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Prevalence and Anthropometric Factors Associated with Flat Foot Among University Students

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Abstract

Flat foot (pes planus) is a deformity characterized by collapse of the medial longitudinal arch, which may lead to postural disturbances and functional limitations. Despite its clinical relevance, flat foot often receives little attention until musculoskeletal symptoms become pronounced. Epidemiological data on its prevalence and anthropometric determinants among university students, particularly in Southeast Asia, remain limited. This study aimed to determine the prevalence of flat foot and its association with gender, age, body weight, height, and body mass index (BMI) among university students as a basis for early prevention strategies. A quantitative descriptive, cross-sectional study was conducted involving 107 university students (21 males and 86 females). Foot arch structure was assessed using the footprint test, and data were analyzed using descriptive and inferential statistics. Flat foot prevalence was higher in females (67.29%) than males (14.95%) and was most common in respondents aged 21–23 years (64.49%). Higher prevalence was observed among students with body weight ≥60 kg (33.64%), height ≥166 cm (18.69%), and elevated BMI. Anthropometric factors, particularly gender, body weight, height, and BMI, are significantly associated with flat foot prevalence among university students.

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INTRODUCTION

Flat foot, also known as pes planus, is a condition characterized by the reduction or loss of the medial longitudinal arch of the foot, resulting in the entire sole coming into contact with the ground during standing. This condition is commonly regarded as a musculoskeletal problem that may affect postural stability and cause pain or discomfort in the feet, knees, hips, and lower back. Although flat foot can occur across all age groups, its prevalence tends to be higher among individuals in their developmental years, including university students (Hakukawa et al., 2022)(Jiang et al., 2023). Such biomechanical alterations may compromise postural control and increase the risk of secondary musculoskeletal disorders if left unaddressed.

Both intrinsic and extrinsic factors contribute to the development of flat foot, including genetic predisposition, increased body mass, age-related changes, physical inactivity, and inappropriate lifestyle habits (Napolitano et al., 2000; Bednarczyk et al., 2024). Among university students, these factors are often interrelated with sedentary behaviour, improper footwear selection, and limited awareness of foot health (Minaie et al., 2020; Wist et al., 2022). Therefore, investigating the prevalence and associated factors of flat foot among university students is essential to provide insights for preventive and management strategies.

If left undetected and untreated, flat foot can lead to more serious long-term health issues such as chronic pain in the back, ankles, and other joints. Early identification of flat foot in young adults is therefore essential to prevent long-term functional impairment. This study aims to identify potential preventive and early management measures to reduce the risk of developing long-term musculoskeletal complications (Napolitano et al., 2000; Fine et al., 2022).

The prevalence of flat foot in the adult population, including university students, is increasing in line with sedentary lifestyles and improper footwear use. Most students spend long hours sitting, often unaware of the importance of maintaining proper foot health. Poor habits, such as wearing uncomfortable or unsupportive shoes, can aggravate this condition. Flat foot not only affects physical comfort but may also influence body posture, mobility, and overall quality of life (Ojukwu, Anyanwu and Nwafor, 2017; Minaie et al., 2020).

Research on the prevalence of flat foot among university students is therefore crucial to determine the extent to which this condition affects their quality of life(Bednarczyk et al., 2024). Additionally, this study aims to explore the factors contributing to the development of flat feet among students and their implications for physical and psychological well-being. By providing clearer information on prevalence and risk factors, this research aims to identify effective solutions for prevention and management, including education, lifestyle modification, and medical intervention. Ultimately, it is expected that the findings will raise awareness among students about the importance of maintaining foot and overall body health.

Therefore, this study aimed to investigate the prevalence of flat foot among university students and to analyse its association with gender, age, body weight, height, and body mass index (BMI). Understanding these relationships is essential for developing preventive strategies and early rehabilitative interventions in young adult populations.

The novelty of this research lies in its focus on university-aged young adults, a population that has received limited attention in flat foot epidemiology, and in the simultaneous analysis of multiple anthropometric factors within this age group. This approach provides early risk profiling and clinically relevant evidence to support preventive and rehabilitative strategies before long-term musculoskeletal consequences develop.

METHODS

This study employed a descriptive cross-sectional design to assess the prevalence of flat foot and its associated anthropometric factors among university students. This study received ethical approval (Ethical Clearance Letter) from Universitas Muhammadiyah Surakarta, under reference number 5622/B.1/KEPK-FKUMS/III/2025.

