https://doi.org/10.35845/kmuj.2023.22335

ORIGINAL ARTICLE

Prevalence of flatfoot among children aged 5-10 years: A population-based descriptive cross-sectional study

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ABSTRACT

OBJECTIVE: To evaluate the prevalence of flatfoot among children aged 5-10 years.

METHODS: This population-based cross-sectional study was conducted from April to July 2021, involving 379 children (aged 5-10 years) in Jhelum and Gujrat districts of Pakistan. Data was collected through non-probability convenient sampling using a questionnaire. Demographic data, including residential type, gender, age, height, weight, rear foot angle, flatfoot, injury, or pain in the lower limb were collected. The presence of flatfoot was determined using a footprint test, where inked soles were imprinted on paper as children stood.

RESULTS: Of 379 participants, 196 (51.7%) were females and 183 (49.3%) were males, with a mean age of 7.90±1.60 years. The majority (59.6%) resided in urban areas, and 53.6% had normal weight and only 12.4% were overweight. Flatfoot was prevalent in 63.9% of children, with males exhibiting a significantly higher medial arch than females. Notably, a slight positive association was observed between gender, residence, and BMI with the medial arch, although statistical significance was not reached. These findings underscore the gender-related distinctions in arch development among pediatric populations in this region.

CONCLUSION: The study revealed a 63.9% prevalence of flatfoot in children aged 5-10 years, notably higher in males with elevated medial arches. Moreover, the prevalence of flatfoot was particularly high among normal-weight children. The findings emphasize gender-related distinctions in pediatric flatfoot development, warranting further research and targeted interventions.

KEYWORDS: Foot (MeSH); Flatfoot (MeSH); Child (MeSH); Child, Preschool (MeSH); 5-10 years (Non-MeSH); Medial arch (Non-MeSH); Prevalence (MeSH); Body Mass Index (MeSH).

THIS ARTICLE MAY BE CITED AS: John N, Islam F, Raza A, Salam S. Prevalence of flatfoot among children aged 5-10 years: A population-based descriptive cross sectional study. Khyber Med Univ J 2023;15(4):241-6. https://doi.org/10.35845/kmuj.2023.22335

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Date Submitted: December 21, 2021
Date Revised: November 20, 2023
Date Approved: November 22, 2023

INTRODUCTION

The structural foundation of the body, specifically the feet, is comprised of bones interconnected and supported by muscles and ligaments.[1] Issues such as ligament laxity or foot muscle weakness can result in a reduction of the length of the medial longitudinal arch.[2,3] For infants born with level feet, the normal development of longitudinal curvature occurs within the initial decade of life.[4] Parents commonly express concern about the emergence of a level foot when their children first stand, leading them to seek therapy from muscular specialists and demonstrating a shared awareness of their children's well-being.[5] As flat-footed youngsters undergo the natural development of longitudinal curvature over the initial decade of childhood, maintaining the established degree of footedness from their early years becomes a significant parental concern.[6]

Newborns often exhibit flatfoot due to excess fat, [7] and the longitudinal arch typically develops spontaneously later in childhood. Upon standing, flatfoot can be diagnosed, potentially resulting in side effects such as bunions, hammertoes, and shin splints.[8] The posture of the foot plays a crucial role in defining lower-limb function and influencing the risk of repetitive injury.[9] In pediatric orthopedic and rehabilitative therapies, flatfoot deformity is a commonly encountered issue.[10]

Flexible flatfoot may disappear when the lower limb is not bearing weight, leading to severe impairment or necessitating treatment, while overuse can result in pain.[11] On the contrary, rigid flatfoot, a pathological condition, can be caused by various factors such as pathological changes, connective diseases, orthopedic abnormalities, trauma, muscular disorders, or neurological difficulties.[11] Those who walk flat-footed are more susceptible to stress fractures and impaired physical performance, and the prevalence of pes planus tends to decline with age according to several studies.[12] Factors contributing to flatfoot include obesity, footwear choices, a child's sitting and sleeping habits, abnormalities in the lower limbs, muscle and ligament weakening, and tendon tears.[13] Flatfoot can manifest as either symptomatic or asymptomatic, and it may be either flexible or inflexible.

