Original Research https://doi.org/10.5281/zenodo.21105937

Volume 8, Issue 1, pp 25-37, June 2026

ACHIEVERS JOURNAL OF SCIENTIFIC RESEARCH

Opeen Access Publications of Achievers University, Owo

Available Online at www.achieversjournalofscience.org

Prevalence of Flatfoot and its Association with Foot Pain and Balance Performance among Secondary School Students in Owo, Nigeria

S.O. Bolarinde[1,2], O.N. Babalola[1], O.A. Adegoke[1], B.B. Ayodeji[1], C.P. Atere[1], B.D. Awobusuyi[1]

[1] Department of Physiotherapy, Federal Medical Centre, Owo, Ondo State, Nigeria
[2] Department of Physiotherapy, Achievers University, Owo, Ondo State, Nigeria

Corresponding author: oladayoBB@gmail.com

Submitted: February 2, 2026; **Revised:** April 20, 2026; **Accepted:** May 29, 2026; **Published:** June 30, 2026

Abstract

Flatfoot is a common variation in foot posture during childhood and adolescence, yet its clinical significance remains debated. Although often considered benign, persistent flatfoot has been associated with foot pain and impaired balance in some populations. Evidence from Nigerian adolescents is limited. This study aimed to determine the prevalence of flatfoot among junior secondary school students in Owo, Nigeria, and to examine its association with foot pain and balance performance. A cross-sectional study was conducted among 369 adolescents aged 10–15 years recruited from three secondary schools in Owo, Ondo State. Flatfoot was assessed using the Navicular Drop Test. Participants reporting foot pain completed a structured questionnaire. Static and dynamic balance were assessed using the Single-Leg Stance Test and the Tandem Walk Test, respectively. Data were analyzed using chi-square tests, Mann–Whitney U tests, and binary logistic regression with significance set at $p < 0.05$. The prevalence of flatfoot was 8.1% (95% CI: 5.3–10.9%), with a higher prevalence in males than females. Flatfoot was not a significant predictor of foot pain after adjusting for age, gender, and body mass index (OR = 1.34, 95% CI: 0.57–3.17; $p = 0.50$), and no significant differences were observed in static or dynamic balance performance between groups ($p > 0.05$). Flatfoot was relatively uncommon among adolescents in this population and showed no significant association with foot pain or balance performance, suggesting that it may represent a benign anatomical variation in this age group.

Keywords. Adolescents, Static Balance, Dynamic Balance, Medial Longitudinal Arch, Musculoskeletal Health.

1.0 Introduction

The human foot is a complex anatomical structure that plays a critical role in maintaining posture and balance, facilitating locomotion, and absorbing shock during weight-bearing activities (Hyong & Kang, 2016). The foot arches, supported by bones, ligaments, fascia, and the muscles of the foot help absorb shock and maintain stability during movement (Henry *et al*., 2019; Takata *et al*., 2013). However, the medial longitudinal arch is the primary determinant of foot morphology (Razeghi & Batt, 2002), and its collapse or absence known as flatfoot, results in the plantar surface of the foot making near-complete or complete contact with the ground while standing (Bordin *et al*., 2001). While flatfoot is often considered a normal variant in early childhood, its persistence into adolescence and adulthood can lead to altered biomechanics, reduced functional performance, and musculoskeletal discomfort (Pfeiffer *et al*., 2006).

Adolescence is a critical developmental window marked by rapid growth and biomechanical adaptation (Evans & Karimi, 2015). During this period, persistent flatfoot may contribute to balance deficits due to impaired foot-ground interaction, potentially increasing the risk of falls or musculoskeletal strain (Hrysomallis, 2011; Tenenbaum *et al*., 2013). Static balance, which refers to the body's ability to maintain postural stability while stationary, and dynamic balance, which involves stabilization during movement, both rely heavily on the structural integrity of the foot.[1] Flatfoot has been hypothesized to compromise these functions, although existing evidence is mixed (Adegoke *et al*., 2021; Kim *et al*., 2015).

