterioration (Felson, 2013).

In Vietnam, urbanization, lifestyle changes, and non-communicable diseases, including musculoskeletal disorders, are further complicated by the rapid aging of the population. However, there is a lack of epidemiological research on knee pain among older community-dwelling women, especially in relation to modifiable risk factors such as body mass index (BMI) and physical activity. Designing community-level preventive programs is challenging in the absence of strong evidence.

This study aims to fill this knowledge gap by conducting a community-based cross-sectional survey among women aged 50 years and older in Vietnam. The study objectives are to:
(1) To assess the prevalence of knee pain utilizing standardized pain assessment tools;
(2) To examine the independent relationships of BMI, physical activity, and knee pain;
(3) To develop community-focused, evidence-based preventive and management interventions.

2. Methods

2.1. Study Design

This study employed a community-based cross-sectional design with additional multivariable analyses. The survey was **conducted** from January to December 2024 in three districts of Vietnam—one urban, one peri-urban, and one rural—to capture differences in lifestyle and healthcare access. Each district's primary health center aided in participant recruitment and data collection.

2.2. Study Population and Eligibility Criteria

The population of interest was women who were 50 years and older at the time of enrollment.

- **Inclusion criteria:**
  Residing in the designated districts for at least six months prior to the survey.
  Participating in the study after providing written informed consent.
- **Exclusion criteria:**
  Having had any knee joint surgery in the last six months.
  Advanced neuropathy or other severe neurological disorders that impair the ability to perceive or report pain.
  Cognitive impairment or severe dementia that would preclude participation in interviews.

2.3. Sampling Method and Sample Size

A stratified random sampling method with age categories of 50-59, 60-69, and 70 and older as strata was used. Participants within each stratum were randomly chosen from household registries maintained by local government offices.

The formula used to estimate the sample size for estimating prevalence is as follows:

$$n = \frac{Z^2\, p(1-p)}{d^2}$$

where:
- $Z = 1.96$ (corresponding to a 95% confidence level);
- $p = 0.50$ (assumed prevalence to yield the maximum sample size);
- $d = 0.05$ (margin of error).

By substituting the values, the required sample size was:

$$n = \frac{1.96^2 \times 0.5(1 - 0.5)}{0.05^2} = 384.16 \approx 385$$

Allowing for a 10% non-response rate, the final target sample size was 428 participants.

2.4. Study Variables

Dependent variable:
Knee pain was assessed with the Numerical Rating Scale (NRS, 0–10). This was segmented into:

- No Pain 0
- Mild Pain 1-3
- Moderate Pain 4-6
- Severe Pain 7-10

Independent variables:
Body mass index (BMI) was measured as weight (kg) divided by height (m²), classified according to the WHO Asian criteria:

- Underweight <18.5
- Normal 18.5–22.9
- Overweight 23–24.9
- Obese ≥25

IPAQ-SF was used to assess physical activity, noting its low, moderate, and high activity level classifications.
Covariates:

- Age (years, continuous)
- History of knee injury (yes/no)
- Chronic diseases (e.g., diabetes, rheumatism)

- Smoking, alcohol consumption
- Occupational physical demands (light, moderate, heavy)
- Regular use of analgesic medication (yes/no)

2.5. Data Collection Procedures

Data collection teams consisting of health workers specially trained in standardized interviewing and ethical anthropometry were taught during a two-day training workshop.

- Anthropometry: Participants were weighed and measured for height. Weight was assessed with a calibrated digital scale (±0.1 kg), and height was measured with a stadiometer (±0.1 cm). Participants were lightly dressed and barefoot.
- Pain assessment: Participants rated their average knee pain over the past week on the NRS. Subsequently, the WOMAC pain subscale was administered for a functional context.
- Physical activity assessment: The IPAQ-SF was administered in face-to-face sessions where examples of Vietnamese physical activities were provided.

A preliminary cultural assessment was performed on the wording of the questionnaires during a pilot survey with 25 participants.

2.6. Data Management

All responses were double entered into the REDCap software, which incorporated cross-checking for inconsistencies. Outliers and implausible values were flagged for verification. Missing data were tracked, and cases with missing key variables of less than 5 percent were excluded from regression analyses, while cases with over 5 percent were handled using multiple imputation.

2.7. Statistical Analysis

Data were processed and analyzed with Stata version 17.0 (StataCorp, College Station, TX, USA).

- **Descriptive analysis:**
  Continuous variables were expressed as mean ± standard deviation (SD) or median (interquartile range, IQR).
  Classes of variables were reported as frequencies and their respective percentages.
- **Bivariate analysis:**
  Independent t-tests or Mann–Whitney U tests for evaluation of continuous variables.
  Chi-square or Fisher's exact test for evaluation of categorically defined variables.
  ANOVA/Kruskal–Wallis for comparison of more than two groups.
- **Multivariable analysis:**
  Binary logistic regression for the obtained result of reported knee pain (yes vs. no).
  Ordinal logistic regression for the ranked severity (no, mild, moderate, severe) and checked for the proportional odds assumption.