The persistent debate among clinicians regarding pediatric flatfoot highlights significant information gaps and unresolved questions surrounding the treatment of non-formative asymptomatic level feet and the prevalence of flatfoot among school-

Table I: Demographic distribution of participants by gender, residence, and body mass index

VARIABLES		Frequency (n= 379)	Percentage
Gender	Female	196	51.70
	Male	183	49.30
Residence	Rural	153	40.40
	Urban	226	59.60
Body Mass Index (kg/m2)	Underweight	121	31.90
	Normal weight	203	53.60
	Overweight	47	12.40
	Obese	8	2.10

Table II: Distribution of gender, residence and body mass index among children with normal and flatfoot

VARIABLES		Normal Feet (n=137)		Flatfoot (n=242)		Total (n=379)	
		n	%	n	%	n	%
Gender	Female	78	56.9	118	48.76	196	51.72
	Male	59	43.1	124	51.24	183	48.28
Residence	Rural	58	42.3	95	39.26	153	40.37
	Urban	79	57.7	147	60.74	226	59.63
Body Mass Index (kg/m2)	Underweight	43	31.38	78	32.23	121	31.93
	Normal weight	72	52.56	131	54.13	203	53.56
	Overweight	18	13.14	29	11.98	47	12.4
	Obese	4	2.92	4	1.66	8	2.11

Table III: Associations between participant characteristics and medial arch of the feet

VARIABLES	Chi-Square	Spearman Correlation	P-Value
Gender of participants vs. Medial arch of foot	2.7	0.084	0.101
Residence of participants vs. Medial arch of foot	0.457	0.035	0.50
Body Mass Index of participants vs. Medial arch of foot	2.314	0.041	0.43

aged children.[14,15] Furthermore, it is imperative to acknowledge that surveying individuals aged six may lead to an overestimation of flatfoot prevalence, considering the crucial period for the formation of the plantar curve before this age.[16] Flatfoot, whether acquired or congenital, presents itself with two categories of congenital flatfoot: flexible and stiff. Acquired flatfoot may manifest in children with initially normal feet as they age.[17] This emphasizes the pressing need for further research, especially in the context of refining survey methodologies for accurate prevalence assessments.

Due to limited local data, we planned this study in Jhelum and Gujrat districts of Pakistan to reveal the prevalence of flatfoot in children and shed light on contributing factors, addressing a notable gap in prior research in the region. By examining associated characteristics such as age, gender, joint laxity, and obesity, the study sought to not only address knowledge gaps but also offer essential insights for the education of mothers and the implementation of preventive measures for children. In doing so, it will contribute valuable information to the broader comprehension of pediatric flatfoot.

METHODS

This population-based descriptive cross-sectional study was conducted from April 2021 to July 2021. The research encompassed the general population in the districts of Jhelum and Gujrat, in the Punjab province of Pakistan. The study enrolled 379 children between the ages of 5 and 10 through non-probability convenient sampling. Schools catering to the specified age group were randomly selected from both urban and rural areas. Data were gathered from individuals meeting the established inclusion and exclusion criteria.

Inclusion Criteria:

- Both gender included.[18]
- Aged 5–10 years.[18]
- Willing participants with informed parental or legal guardian consent.[21].

Exclusion Criteria:

- Evidence of a fixed-foot deformity or a previously reported intervention (for example, clubfoot or surgery).[19]
- Injuries like open injuries, foot ulcers, foot surgery, ankle dislocation and lower limb fractures was excluded from this study.[20]

After obtaining written consent, demographic information, encompassing residential type, gender, age, height, weight, rear foot angle, flatfoot, and instances of injury or pain in the lower limb, was systematically collected. A specially designed sheet was then imprinted on the sole of each participant's foot. Utilizing the Denis approach, the diagnosis and severity of flatfoot were determined. The footprint test, involving the application of ink on the soles of both right and left feet, was employed to assess the presence of a flatfoot. Children were requested to stand on a white sheet of paper after the ink application to capture their footprints, with the test repeated twice for each foot. Consistency in measurements was ensured by having the same individual conduct all assessments. We developed a questionnaire and acquired information was meticulously recorded during the data collection phase. Subsequently, all data were input into an Excel sheet and later transferred to SPSS for result analysis.

Data entry and statistical analysis were executed using the Statistical Package for Social Science (SPSS) software, version 24.0. Categorical data were

presented in frequencies and percentages. The normality of numerical data was assessed through the Shapiro-Wilk test or Kolmogorov-Smirnov test. For normally distributed data, the mean and standard deviation were calculated, while for non-normally distributed data, descriptive analysis involved the use of the median and interquartile range. Appropriate statistical tests were employed to determine significance, with a p-value of <0.05 considered statistically significant. The analysis was conducted at a 95% confidence interval.