Flatfoot is generally categorized into two distinct types: flexible flatfoot and rigid flatfoot. Flexible flatfoot is the more common and generally benign type, characterized by an arch that collapses during weight-bearing but reforms during non-weight-bearing positions. In contrast, rigid flatfoot is characterized by a consistently flattened arch that persists under both weight-bearing and non-weight-bearing conditions (Mosca, 2010). While many adolescents with flexible flatfoot do not experience symptoms, others may report intermittent foot pain, particularly following prolonged activity (Jannini *et al*., 2011; Mosca, 2010). This discomfort is frequently localized to the arch or heel and may negatively affect participation in sports, academic engagement, and quality of life (Buldt *et al*., 2013; Yeagerman *et al*., 2011). Nevertheless, the extent to which flatfoot independently contributes to pain and balance impairment remains unclear, with some studies reporting associations and others finding none (Abich *et al*., 2020; Alsuhaymi *et al*., 2019; Birhanu *et al*., 2023). In field-based epidemiological studies, flatfoot is often identified using clinical screening measures of medial longitudinal arch collapse, without differentiation between flexible and rigid forms.

Despite growing global interest in pediatric foot posture, there remains a paucity of data from Nigeria, particularly among adolescents in underserved communities. Most previous Nigerian studies have focused on younger children or have used different assessment protocols, limiting comparability and generalizability of findings. Furthermore, the relationship between flatfoot, foot pain, and balance performance has been insufficiently explored in this population. Therefore, this study investigated the prevalence of flatfoot among junior secondary school students in Owo, Nigeria, and examined its association with foot pain and balance performance, thereby addressing an important gap in the regional literature.

2.0 Materials and methods

2.1 Study Design and Setting

This cross-sectional study was conducted among junior secondary school students (JSS1–JSS3) aged 10-15 years in Owo, Ondo State, Nigeria. Data collection took place across three conveniently selected coeducational schools: Owo High School, Methodist High School, and Complete Child Development College, between January and March of 2025.

2.2 Participants

Eligible participants were apparently healthy adolescents aged 10–15 years enrolled in the selected schools. Inclusion required written parental consent for all participants, in addition to student assent. Students were excluded if they had congenital foot deformities (other than flatfoot), neurological or musculoskeletal conditions affecting gait or balance, or a history of major foot or knee trauma or surgery.

2.3 Sample Size Determination

Sample size was determined a priori using a single-proportion formula:

Where Z = 1.96, d = 0.05, and estimated prevalence p = 39.7% based on the study by Adegoke *et al*. (2021), the sample size was estimated to be 368. To allow for potential non-response, a total of 405 participants were targeted.

2.4 Sampling Technique

A multistage sampling approach was used:

- Stage 1. Convenience sampling of three junior secondary schools.
- Stage 2. Stratification by class (JSS1–JSS3) and gender.
- Stage 3. Proportional random sampling of an equal number of male and female students from each class stratum.

2.5 Data Collection Methods

Ethical approval and informed consent were obtained prior to data collection. Each assessment procedure was conducted by the same trained assessor using standardized procedures throughout the study.

2.6 Anthropometric Assessment

Height and weight were measured using a stadiometer and calibrated weighing scale, respectively, following standard procedures and BMI was calculated using:

2.6.1 Flatfoot Assessment

Flatfoot was assessed using the Navicular Drop Test, a validated method for detecting medial longitudinal arch collapse. The navicular height was measured in both subtalar neutral (non-weight-bearing) and relaxed standing (weight-bearing) positions. A navicular drop ≥10 mm in either foot was classified as flatfoot (Adegoke *et al*., 2021; Brody, 1982).

2.6.2 Foot Pain Assessment

Participants who reported experiencing foot pain in the preceding six months completed a structured questionnaire detailing the location, frequency, duration and intensity of their symptoms. These responses were used to describe general patterns of foot pain among participants with flatfoot.

2.6.3 Balance Performance Assessment

Static balance was evaluated using the Single-Leg Stance Test (SLST), as described by Adegoke *et al*. (2021). Participants performed the test barefoot to ensure accurate assessment of balance without the influence of footwear. Before performing the test, participants were familiarized with the procedure and practiced briefly to minimize the learning effect during the actual test. Participants stood on one leg with their arms crossed over the chest and their eyes open. The other limb was lifted off the ground, with the hip and knee flexed to 90 degrees. Timing began when the non-test limb is lifted and stopped upon loss of balance, ground contact by the elevated limb, or voluntary test termination. Three trials were performed on each leg, with 30-second rest intervals. The average time (in seconds) across trials was recorded (maximum = 30 seconds).

