e-ISSN: 0975-9506, p-ISSN: 2961-6093

Available online on www.ijpqa.com

International Journal of Pharmaceutical Quality Assurance 2026; 17(10); 69-73

Original Research Article

Prevalence of Flatfoot and its Association with BMI, Age, and Gender among Adults in the Saurashtra Region of Gujarat

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Received: 25-07-2026 / Revised: 23-08-2026 / Accepted: 26-09-2026
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Conflict of interest: Nil

Abstract:

Introduction: Flatfoot (pes planus) is a condition characterised by a reduced medial longitudinal arch of the foot. This study aimed to assess the prevalence of flatfoot and its association with age, gender, and body mass index (BMI) among adults in the Saurashtra region of Gujarat.

Materials and Methods: A community-based analytical cross-sectional study was conducted among 259 adults in the Saurashtra region from January to June 2023. Age, gender, height, weight, and BMI were recorded, and flatfoot was assessed using the Navicular Drop Test. Data were analysed using descriptive statistics and the chi-square test.

Results: Among 259 participants, 42 (16.2%) had flatfoot. Prevalence was higher among participants aged 30–40 years (27.6%) than in those younger than 20 years (13.8%) and those aged 20–29 years (15.2%). Flatfoot was observed in 17.9% of females and 14.3% of males. Prevalence increased across BMI categories, from 8.8% among underweight participants to 27.8% among obese participants. However, associations with age ($p = 0.21$), gender ($p = 0.44$), and BMI ($p = 0.19$) were not statistically significant.

Conclusion: Flatfoot prevalence was 16.2% in the study population. No statistically significant association was found with age, gender, or BMI.

Keywords: Flatfoot; Pes planus; Body mass index; Navicular Drop Test.

DOI: 10.25258/ijpqa.17.10.11

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Introduction

Flatfoot, also known as pes planus, is a condition in which the arch on the inner side of the foot is reduced or absent. [1] As a result, more of the foot comes into contact with the ground while standing. Some people with flatfoot do not have any symptoms, while others may experience foot pain, discomfort while walking, or changes in their walking pattern. [2] The arch of the foot helps maintain balance, distribute body weight, and absorb the impact of walking. Changes in the arch may affect these functions and can sometimes lead to problems involving the feet and lower limbs. [3]

Body mass index (BMI) is one of the factors that may be related to foot posture. Increased body weight places greater pressure on the feet and may affect the structures that support the arch. [4] Age and gender may also be associated with differences in foot structure. However, previous studies have reported varying findings regarding the relationship between flatfoot and these factors. [5,6] The reported prevalence of flatfoot also differs between studies because of differences in the population studied and the methods used to assess foot posture. [5,6]

The prevalence of flatfoot and its possible association with BMI and other demographic factors need to be studied in different populations. The Navicular Drop Test is a simple clinical method used to measure changes in the height of the navicular bone between sitting and standing positions. [7] It can help assess the movement of the medial arch of the foot. However, information on flatfoot among adults in the Saurashtra region of Gujarat is limited. Therefore, this study was conducted to determine the prevalence of flatfoot among adults in the region and to examine its association with BMI, age, and gender.

Material and Methods

This community-based, analytical cross-sectional study was conducted among adults in the Saurashtra region of Gujarat, India, from January

2023 to June 2023. The study aimed to determine the prevalence of flatfoot (pes planus) and assess its association with body mass index (BMI), age, and gender.

The study included 259 adults aged 18 years and above. The sample size was estimated using an expected flatfoot prevalence of 20%, a 95% confidence level, and a 5% margin of error. Participants were recruited using convenience sampling from public areas, outpatient departments, and educational institutions. Individuals who were willing to participate and provided written informed consent were included. Those with recent lower-limb injuries, congenital deformities, neuromuscular disorders, systemic diseases affecting gait, previous foot or ankle surgery, postural abnormalities, or pain related to structural problems were excluded.

Data were recorded using a structured proforma that included age, gender, height, weight, BMI, and findings of the foot examination. Height was measured using a measuring tape with participants standing without footwear and was recorded to the nearest 0.1 cm. Body weight was measured using a calibrated digital weighing machine, with participants wearing light clothing and no footwear, and was recorded to the nearest 0.1 kg. BMI was calculated by dividing weight in kilograms by the square of height in metres (kg/m²). Participants were classified according to the Asian BMI criteria described in the study: [8] underweight (<18.5 kg/m²), normal weight (18.5–22.9 kg/m²), overweight (23–24.9 kg/m²), obesity class I (25–29.9 kg/m²), and obesity class II (≥30 kg/m²).

