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Parental history and body mass index as predictors of osteoporosis among urban elderly women in Depok, Indonesia

Kunthi Ayu Kusumawardani[1], Basuki Supartono[1], Yanti Harjono Hadiwiardjo[1], Mila Citrawati[1]

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[1]Faculty of Medicine, National Veteran Development University, Jakarta, Indonesia

***Correspondence:**
kunthiayuk@upnvj.ac.id

Abstract

Purpose: This study aims to identify the risk factors associated with osteoporosis among urban elderly women in Depok, Indonesia. **Methods:** This research employed a cross-sectional design and involved 110 elderly women living in Cimanggis District, Depok. Participants were selected through consecutive sampling. Data were collected through interviews using the risk factor checklist from the International Osteoporosis Foundation, and bone density measurements were obtained using heel bone ultrasound. The relationship between variables was analyzed using the Chi-square test and logistic regression. **Results:** The results showed that most elderly suffer from osteoporosis (77.3%). BMI and parental history of hip fracture showed a significant relationship with bone density. History of fractures after 50 years of age, height loss greater than 4 cm, comorbidities, long-term medication use (over three months), smoking, and alcohol consumption showed no significant relationship with bone density. The most influential risk factor was a parental history of hip fracture. **Conclusion:** The majority of elderly women have osteoporosis. Low body mass index and a family history of hip fractures are significantly associated with lower bone density. These results highlight the need for preventive strategies and lifestyle interventions to reduce osteoporosis risk among the elderly.

Keywords: body mass index; elderly women; osteoporosis; parental history; urban area

INTRODUCTION

Osteoporosis is a condition characterized by the deterioration of bone microarchitecture and decreased bone density, which leads to increased bone fragility and susceptibility to fractures [1]. These fractures, especially in the elderly, can result in significant functional decline, reduced quality of life, and increased mortality [2]. Globally, the number of individuals with osteoporosis reached 200 million in 2016 [3], with women being four times more likely to be affected than men [4].

In Indonesia, data from the Ministry of Health show that 23 percent of women aged 40 to 80 years suffer from osteoporosis, and this prevalence rises to 53 percent in women over 70 years old. Demographic trends compound this situation. The United Nations reported 702.9 million elderly individuals worldwide, and this number is projected to increase by 120 percent by 2050. According to national data, in 2021, Indonesia had 28.2 million elderly individuals, of whom approximately 14.6 million were women. In Depok City alone, 174,412 elderly individuals were recorded in 2022, including 90,779 elderly women. The rapid

growth of the elderly population is directly correlated with increased physical, social, economic, and health-related challenges [5].

Fractures due to osteoporosis impose a heavy burden on health systems, with estimated treatment costs for pathological fractures reaching 300 trillion Indonesian Rupiah per year [6]. Previous studies have identified several risk factors for osteoporosis, including age, sex, body mass index, duration of menopause, smoking, alcohol consumption, family history of osteoporosis, height loss, history of fractures, and the presence of comorbidities [7–9].

However, many of these studies have been conducted in rural populations or used varied criteria and tools, making their findings less applicable to urban elderly populations. Most notably, existing studies often lack standardized instruments such as the International Osteoporosis Foundation risk factor checklist, particularly within Indonesian urban settings. Moreover, bone density assessments using portable heel bone ultrasonography remain underutilized, despite being practical and cost-effective for early screening [10].

To address these gaps, this study aims to explore osteoporosis's prevalence and risk factors, specifically among elderly women in an urban area of Depok City, Indonesia. By employing standardized risk factor assessment tools and accessible diagnostic techniques, this study contributes to the growing body of evidence on osteoporosis in developing countries and offers a context-specific perspective for targeted prevention strategies.

METHODS

This study employed an observational, analytic, and quantitative approach using a cross-sectional design. Primary data were collected from 110 elderly women residing in the Cimanggis District, Depok City. The population consisted of all elderly women who visited public health facilities within the Cimanggis Community Health Center's working area. Participants were selected using a consecutive sampling method. The inclusion criteria included elderly women who could communicate effectively and consented to participate. Participants were excluded if they had a history of bulimia, anorexia nervosa, psychiatric disorders, or cognitive impairments.

The dependent variable in this study was bone density, classified into three categories: normal, osteopenia, and osteoporosis. The independent variables included body mass index, history of fractures after the age of 50, height loss greater than 4 centimeters, parental history of hip fractures, presence of comorbidities, long-term medication use (over three months), smoking behavior, and alcohol consumption. These variables were measured through structured interviews and supported by physical measurements where applicable.