Dynamic balance was evaluated using the Tandem Walk Test (TWT). Participants performed a heel-to-toe walk, taking 10 barefoot steps along a straight line marked on the floor, under two conditions: eyes open and eyes closed. The number of consecutive correct steps taken before an error occurs was recorded as a measure of dynamic balance, with the test terminated upon stepping outside the marked line, stepping with a space between the feet, or opening the eyes during the eyes-closed test resulted in termination of the test. The number of correct steps was recorded for both eyes-open and eyes-closed attempts. The average number of correct steps across the two trials was used for analysis.

2.7 Statistical Analysis

Data were analyzed using IBM SPSS Statistics (version 21). Descriptive statistics were used to summarize the data: frequencies and percentages for the categorical variables and means and standard deviations for the continuous demographic variables. Chi-square tests were used to assess associations between flatfoot and gender, and between flatfoot and foot pain. Normality of the data distribution was assessed using the Shapiro-Wilk test. As the balance performance data (SLST and TWT scores) were not normally distributed ($p < 0.05$), Mann-Whitney U test was used to compare differences between participants with and without flatfoot. Binary logistic regression was conducted to determine whether flatfoot was a significant predictor of foot pain, adjusting for age, gender, and BMI. Statistical significance was set at $p < .05$ for all analyses.

3.0 Results

A total of 369 adolescents aged 10 to 15 (Mean ± SD = 12.48 ± 1.23) years were included in the final analysis. The participants presented with a mean Body Mass Index (BMI) of 17.5 kg/m², and their anthropometric characteristics (height and weight) showed a distribution consistent with the study's age range. A detailed summary of the participants' demographic characteristics is presented in Table 1.

Table 1. Descriptive Statistics of Age, Height, Weight, and BMI (N = 369).

Variable	Mean	SD	Min	Max
Age (years)	12.48	1.23	10	15
Height (cm)	145.79	10.29	100	178
Weight (kg)	37.46	8.09	15.70	70.70
BMI (kg/m²)	17.48	2.43	12.45	30.60

Key: SD: Standard Deviation; BMI: Body Mass Index; Min: Minimum; Max: Maximum

Table 2 presents the distribution of gender, flatfoot prevalence, and foot pain characteristics. The study population comprised 181 males (49.1%) and 188 females (50.9%). The overall prevalence of flatfoot was 8.13% (n = 30; 95% CI: 5.3% – 10.9%). Among the participants with flatfoot, 26.7% (n = 8) reported experiencing foot pain within the preceding six months. The most frequently reported pain location was the heel, followed by the arch, with most participants reporting occasional pain lasting only a few minutes. The average pain intensity score was 5.1 ± 2.0 on the Visual Analog Scale (0–10).

Table 2. Descriptive Summary of Gender Distribution, Flatfoot Prevalence, and Foot Pain Patterns (N = 369).

Variable	Frequency	Percentage (%)
Gender		
Male	181	49.1
Female	188	50.9
Flatfoot Status		
Flatfoot Present	30	8.1
Flatfoot Absent	339	91.9
Foot Pain Status (in flatfoot group)		
Reported Pain	8	26.7
No Pain	22	73.3

Foot Pain Location (n = 8)		
Arch	2	25.0
Heel	3	37.5
Forefoot	1	12.5
Toes	1	12.5
Others	1	12.5
Foot Pain Frequency (n = 8)		
Daily	1	12.5
Weekly	1	12.5
Monthly	1	12.5
Occasionally	5	62.5
Foot Pain Duration (n = 8)		
Few minutes	6	75.0
Few hours	2	25.0
Pain Intensity	Mean = 5.1	S.D = 2.0

Note: Percentages for Pain Location, Frequency, and Duration are calculated based on the sub-sample of participants reporting pain (n = 8)

The relationship between flatfoot prevalence, gender, and foot pain is presented in Table 3. A statistically significant association was observed between gender and flatfoot ($\chi^2 = 4.06$, $p = 0.04$). Males exhibited a higher prevalence of flatfoot (11.1%, n = 20) compared to females (5.3%, n = 10). Conversely, the presence of flatfoot was not significantly associated with reported foot pain ($\chi^2 = 0.60$, $p = 0.44$). Although a slightly higher proportion of participants with flatfoot reported pain (26.7%) compared to those with normal arches (20.7%), this difference did not reach statistical significance.