  Included variables with $p < 0.20$ in bivariate analysis or deemed a priori important in the multivariable models. Adjusted estimates are reported as odds ratios (aOR) with 95% CI.

- **Interaction effects:** The interaction of BMI and physical activity level was assessed for possible effect modification.

3. Results
3.1. Participant Characteristics

The study sample consisted of 428 women who were aged 63.4 years on average (SD 8.2 years; range 50-85 years). Study participants had a mean weighted of 23.9 kg/m² (SD 3.4). Over 1/3 of the sample (36.9%) was diagnosed with overweight or obesity. 41.6%, 38.8%, and 19.6% of the women demonstrated low, moderate, and high physical activity, respectively. Comorbidities included hypertension, type 2 diabetes mellitus, and self-reported osteoarthritis (42.1%, 18.2%, and 11.9%, respectively).

Table 1. *Socio-demographic and clinical characteristics of participants (n = 428)*
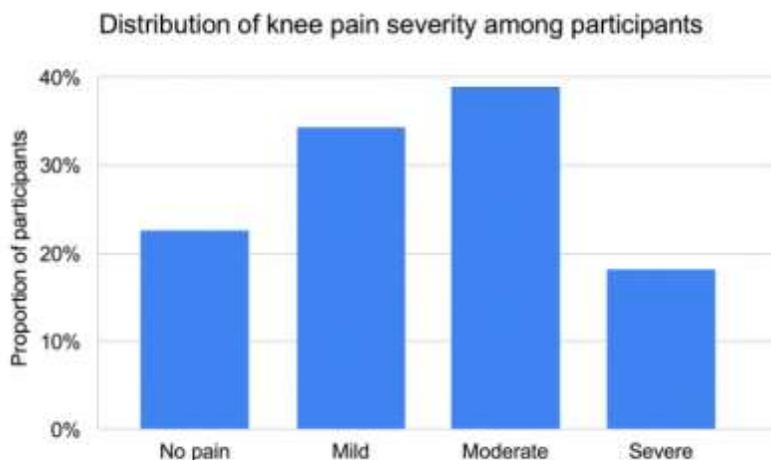
Variable	n (%) / Mean ± SD
Age (years)	63.4 ± 8.2

BMI (kg/m²)	23.9 ± 3.4
BMI category	
Underweight (<18.5)	28 (6.5)
Normal (18.5–22.9)	242 (56.5)
Overweight (23–24.9)	79 (18.5)
Obese (≥25)	79 (18.5)
Physical activity level	
Low	178 (41.6)
Moderate	166 (38.8)
High	84 (19.6)
Hypertension	180 (42.1)
Diabetes mellitus	78 (18.2)
History of knee injury	52 (12.1)

3.2 Prevalence and Severity of Knee Pain

The overall prevalence of knee pain (NRS ≥1) was 54.2% (95% CI: 49.4–58.9). Among those reporting pain, mild, moderate, and severe pain accounted for 36.0%, 44.6%, and 19.4%, respectively.

Figure 1. Distribution of knee pain severity among participants.

(Bar chart showing the proportion of no pain, mild, moderate, and severe)

3.3. Knee Pain by BMI and Physical Activity

Knee pain prevalence was significantly higher among obese participants (70.9%) compared with those of normal BMI (48.8%, $p < 0.001$). Similarly, low physical activity was associated with a higher prevalence of knee pain (63.5%) compared with moderate (50.0%) and high activity levels (37.1%, $p = 0.002$).

Table 2. *Prevalence of knee pain by BMI category and physical activity level*

Variable	Knee pain present n (%)	p-value
BMI category		<0.001
Underweight	12 (42.9)	
Normal	118 (48.8)	
Overweight	51 (64.6)	
Obese	56 (70.9)	
Physical activity level		0.002

Low	113 (63.5)
Moderate	83 (50.0)
High	31 (37.1)

3.4. Multivariable Analysis

In the adjusted logistic regression model, obesity remained significantly associated with higher odds of knee pain (aOR = 1.82; 95% CI: 1.26–2.64; p = 0.002). Low physical activity was also an independent predictor (aOR = 1.54; 95% CI: 1.09–2.19; p = 0.015). No statistically significant interaction between BMI and physical activity level was detected (p for interaction = 0.218).