Data collection was conducted from December 2022 to January 2023. Participants provided informed consent after receiving education regarding osteoporosis and its prevention. Structured interviews were conducted using the osteoporosis risk factor checklist developed by the International Osteoporosis Foundation [7]. Anthropometric measurements, including height and weight, were taken to calculate body mass index. Bone density was assessed using heel bone ultrasonography (Osteosys, Sonost 3000). Heel bone ultrasonography, a portable and non-invasive screening tool, was chosen due to its affordability, safety (no radiation), and accessibility in community settings. It has been recommended as a practical alternative to dual-energy X-ray absorptiometry for early detection, particularly in rural or resource-limited areas [10].

Bivariate analysis was performed using the Chi-square test. If the assumptions were not met, Fisher’s exact test examined the relationship between the independent variables and bone density. Multivariate analysis was conducted using logistic regression (backward stepwise method) to identify the most influential risk factors and to calculate odds ratios with 95 percent confidence intervals.

RESULTS

Table 1 presents the demographic and clinical characteristics of the study participants. The majority of the elderly women fell within the younger age bracket of the elderly population and had a diverse range of body mass index classifications, with a notable proportion in the overweight and obese categories. Most participants had no history of fractures after the age of 50, did not experience height loss exceeding four centimeters, and reported no parental history of hip fractures. Slightly more than half of the respondents did not report comorbidities or prolonged medication use. In terms of lifestyle factors, almost all participants were non-smokers and abstained from alcohol.

Notably, the prevalence of osteoporosis among this urban elderly population was high, with only a small fraction maintaining normal bone density, while the remainder exhibited osteopenia or osteoporosis. These findings provide a contextual foundation for understanding the distribution of potential risk factors in the study population.

Table 1. Study demographic profiles (n=110)

Characteristics	n	%
Age (years)		
60-69	75	68.2
70-79	35	31.8
BMI (kg/m^2)		
Underweight	4	3.6
Normal	35	31.8
Overweight	17	15.5
Obesity I	38	34.5
Obesity II	16	14.5
History of fractures after age 50 years		
Yes	11	10.0
No	99	90.0
Height loss		
Yes	23	20.9
No	87	79.1
Parental history of hip fractures		
Yes	9	8.2
No	101	91.8
Comorbidity		
Yes	50	45.5
No	60	54.5
History of long-term drug consumption		
Yes	34	30.9
No	76	69.1
Smoke		
Yes	3	2.7
No	107	97.3
Alcohol consumption		
Yes	2	1.8
No	108	98.2
Bone density		
Normal	11	10
Osteopenia	14	12.7
Osteoporosis	85	77.3

Table 2 illustrates the relationship between various risk factors and bone density status among the elderly women studied. The analysis revealed a statistically significant association between body mass index and parental history of hip fractures with the occurrence of osteoporosis. Elderly women with low body mass index or with a parental history of hip fractures were more likely to have lower bone density. In contrast, other factors such as history of fractures after age fifty, height loss, presence of comorbidities, long-term medication use, smoking, and alcohol consumption did not demonstrate a significant relationship with bone density. These findings highlight the dominant influence of hereditary factors and nutritional status in determining osteoporosis risk within this population.

Table 3. Logistic regression test analysis results

Independent variables	p	OR	95% CI	
			Min	Max
BMI	0.03	0.05	0.00	0.47
Parental history of hip fractures	0.00	9.20	1.76	48.02

Table 3 presents the results of the logistic regression analysis, identifying the most influential risk factors associated with osteoporosis. The analysis confirmed that a parental history of hip fractures was the strongest predictor of low bone density, indicating a considerable genetic predisposition. Additionally, body