Table 3: Association between Flatfoot Prevalence, Gender, and Foot Pain (N = 369)

Variable	Flatfoot Present (n = 30)	Flatfoot Absent (n = 339)	χ^2 Value	p-value
Gender			4.06	0.04*
Male	20 (11.1%)	161 (88.9%)		
Female	10 (5.3%)	178 (94.7%)		
Foot Pain			0.60	0.44
Reported Pain	8 (26.7%)	70 (20.7%)		
No pain	22 (73.3%)	269 (79.4%)		

*: significant at $P = .05$

Table 4 compares the static and dynamic balance performance between participants with and without flatfoot. As the balance data were not normally distributed, the Mann-Whitney U test was used to assess differences. Participants in both groups exhibited high static stability, with a median single-leg stance time of 30 seconds for both limbs. Dynamic balance performance was also comparable between groups; no statistically significant differences were observed in the Tandem Walk Test under either eyes-open ($p = 0.19$) or eyes-closed ($p = 0.99$) conditions.

Table 4: Comparison of Median Balance Scores between Flatfoot and Non-Flatfoot Groups

Variable	Flatfoot Present Median (IQR)	Flatfoot Absent Median (IQR)	p-value *(Mann-Whitney U)*
SLSRt (sec)	30 (5.25)	30 (7.16)	0.81
SLSLt (sec)	30 (1.76)	30 (2.19)	0.67
TWTOpen (steps)	10 (0)	10 (0)	0.19
TWTClosed (steps)	3 (2)	3 (3)	0.99

Note: SLSRt = Single-Leg Stance Test (right leg); SLSLt = Single-Leg Stance Test (left leg); TWTOpen = Tandem Walk Test (eyes open); TWTClosed = Tandem Walk Test (eyes closed).

A binary logistic regression analysis was conducted to ascertain if flatfoot significantly predicted the presence of foot pain when adjusting for age, gender, and BMI. The overall model was not statistically significant ($p > 0.05$). As detailed in Table 5, none of the included variables emerged as significant independent predictors. Specifically, the presence of flatfoot did not significantly increase the odds of reporting foot pain (OR = 1.34; 95% CI: .57–3.17; $p = 0.50$) after controlling for confounders.

Table 5: Binary Logistic Regression Predicting Foot Pain.

Variable	B	Standard Error	Wald	df	p-value	Odds Ratio (95% CI)
Flatfoot	0.29	0.44	0.45	1	0.50	1.34 (0.57-3.17)
Age	0.07	0.11	0.46	1	0.50	1.07 (0.87-1.32)
Gender	-0.16	0.26	0.35	1	0.56	0.86 (0.51-1.44)
BMI	-0.05	0.05	0.80	1	0.37	0.95 (0.86-1.06)

4.0 Discussion

This study investigated the prevalence of flatfoot and its association with foot pain and balance performance among junior secondary school students in Owo, Nigeria. The findings revealed a relatively low prevalence of flatfoot in the study population, with males demonstrating a significantly higher prevalence than females. Although some participants with flatfoot reported foot pain, no significant associations were observed between flatfoot and foot pain or balance performance. These findings suggest that flatfoot in this adolescent population may not necessarily be associated with functional impairment or discomfort.