The Navicular Drop Test (NDT) was used to assess the medial longitudinal arch of both feet. [9] Initially, participants were seated with their feet relaxed, and the height of the navicular tuberosity from the floor was measured using a standard steel ruler. Participants were then asked to stand in a relaxed position with their body weight distributed equally between both feet, and the navicular height was measured again. The difference between the seated and standing measurements was recorded in millimetres. Both feet were examined separately by trained clinicians. The primary outcome was the prevalence of flatfoot, while the secondary outcomes were its associations with BMI, age, and gender.

Data were entered into Microsoft Excel and analysed using SPSS version 25.0. Continuous variables were summarised using means and standard deviations, while categorical variables were presented as frequencies and percentages. The chi-square test was used to assess associations between flatfoot and categorical variables, and the unpaired t-test was used to compare continuous variables between groups. A p-value of less than 0.05 was considered statistically significant. Ethical approval was obtained from the Institutional Ethics Committee before the study began. Written informed consent was obtained from all participants, and confidentiality was maintained throughout the study.

Results

A total of 259 participants were included in the study. The prevalence of flatfoot was assessed using the Navicular Drop Test, and its association with age, gender, and body mass index (BMI) was examined.

Table 1: Baseline characteristics of the study participants (n = 259)

Characteristic	Category	Number (n)	Percentage (%)
Age	<20 years	65	25.1
	20–29 years	165	63.7
	30–40 years	29	11.2
Gender	Female	140	54.1
	Male	119	45.9
BMI category	Underweight	57	22.0
	Normal	118	45.6
	Overweight	66	25.5
	Obese	18	6.9
Total		259	100.0

The largest age group was 20–29 years (63.7%). Females accounted for 54.1% of the participants. Normal BMI was the most common category (45.6%), followed by overweight (25.5%), underweight (22.0%), and obesity (6.9%).

Table 2: Prevalence of flatfoot among the study participants (n = 259)

Foot posture	Number (n)	Percentage (%)
Flatfoot	42	16.2
Normal foot arch	217	83.8
Total	259	100.0

Flatfoot was identified in 42 participants, giving an overall prevalence of 16.2%. The remaining 217 participants (83.8%) had a normal foot arch.

Table 3: Association of flatfoot with age and gender

Variable	Category	Flatfoot, n (%)	Normal arch, n (%)	Total (n)	χ^2	p-value
Age	<20 years	9 (13.8)	56 (86.2)	65		
	20–29 years	25 (15.2)	140 (84.8)	165		
	30–40 years	8 (27.6)	21 (72.4)	29	3.16	0.21
Gender	Female	25 (17.9)	115 (82.1)	140		
	Male	17 (14.3)	102 (85.7)	119	0.60	0.44
Total		42 (16.2)	217 (83.8)	259		

The prevalence of flatfoot was highest among participants aged 30–40 years (27.6%). Although the prevalence was higher in females (17.9%) than in males (14.3%), neither age nor gender showed a statistically significant association with flatfoot.

Table 4: Association between BMI category and flatfoot

BMI category	Flatfoot, n (%)	Normal arch, n (%)	Total (n)
Underweight	5 (8.8)	52 (91.2)	57
Normal	19 (16.1)	99 (83.9)	118
Overweight	13 (19.7)	53 (80.3)	66
Obese	5 (27.8)	13 (72.2)	18
Total	42 (16.2)	217 (83.8)	259

$\chi^2 = 4.68$; $p = 0.19$.

The prevalence of flatfoot increased across the reported BMI categories, from 8.8% among underweight participants to 27.8% among obese participants. However, the association between BMI category and flatfoot was not statistically significant ($p = 0.19$). The figure presents the percentage of participants with flatfoot across the age, gender, and BMI categories.