The study population comprised all students from the Faculty of Health Sciences at UMAD Palembang. Samples were selected randomly using a random sampling technique based on the following inclusion criteria: male or female students aged 18–25 years; no prior history of foot trauma or injury; not using walking aids; and providing informed consent to participate. The final sample consisted of 107 students, including 21 males and 86 females, reflecting the gender distribution of the faculty population.

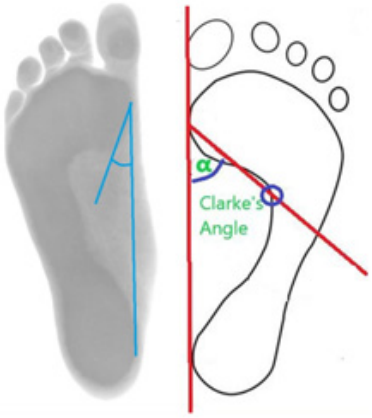
All eligible participants underwent a footprint assessment, flat feet were assessed using the footprint method, a simple, non-invasive pro-

cedure that uses water and cardboard as the primary materials. The footprint method combined with Clarke's Angle measurement has been widely recognized as a valid and practical tool for assessing medial longitudinal arch integrity in population-based studies. A basin of clean water and a piece of light-coloured cardboard were placed on a stable surface. Each participant's foot was gently immersed in the water to ensure an even coating across the entire plantar surface. Participants then stood barefoot on the cardboard for approximately three to five seconds, with their weight evenly distributed on both feet, allowing for the formation of a clear footprint.

After the foot was removed, the footprint was outlined and allowed to dry. The footprint was then visually analysed using Clarke's Angle to classify the medial arch type. A normal foot exhibits a clear curvature on the medial side, a low arch exhibits partial contact along the inner edge, and a flat foot exhibits full contact between the sole of the foot and the surface, with a completely collapsed medial arch. This method provides a practical way to identify flat feet among participants.



Picture 1. Footprint assessment procedure



Picture 2. Clarke's Angle.

RESULTS AND DISCUSSION

The distribution of respondent characteristics and flat foot prevalence across demographic and anthropometric variables is presented in **Table 1.**

Table 1. Respondent Characteristics

Sub-Category	Category	Total Participants	Total Flat Foot	(%)	Prevalence (%)
Gender	Male	21	16	76.19	14.95
	Female	86	72	83.72	67.29
	Total	107	88		
Age (Years)	18 – 20	23	14	60.87	15.91
	21 – 23	69	59	85.51	67.05
	24 - 25	15	15	100	17.05
	Total	107	88		
Weight (kg)	≤ 48	7	4	57.14	3.74
	49–52	13	8	61.54	7.48
	53–55	19	19	100.00	17.76
	56–58	26	21	80.77	19.63
	≥ 60	42	36	85.71	33.64
	Total	107	88		
Height (cm)	≤ 153	12	7	58.33	6.54
	154–157	19	15	78.95	14.02
	158–160	23	18	78.26	16.82
	161–165	31	28	90.32	26.17
	≥ 166	22	20	90.91	18.69
	Total	107	88		
BMI	Low	23	15	65.22	14.02
	Normal	67	56	83.58	52.34
	Haight	17	17	100.00	15.89
	Total	107	88		

The Chi-Square test results presented in **Table 2** demonstrate the relationship between several variables (gender, BMI, age, body weight, and height) and the prevalence of flat foot. A significant relationship was found between gender and flat foot prevalence ($\chi^2 = 6.542$, $p = 0.011$), indicating that gender plays a role, with females showing a higher prevalence than males. BMI also demonstrated a significant association with flat foot ($\chi^2 = 8.318$, $p = 0.016$), suggesting that higher BMI categories (e.g., overweight or obese) are linked to increased flat foot prevalence.

In contrast, age did not show a significant relationship ($\chi^2 = 5.432$, $p = 0.234$), indicating that within this sample, age did not influence flat foot occurrence. Body weight, however, was significantly associated ($\chi^2 = 8.412$, $p = 0.039$), showing that individuals with higher body weight were more prone to flat feet. Meanwhile, height ($\chi^2 = 7.212$, $p = 0.062$) showed a near-significant relationship but was not statistically significant at the 0.05 level.