The observed flatfoot prevalence was 8.1%, which is relatively low compared to findings from previous Nigerian studies. For example, Adegoke *et al*. reported a 39.7% prevalence among students aged 10–14 years in Ibadan, while Ezema *et al*. reported 22.4% in 6–10-year-olds in Enugu (Adegoke *et al*., 2021; Ezema *et al*., 2014). However, our finding aligns more closely with Ibeabuchi *et al*. (13.5%) and Chibuzom *et al*. (15.7%), as well as international studies such as Chou *et al*. in Taiwan (13.9%) (Chibuzom *et al*., 2022; Chou *et al*., 2009; Ibeabuchi *et al*., 2020). The wide variation in global prevalence estimates, ranging from 17.1% to 59% (Alsuhaymi *et al*., 2019; Chang *et al*., 2010; Pfeiffer *et al*., 2006; Sadeghi-Demneh *et al*., 2015), is consistently attributed in the literature to differences in diagnostic criteria, participant age ranges, and population characteristics.

One key contributor to this variability is the use of different assessment methods (Giuca *et al*., 2025). Unlike this study, which employed the navicular drop method (a clinical measure of midfoot mobility), some of the aforementioned investigations utilized footprint-based techniques with varying protocols (Abolarin *et al*., 2011; Ezema *et al*., 2014; Pfeiffer *et al*., 2006). Footprint analysis often yields higher prevalence rates because it captures surface contact area, which can be influenced by soft tissue rather than skeletal alignment, potentially overestimating flatfoot in healthy children (Mickle *et al*., 2006; Volpon, 1994). This methodological distinction likely contributes to the lower prevalence observed in our cohort compared to studies using footprint indices. Furthermore, the specific demographic context of Owo, a semi-urban community, may play a protective role. It has been suggested that children in rural or semi-urban settings, who engage in more barefoot walking or use open footwear, often exhibit better arch development compared to urban counterparts who wear enclosed, supportive shoes more frequently (Abolarin *et al*., 2011). This combination of a stricter diagnostic tool and environmental factors likely explains the lower prevalence rates found in this study.

A significant finding of this study was the association between gender and flatfoot. Males exhibited a significantly higher prevalence of flatfoot (11.1%) compared to females (5.3%). This aligns with several previous studies that have reported a male predominance in flatfoot prevalence (Abich *et al*., 2020; Birhanu *et al*., 2023; Chang *et al*., 2010; Ezema *et al*., 2014; Pfeiffer *et al*., 2006). This gender disparity is frequently attributed to developmental differences; specifically, boys may experience delayed maturation of the rear foot and greater valgus alignment, which can impede timely arch formation compared to girls (Ezema *et al*., 2014). In contrast, studies such as Eluwa *et al*. have found a higher prevalence among adult females (Eluwa *et al*., 2008), suggesting that the gender dynamic may reverse in adulthood due to factors such as pregnancy-related ligament laxity and cumulative weight-bearing stress (Mickle *et al*., 2006; Ojukwu *et al*., 2017; Volpon, 1994).

Although flatfoot in adolescents is often asymptomatic, it can sometimes be associated with pain, altered gait, or reduced physical activity, especially in the presence of risk factors such as obesity, Achilles tightness, joint hypermobility, or inappropriate footwear (Giuca *et al*., 2025; Minaie *et al*., 2020; Mosca, 2010; Tanos, 2020). In terms of symptoms, fewer than one-third of adolescents with flatfoot in this study reported foot pain, and statistical analysis revealed no significant association between flatfoot and foot pain. Logistic regression further confirmed that flatfoot was not a significant predictor of pain after adjusting for age, gender, and BMI. These results are consistent with Alsuhaymi *et al*., who also found no significant association between foot pain and flatfoot in Saudi Arabian children (Alsuhaymi *et al*., 2019). This supports the prevailing view that flatfoot in adolescents is often a benign anatomical variant, with symptoms more likely arising only when compounded by additional factors such as obesity or overuse (Giuca *et al*., 2025; Mosca, 2010; Ueki *et al*., 2019). In contrast, studies by Abich *et al*., Birhanu *et al*., and Dabholkar and Agarwal reported stronger pain associations (Abich *et al*., 2020; Birhanu *et al*., 2023; Dabholkar & Agarwal, 2020). These inconsistencies may stem from differences in participant selection, obesity prevalence, or exclusion criteria. Unlike our study which excluded participants reporting foot pain linked to previous injuries, their methodologies may not have filtered out such confounding factors, potentially inflating the association.