Table 2. Relationship of risk factors and bone density

Variables	Bone density				Total		p	OR	95% CI	
	Osteoporosis		Normal						Min	Max
	n	%	n	%	n	%				
BMI (kg/m^2)										
<18.5	2	50	2	50	4	100	0,04	12.25	1,51	98,86
≥18.5	98	92.5	8	7.5	106	100				
History of fractures after 50 years old										
Yes	9	81.8	2	18.2	11	100	0.26	0.39	0.07	2.15
No	91	91.9	8	8.1	99	100				
Height loss >4 cm										
Yes	21	91.3	2	8.7	23	100	1.00	1.06	0.21	5.38
No	79	90.8	8	9.2	87	100				
Parental history of hip fractures										
Yes	6	66.7	3	33.3	9	100	0.01	6.71	1.37	32.74
No	94	93.1	7	6.9	101	100				
Comorbidities										
Yes	44	88	6	12	50	100	0.50	0.52	0.13	1.97
No	56	93.3	4	6.7	60	100				
Medication >3 months										
Yes	29	85.3	5	14.7	34	100	0.27	0.40	0.11	1.51
No	71	93.4	5	6.6	76	100				
Smoking										
Yes	2	66.7	1	33.3	3	100	0.25	0.18	0.01	2.22
No	98	91.6	9	8.4	107	100				
Alcohol consumption										
Yes	1	50	1	50	2	100	0.17	0.09	0.00	1.57
No	99	91.7	9	8.3	108	100				

mass index remained a significant factor, with underweight individuals showing a markedly increased likelihood of having osteoporosis. These multivariate results underscore the importance of genetic history and nutritional status in assessing osteoporosis risk among elderly women.

DISCUSSION

This study found that two factors—low body mass index and a parental history of hip fracture—were significantly associated with osteoporosis among elderly women in Cimanggis District, Depok. These findings highlight the relevance of both nutritional status and genetic predisposition in determining bone health in later life. The association between a low body mass index and reduced bone density aligns with previous studies, which found that underweight individuals are at a higher risk of osteoporosis [11,12]. Low body weight can reduce the mechanical loading necessary for bone maintenance and is often linked with hormonal imbalances, such as decreased estrogen levels, essential for bone formation. Although some literature suggests that obesity may negatively impact bones due to metabolic and inflammatory changes [13], this study suggests that the protective effect of adequate weight is more prominent. These results support maintaining a healthy weight as a modifiable factor to reduce the risk of osteoporosis in elderly women.

A parental history of hip fractures is also strongly associated with osteoporosis, suggesting the critical role of hereditary and genetic factors in bone health. This is consistent with earlier studies that reported familial fracture history as a predictor of low bone density and future fracture risk [14,15,16]. Genetic influences can affect bone mass, architecture, turnover, and response to external stressors. Because this is a non-modifiable risk factor, identifying it is essential for targeting individuals for early screening and preventive interventions.

This study has several limitations. The cross-sectional design limits the ability to establish causal relationships between risk factors and osteoporosis. Recall bias may have affected responses about fracture history, height changes, and family medical background. The use of calcaneal ultrasonography, although practical and accessible, measures bone density at a single site and may not fully reflect overall skeletal health. The relatively small number of participants with specific characteristics, such as positive family history, may limit the precision of estimates. Finally, the findings may not generalize to populations with different socio-demographic or cultural profiles.

The identification of low body mass index and family history of hip fractures as significant risk factors for osteoporosis has practical implications for public health programs. Community health centers should integrate routine screening efforts for elderly women, particularly those with an underweight status or a known family history of fractures. Educational campaigns should emphasize the importance of maintaining a healthy diet and body weight for good bone health. In addition, simple family history inquiries during primary care visits can serve as a low-cost and effective way to identify high-risk individuals. In this study, it was found that lower BMI and history of fracture in the elderly are significantly associated with the incidence of osteoporosis, so early prevention and early intervention is needed against the above risk factor findings. These strategies can help reduce osteoporosis-related complications, maintain independence in older adults, and lower the burden on the healthcare system.

CONCLUSION

This study revealed that a large proportion of elderly women in Cimanggis District, Depok, suffer from osteoporosis. Low body mass index and a parental history of hip fractures were significantly associated with reduced bone density among the risk factors analyzed. These findings underscore the importance of nutritional status and hereditary predisposition in determining osteoporosis risk in later life. Other factors, such as history of fractures, height loss, comorbid conditions, prolonged medication use, smoking, and alcohol consumption, showed no significant association. Parental history of hip fracture emerged as the most influential risk factor.

Based on these findings, it is recommended that public health initiatives prioritize routine osteoporosis screening among elderly women, especially those with an underweight status or a family history of fractures. Nutrition education and weight maintenance programs should be integrated into community health services to mitigate the risk of bone loss. Primary healthcare providers should also incorporate simple family history assessments during routine visits to identify high-risk individuals early and provide appropriate preventive interventions.

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