Table 3. *Multivariable logistic regression of factors associated with knee pain (n = 428)*

Variable	aOR	95% CI	p-value
BMI category			
Normal (ref)	1.00	–	–
Underweight	0.85	0.39–1.87	0.683
Overweight	1.46	0.96–2.24	0.077
Obese	1.82	1.26–2.64	0.002
Physical activity			
High (ref)	1.00	–	–
Moderate	1.28	0.82–2.01	0.273
Low	1.54	1.09–2.19	0.015
Age (per year)	1.02	1.00–1.05	0.052
History of knee injury	2.36	1.35–4.11	0.003
Diabetes mellitus	1.41	0.89–2.24	0.142

This study observed a high prevalence of knee osteoarthritis among Vietnamese women aged 50 and older. More than 50% of these women reported having knee pain. The data also **reveal** a substantial correlation between obesity, low physical activity, and knee pain, even after accounting for age, relevant comorbid conditions, and previous knee surgeries. The data **indicate** the high prevalence of knee pain in this population and highlight the need for lifestyle changes and comprehensive management.

4. Discussion

4.1. Comparison with Earlier Research

The reported figure of 54.2% prevalence is in line with the figure reported in other Asian countries; women in these countries also reported a prevalence of between 40% and 60% (Zhang & Jordan, 2010; Muraki, 2011). The strong association observed in this study between obesity and knee pain corroborates previous studies that have justified the association because of the mechanical strain on the knee joint as well as the inflammatory responses resulting from obesity (Blagojevic, 2010; Felson, 2013).

In the same manner, the protective factor associated with physical activity that emerged from our analysis is aligned with Fransen et al (2015). Studies have suggested that physical activity, particularly within a moderate range, bolsters musculature, enhances joint flexibility, and slows down the degeneration of cartilage. However, the findings from our study suggest that moderate activity appears to have minimal impact on the risk of developing knee pain in comparison to a more active lifestyle.

Also, fat tissue is known to produce cytokines, which are inflammatory signaling molecules such as interleukin-6 (IL-6) and TNF-α (tumor necrosis factor-alpha), which are associated with the development of osteoarthritis. Furthermore, insufficient levels of physical exercise lead to the weakening of the quadriceps muscle and reduced proprioception, which tends to increase knee joint instability and pain.

4.2. Strengths and Limitations

The community-based nature of the research is a particular strength, especially given the rigor of the study design, which included standardized and validated methods for assessing pain and physical activity. In addition, the inclusion of both urban and rural participants enhanced the representativeness of the findings within the Vietnamese population. Furthermore, purposeful random sampling reduced selection bias.

Regardless, the cross-sectional design does not provide the means to establish a causal relationship between BMI, physical activity, and knee pain. Although physical activity and comorbidity data collection utilized standardized questionnaires and trained interviewers, the data were still susceptible to recall bias. In addition, the lack of dietary evaluation and muscle mass quantification as possible factors contributing to knee pain was also a significant gap in this research.

4.3 Implications for Public Health

This research underlines the potential for knee pain prevention by implementing changes in lifestyle and demonstrates that primary prevention is achievable. For patients labeled as overweight and obese, a modest weight reduction of 5 to 10% not only alleviates knee pain but also significantly improves functional performance. Furthermore, there is additional evidence to suggest that the management of knee pain will benefit from aerobic and balance training, as well as low-impact aerobics and quadriceps strengthening exercises.

At the community level, public health efforts need to concentrate on creating exercise facilities designed to promote older adults' safety, train primary care clinicians to adopt **proactive** preventive care regarding joints, and address the systematic assessment of knee pain in women over the age of 50.

5. Conclusion and Recommendations

5.1. Conclusion

This study has recognized knee pain as a widespread health issue for Vietnamese women over fifty years of age, with more than fifty percent of the surveyed population suffering from it. Obesity, alongside low levels of physical activity, emerged as independent and modifiable risk factors, underlining the importance of lifestyle choices on musculoskeletal health.

Despite the study's cross-sectional design, which limits establishing cause and effect, the community-based sampling, along with the appropriate measurement tools used, strengthens the study's contextual Vietnam-specific evidence for the development of tailored preventive interventions. It remains to be seen how such lifestyle factors as physical activity and knee pain influence each other over time, which is why the study's findings must be followed up with longitudinal research.

5.2. Recommendations

Public Health Interventions:

1. *Weight Control Programs:*
- Emphasis should be placed on community-centered weight reduction initiatives for older, overweight, and obese women, aiming for a 5-10% weight reduction.
- Improve accessibility, personalized nutrition should be available through mobile platforms.
2. *Structured Physical Activity:*

Physical activity programs aimed at older individuals should be developed and marketed. These should feature:

- Exercises concentrating on the strengthening of the quadriceps and hamstring muscles.
- Low-impact aerobic activities such as walking, cycling, or swimming.
- Balance and flexibility training to mitigate the risk of falling.

Support attendance through community centers, designated parks, and even through primary health facilities.