RESULTS

The present study included a cohort of 379 children with flatfoot, drawn from the general population of Jhelum and Gujrat districts. Among them, 196 (51.7%) were females and 183 (49.3%) were males. Mean age of the entire study population was 7.90±1.60 years, with children having normal feet and flatfoot showing mean ages of 7.45±1.29 years and 7.21±1.85 years, respectively.

The majority of participants hailed from urban areas, constituting 226 (59.6%). Regarding weight distribution, the largest proportion fell within the normal weight category, accounting for 203 (53.6%) children, and only 8 (2.1%) children were classified as obese (Table I).

Among the 379 participants, 242 (63.9%) had flatfoot, while 137 (36.1%) had normal foot arches. Table II presents the gender, demographic and BMI distribution among children categorized by foot type. In the Normal Feet group (n=137), majority (56.9%) are females and among those with flatfoot (n=242), majority (51.24%) are males. Regarding residence, majority of those with Normal Feet (n=79/137; 57.7%) and flatfoot group (n=147/242; 60.74%) were residing in urban areas. The distribution of BMI categories across both groups showed that majority were having normal weight in children with Normal Feet (52.56%) and flatfoot (54.13%). The medial arch of the foot was more pronounced in flat-footed normal-weight participants than in normal-weight individuals with both normal and flatfoot, including overweight normal feet and flatfoot, as well as underweight and obese normal feet and flatfoot.

Our findings revealed that males with flatfoot exhibited a higher medial arch compared to those with normal feet, a trend similarly observed in females. This elevation was more pronounced in urban males and females with flatfoot than their normal-footed counterparts.

Analyzing BMI categories, individuals with flatfoot and normal weight had a more prominent medial arch than those with normal feet, in contrast to overweight individuals, where no significant difference was noted between normal and flatfoot. Additionally, underweight individuals with flatfoot exhibited a higher medial arch compared to those with normal feet, as well as compared to underweight or obese individuals with both normal and flatfoot.

Our analysis of different variables, including gender, residence, and BMI in relation to the medial arch of the foot, showed non-significant associations ($p> 0.05$) based on Table III. Despite the lack of statistical significance, a slight positive association was noted according to Spearman correlation coefficient.

DISCUSSION

Our study of 379 children with flatfoot from Jhelum and Gujrat districts revealed demographic variations, with predominant females 51.7% and 49.3% males and urban residents 59.6%. The majority fell into the normal weight category (53.6%), with only 2.1% classified as obese. flatfoot were present in 63.9% of participants. Analyzing gender, residence, and BMI in relation to foot type, we observed higher medial arches in males and females with flatfoot, particularly in urban areas. Notably, flat-footed individuals with normal weight displayed more pronounced medial arches than their normal-footed counterparts, especially compared to overweight individuals.

While there is limited data on the prevalence of flatfoot in children, our findings show slight discrepancies compared to earlier research. Echarri and Forriol[21] reported a flatfoot prevalence of 70% in 3- and 4-year-old children and 40% in 5- to 8-year-olds. Lin et al.,[22] observed a decrease from 57% in 2- to 3-year-olds to 21% in 5- to 6-year-olds. Sachithanandam V and Joseph B [23] found a prevalence of 14.9% at 6 years and 9.1% at 7 years, while Rose G, et al.,[24] focused on footprint measurements. In our study, we employed the flatfoot angle as a criterion for assessment.

While footprint metrics are commonly utilized to define foot form, concerns have been raised about the influence of body composition on these measurements, particularly in children. In this age group, a medial pressure pattern is often observed, which may not necessarily indicate any issues. The accuracy of footprint methods in characterizing the longitudinal arch has been questioned by several scholars. The assessment of flatfoot in children commonly considers the flatfoot valgus during weight bearing. Our findings in the 6-year-old group align with Sobel et al.,[25] showing a decline in the flatfoot angle with age, reaching a peak of 4° valgus at 7 years. The medial arch undergoes improvement with age, notably rapid up to six years, gradual up to ten years, and then stabilizing without significant development.[26]

In our study, boys displayed a significantly higher prevalence of flatfoot compared to girls, with flatfoot observed in 51.24% of boys and 43.1% of girls. Our study results align with the findings of Jananh SM,[27] indicating a higher prevalence of flatfoot in males compared to females. Across all age groups, boys consistently exhibited a greater incidence of flatfoot valgus than girls. Moreover, a significant difference in the advancement of flatfoot valgus was noted in the studied sample, indicating a one-year delay in boys compared to girls when assessing different age groups.

flatfoot are more prevalent in normal-weight children than in obese children, as indicated by previous research,[23] and our results are in line with these findings. Studies suggest that flat-footedness is up to three times more common in underweight and normal-weight children compared to obese and

overweight children. Dowling et al.,[28] propose that obesity can lead to structural anomalies, including a flattening of the longitudinal arch, although it remains unclear whether these changes are reversible or if obese children will encounter foot problems later in life.