Table 2 shows the chi-square analysis demonstrated that gender, body mass index (BMI),

and body weight were significantly associated with the prevalence of flat foot among university students ($p < 0.05$). In contrast, age and height did not show statistically significant associations with flat foot ($p > 0.05$). These findings indicate that anthropometric characteristics related to body composition play a more influential role in flat foot occurrence than demographic factors such as age within this young adult population.

These results indicate that gender, body weight, and BMI are significant factors associated with flat foot prevalence, whereas age and height showed no statistically significant association within this sample.

Table 2. Statistical Test Results

Variables	Chi-Square Statistic	p-Value
Gender	6.542	0.011*
BMI	8.318	0.016*
Age	5.432	0.234
Weight	8.412	0.039*
Height	7.212	0.062

Table 3 shows the Clarke's Angle classification revealed that the majority of participants exhibited flat foot, indicating substantial medial arch collapse among the study population. Two showed lower arches (Clarke's Angle 31°–41°), 13 demonstrated normal arches (Clarke's Angle 42°–54°), and 4 had high arches (Clarke's Angle > 55°). These findings suggest that most students display clear signs of flat foot, highlighting the value of Clarke's Angle for detecting structural foot abnormalities that may require attention.

Tabel 3. Clark's Angle

Clarke's Angle	Total	Interpretation
<300	88	Flat foot
310 – 410	2	Lower arch
420 – 540	13	Normal arch
<550	4	Hight arch

This study demonstrated a relatively high prevalence of flat foot among university students, with variations across gender and anthropometric characteristics. In this study, the prevalence of flat foot among Health Sciences students was relatively high and varied according to demographic and physical factors, including gender, age, weight, height, and BMI (Manyukhina et al., 2022; Turri et al., 2023). The majority of respondents were female, supporting previous studies indicating higher flat foot prevalence among women, possibly due to biomechanical and hormonal differences affecting foot structure. Hormonal influences, ligament laxity, and footwear habits may further contribute to the higher prevalence observed among female students.

The prevalence of flat foot also varied across age groups, with the 24–25-year-old group showing the highest prevalence (100%), followed by the 21–23-year-old group (85.51%). Although the Chi-Square test indicated no significant association between age and flat foot prevalence ($p = 0.234$), this may be due to the narrow age range of participants (18–25 years). Other studies suggest that flat foot tends to be more prevalent in older individuals, but it can also be influenced by factors such as physical activity and body weight (Pita-Fernandez et al., 2017; Herchenröder, Wilfling and Steinhäuser, 2021; Alotaibi et al., 2024).

Body weight significantly influenced flat foot prevalence, with heavier individuals showing a higher tendency toward the condition. This aligns with previous research demonstrating that overweight and obese individuals are at greater risk of flat foot due to increased mechanical load on the feet(Ojukwu, Anyanwu and Nwafor, 2017; Herchenröder, Wilfling and Steinhäuser, 2021; Arain, Harrington and Rosenbaum, 2024; Hua et al., 2024). Excess body mass increases plantar loading and alters foot biomechanics, accelerating medial arch deformation over time. A higher BMI similarly correlated with flat foot occurrence, supporting evidence that excess body weight elevates plantar pressure, leading to arch collapse.

Height showed a near-significant association but was not statistically confirmed ($p > 0.05$) (Jiang et al., 2023; Stania et al., 2024). Previous studies have reported that while height may influence body weight distribution, its direct impact on foot deformities like flat foot is relatively minimal compared to other factors such as body weight or BMI (Pita-Fernandez et al., 2017). The use of Clarke's Angle in this study provided a clear depiction of foot arch conditions, confirming that most participants exhibited flat foot and underscoring the need for greater attention in prevention and rehabilitation efforts. The predominance of abnormal Clarke's Angle measurements underscores the importance of routine foot screening programs within university health services.

CONCLUSION

In conclusion, this study indicates that gender, body weight, height, and BMI are important factors associated with the prevalence of flat foot

among young adults. These findings highlight the need for early screening, preventive education, and targeted interventions to reduce future musculoskeletal complications. Further studies with larger and more diverse populations are recommended to explore biomechanical and lifestyle-related determinants in greater depth.

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