3. *Health Education and Screening*
- Include primary knee health education during the primary care windows.
- Prepare all levels of healthcare personnel to undertake early detection of knee pain and relevant functional incapacity.
- Pamphlets should be designed to promote appropriate body mechanics, active self-care, and other pertinent self-management techniques.
4. *Policy recommendation:*
- Allocate funding for the construction and continuous maintenance of safe and age-friendly exercise facilities.
- Develop policies regarding bones, joints, and chronic conditions that have objectives relevant to musculoskeletal health.

Future Directions of the Research:

- Execute longitudinal studies to determine the causal relationships and the timeline of knee pain, levels of physical activity, and body mass index.
- Examine the role of diet, muscle tissue, and inflammatory biomarkers on the development of knee pain.
- Study the prevalence of knee pain in relation to the community-based weight loss and exercise program's cost-effectiveness and scalability**.**

References

1. Blagojevic, M., Jinks, C., Jeffery, A., & Jordan, K. P. (2010). Risk factors for onset of osteoarthritis of the knee in older adults: A systematic review and meta-analysis. *Osteoarthritis and Cartilage, 18*(1),

2. Cui, A., Li, H., Wang, D., Zhong, J., Chen, Y., & Lu, H. (2020). Global, regional prevalence, incidence and risk factors of knee osteoarthritis in population-based studies. *EClinicalMedicine, 29-30*, 100587.

3. Felson, D. T. (2013). Osteoarthritis as a disease of mechanics. *Osteoarthritis and Cartilage, 21*(1),

4. Fransen, M., McConnell, S., Harmer, A. R., Van der Esch, M., Simic, M., & Bennell, K. L. (2015). Exercise for osteoarthritis of the knee: A Cochrane systematic review. *British Journal of Sports Medicine, 49*(24), 1554–1557.

5. GBD 2019 Diseases and Injuries Collaborators. (2020). Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: A systematic analysis. *The Lancet, 396*(10258), 1204–1222.

6. Kim, I. J., Kim, H. A., Seo, Y. I., Song, Y. W., Jeong, J. Y., & Kim, D. H. (2011). Prevalence of knee pain and its influence on quality of life and physical function in the Korean elderly population: A community-based cross-sectional study. *Journal of Korean Medical Science, 26*(9), 1140–1146.

7. Kim, H. I., Choi, J., & Kim, K. (2022). Effects of sarcopenia and sarcopenic obesity on joint pain and degenerative osteoarthritis in postmenopausal women. BMC Musculoskeletal Disorders, 23(1), 726.

8. Lee, J., Chang, R. W., Ehrlich-Jones, L., Kwoh, C. K., Nevitt, M., Semanik, P., Sharma, L., Sohn, M. W., & Dunlop, D. D. (2019). Sedentary behavior and physical function: Objective evidence from the Osteoarthritis Initiative. *Arthritis Care & Research, 71*(1), 28–36.

9. Lee, K. M., Kang, S. B., Chung, C. Y., Park, M. S., Kang, D. W., & Chang, C. B. (2018). Factors associated with knee pain in 5148 women aged 50 years and older: A population-based study. *Plos One, 13*(3), e0192478.

10. Messier, S. P., Mihalko, S. L., Beavers, D. P., Nicklas, B. J., DeVita, P., Carr, J. J., Hunter, D. J., Williamson, J. D., Lyles, M. F., Eckstein, F., Guermazi, A., Miller, G. D., & Loeser, R. F. (2022). Effect of intensive diet and exercise on knee joint loads, inflammation, and clinical outcomes among overweight and obese adults with knee osteoarthritis: The IDEA randomized clinical trial. *JAMA, 328*(24), 2423–2434.

11. Muraki, S., Akune, T., Oka, H., Ishimoto, Y., Nagata, K., Yoshida, M., Tokimura, F., Nakamura, K., Kawaguchi, H., & Yoshimura, N. (2011). Association of radiographic and symptomatic knee osteoarthritis with health-related quality of life in a population-based cohort study in Japan: The ROAD study. *Osteoarthritis and Cartilage, 19*(10), 1227–1234.

12. Nguyen, U.-S. D. T., Zhang, Y., Zhu, Y., Niu, J., Zhang, B., & Felson, D. T. (2011). Increasing prevalence of knee pain and symptomatic knee osteoarthritis: Survey and cohort data. *Annals of Internal Medicine, 155*(11), 725–732.

13. Szilagyi, I. A., Waarsing, J. H., Slieker, J. C., van der Geest, J. N., de Mutsert, R., & Bierma-Zeinstra, S. M. A. (2022). Sex differences in risk factors for knee osteoarthritis: A systematic review and meta-analysis. *Osteoarthritis and Cartilage, 30*(8), 1062–1074.

14. WHO Expert Consultation. (2004). Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *The Lancet, 363*(9403), 157–163.

15. Zhang, Y., & Jordan, J. M. (2010). Epidemiology of osteoarthritis. *Clinics in Geriatric Medicine, 26*(3), 355–369.