The majority of youngsters who did not meet the diagnostic criteria for a pathological flatfoot were provided with arch supports. Rear foot valgus of 20° or a rigid flatfoot was observed in less than 1% of cases among our pupils. The necessity of orthopedic therapy for physiological flatfoot remains debated. While arch supports and corrective shoes have been traditional treatments for flatfoot, recent research suggests their ineffectiveness.[29] Our findings align with the idea that physiological flatfoot tend to improve with age, and flexible flatfoot may not necessitate treatment, as proposed by others.[30] There is an association between wearing shoes and the development of flatfoot, according to Sachithanandam and Joseph.[23] The study suggests that children who wore shoes before the age of six had a higher prevalence of flatfoot than those who remained barefoot, possibly weakening intrinsic foot muscles and causing incorrect development of the medial arch during this crucial phase.

Children often find arch supports and corrective shoes inconvenient. The use of arch supports has not been shown to influence the development of the medial arch in flexible flatfoot; some authors even propose that arch supports may weaken foot muscles and exacerbate the condition. Treating children with physiological flatfoot has proven ineffective and imposes financial burdens on parents and healthcare professionals.[31] It is advised that children with a typical flexible flatfoot should not wear arch supports or corrective shoes. Based on the criteria utilized in this study, we recommend orthopedic treatment for children exhibiting symptomatic or pathological flatfoot; the optimal treatment approach should be tailored to the specific nature of the pathology.

CONCLUSION

Our study investigated the prevalence of flatfoot in 379 children aged 5 to 10 in Jhelum and Gujrat, Pakistan. We found that 63.9% had flatfoot, with a slight inclination in males and urban residents. While certain trends were noted, no statistically significant associations were observed in gender, residence, or BMI categories concerning the medial arch. However, our findings suggest that males, especially in urban areas, and individuals with flatfoot and normal weight exhibit a more pronounced medial arch. Although further research is needed, our study contributes valuable insights for local considerations and emphasizes the importance of tailored preventive measures for pediatric flatfoot.

RECOMMENDATIONS

The study explored BMI, age, and joint laxity's impact on flatfoot in school-aged children, yet omitted factors like race, gender, W-sitting, and shoe wear. Future research should delve into heredity, lifestyle choices, and longer-term follow-ups. This study highlights that younger children with excessive joint laxity are more prone to flatfoot than older children with typical joint laxity, suggesting a need for further exploration of additional factors contributing to pes planus. Recommendations include parental awareness programs, community health initiatives focusing on lifestyle and footwear, healthcare professional guidance for distinguishing physiological and pathological flatfoot, and policies integrating foot health assessments into routine pediatric examinations. Specialized footwear and orthopedic evaluations are crucial for children with symptomatic or pathological flatfoot.

LIMITATIONS

In our study, limitations include the use of a cross-sectional methodology, preventing the establishment of causal associations between variables. Additionally, confounding factors such as genetics and physical activity could influence outcomes. Conversely, the cited study emphasizes the likelihood of flatfoot in overweight children compared to underweight children but doesn't explicitly address the prospective design or explore confounding factors. Both studies share limitations related to cross-sectional analysis and the potential influence of confounding variables, advocating for future research to strengthen causal relationships and account for additional factors.

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AUTHOR'S CONTRIBUTION

Following authors have made substantial contributions to the manuscript as under:

NJ & FI: Concept and study design, drafting the manuscript, critical review, approval of the final version to be published

AR: Study design, analysis and interpretation of data, drafting the manuscript, approval of the final version to be published

SS: Acquisition, analysis and interpretation of data, drafting the manuscript, approval of the final version to be published

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICT OF INTEREST

Authors declared no conflict of interest, whether financial or otherwise, that could influence the integrity, objectivity, or validity of their research work.

GRANT SUPPORT AND FINANCIAL DISCLOSURE

Authors declared no specific grant for this research from any funding agency in the public, commercial or non-profit sectors

DATA SHARING STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request

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