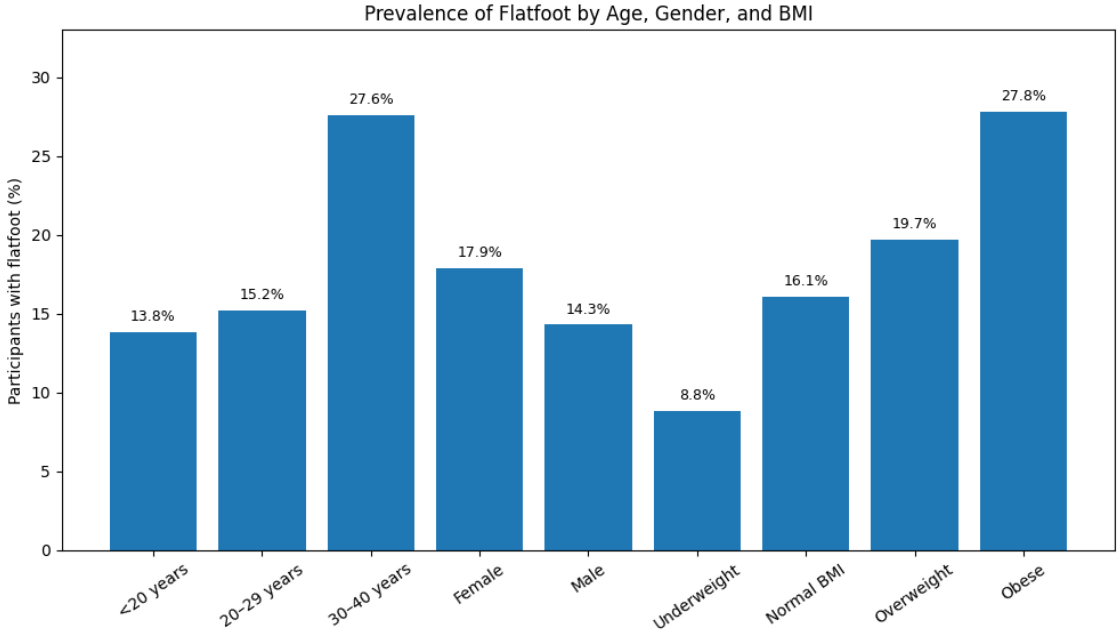


Figure 1: Prevalence of flatfoot across age groups, gender, and BMI categories. The highest prevalence was observed among obese participants (27.8%) and participants aged 30–40 years (27.6%)

Discussion

The present study assessed the prevalence of flatfoot and its association with age, gender, and body mass index (BMI) among 259 adults in the Saurashtra region of Gujarat. Flatfoot was identified in 42 participants, giving an overall prevalence of 16.2%.

This finding is comparable to the population-based systematic review by Salinas-Torres et al. [10], which reported an overall prevalence of 15.6% across the included studies. Aenumulapalli et al. [11] reported a prevalence of 13.6% among 500 young adults from Gujarat using the Navicular Drop Test (NDT). The slightly higher prevalence in the present study may reflect differences in participant characteristics, age distribution, and assessment criteria. However, prevalence estimates should be compared cautiously because studies have used different methods to assess foot posture.

In the present study, flatfoot prevalence increased across the age groups, from 13.8% among participants younger than 20 years to 27.6% among those aged 30–40 years. However, the association between age and flatfoot was not statistically significant ($p = 0.21$). This suggests that the observed increase may represent a trend rather than a confirmed association. The findings also need to be interpreted in view of the small number of participants in the oldest age group. Jayabandara et al. [12] studied 533 undergraduates in Sri Lanka and likewise found no significant association between age and flatfoot. Differences in the age range of participants and the methods used to assess the medial longitudinal arch may partly explain variations between studies.

Regarding gender, flatfoot was observed in 17.9% of females and 14.3% of males in the present study, but the difference was not statistically significant ($p = 0.44$). Aenumulapalli et al. [11] also reported no significant difference between males and females, although the prevalence was slightly higher among females. Similarly, Jayabandara et al. [12] found no significant association between gender and flatfoot, despite reporting a higher proportion of affected females in their study population. In contrast, the systematic review by Salinas-Torres et al. [10] found a stronger association between flatfoot and male gender in its pooled analysis. These differing findings indicate that gender alone may not consistently explain variations in flatfoot prevalence across populations. Differences in participant selection, foot assessment techniques, and other anatomical or lifestyle factors may contribute to the observed variation.

The present study showed an increasing trend in flatfoot prevalence across BMI categories: 8.8% among underweight participants, 16.1% among those with normal BMI, 19.7% among overweight participants, and 27.8% among obese participants. Despite this pattern, the association was not statistically significant ($p = 0.19$). Similar findings have been reported by Aenumulapalli et al. [11], who found no significant correlation between BMI and navicular drop measurements. In contrast, Chougala et al. [13] reported a significant association between BMI and functional flatfoot among college-going participants, while Kahile et al. [14] also reported an association between BMI and flatfoot in selected age groups. A systematic review by Dar and Fauzi Bach identified a significant relationship between BMI and flatfoot in most of the adult studies included in their review. [15] The increasing trend observed in the present study is therefore consistent with the possibility that higher body weight may contribute to altered foot posture. Nevertheless, the non-significant result in this study means that an association cannot be established from these data. The small number of participants in the obese category may also have limited the ability to detect a statistically significant difference.

The study was limited by non-probability sampling in a single region and its cross-sectional design, which restrict generalisability and prevent causal conclusions. Flatfoot was assessed using only the Navicular Drop Test. Physical activity, footwear, and occupational factors were not evaluated, and small subgroup sizes may have reduced statistical power. The flatfoot diagnostic cutoff should also be clearly standardised.

Conclusion

The prevalence of flatfoot among the 259 adults studied in the Saurashtra region was 16.2%. Higher prevalence was observed among participants aged 30–40 years, females, and individuals with higher BMI; however, none of these associations was statistically significant. Larger multicentre studies using standardised foot assessment methods and considering additional anatomical, occupational, and lifestyle factors are needed to clarify the determinants of flatfoot in adults.

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