Regarding balance, our study found no significant differences in either static or dynamic balance between students with and without flatfoot. Participants in both groups achieved high median scores on the Single-Leg Stance Test, indicating a generally high level of postural stability in this age group. This may also reflect a potential ceiling effect of the balance measures used, which could limit their sensitivity in detecting subtle differences in postural control among healthy adolescents. This contrasts with Adegoke *et al*., who reported impaired static balance in adolescents with flatfoot (Adegoke *et al*., 2021). Our findings may reflect the adaptive neuromuscular strategies often seen in adolescents, which preserve balance. Kim *et al*. showed that flatfooted adolescents often exhibit compensatory muscle activation to maintain postural control (Kim *et al*., 2015). Overall, our findings support the view that mild flatfoot does not substantially impair postural function in adolescents (Mosca, 2010).

5.0 Clinical Implications of the Study

Routine intervention for adolescents with asymptomatic flatfoot may not be necessary, particularly in the absence of pain or functional limitations. Clinical management should therefore emphasize individualized assessment and prioritize adolescents presenting with symptoms or additional risk factors such as obesity, joint hypermobility, or gait abnormalities. Screening approaches in schools and healthcare settings may be more effective when focused on functional complaints rather than foot posture alone. In addition, adolescents with flatfoot should not be unnecessarily restricted from physical education or sports participation solely on the basis of arch morphology. Further longitudinal studies with larger sample sizes and more comprehensive biomechanical profiling are recommended to establish the long-term clinical significance of adolescent flatfoot.

6.0 Study Limitations

The cross-sectional design precludes causal inferences between flatfoot and the functional outcomes examined. The use of a convenience sampling approach may also limit the generalizability of the findings to the wider adolescent population. We did not differentiate between rigid and flexible flatfoot because the study protocol focused on screening for reduced medial longitudinal arch height rather than performing a detailed clinical classification of flatfoot type. In addition, the balance tests employed (Single-Leg Stance Test and Tandem Walk Test) may have limited sensitivity for detecting subtle postural control differences in healthy adolescents. Additionally, we were unable to control for potential confounding variables such as footwear history, socioeconomic status, and pubertal stage, which have been suggested to influence foot morphology. Also, the relatively low prevalence of flatfoot observed in our sample (8.1%) yielded a small subgroup of affected participants. This reduced sample size may have limited the statistical power to detect subtle associations with foot pain.

7.0 Conclusion

Flatfoot was present in 8.1% of the adolescents in this study, with a significantly higher prevalence observed in males compared to females. Although some participants with flatfoot reported foot pain, no significant association was found between flatfoot and foot pain after adjusting for age, gender, and BMI. In addition, flatfoot was not associated with impairments in static or dynamic balance performance. These findings suggest that reduced medial longitudinal arch height identified using the navicular drop test may not necessarily result in functional limitations or pain in adolescents. Consequently, routine intervention for asymptomatic flatfoot may not be necessary. Clinical attention should instead focus on adolescents presenting with pain or additional risk factors such as obesity or joint hypermobility.

Declarations

Funding

This research received no specific grant or funding.

Author contributions

Conceptualization, B.S.O. and B.O.N.; Methodology, A.O.A., A.C.P., A.B.D. and A.B.B.; Validation, B.S.O. and B.O.N.; Formal Analysis, B.O.N.; Investigation, A.O.A., A.C.P., A.B.D. and A.B.B.; Data Curation, A.C.P., A.B.D. and A.B.B.; Writing - Original Draft Preparation, B.O.N.; Writing - Review & Editing, B.S.O., B.O.N., A.O.A., A.C.P., A.B.D. and A.B.B.; Supervision, B.S.O.; Project Administration, B.O.N. All authors have read and approved the final version of the manuscript.

Conflicts of interest

The authors declare no competing interests.

Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval

All subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Health Research Ethics Committee of the Federal Medical Centre, Owo, Nigeria (FMCOWO/HREC/2025/11).

References

1. Abich, Y., Mihiret, T., Akalu, T. Y., Gashaw, M., & Janakiraman, B. (2020). Flatfoot and associated factors among Ethiopian school children aged 11 to 15 years: A school-based study. *PLOS ONE*, *15*(8), e0238001. https://doi.org/10.1371/journal.pone.0238001
2. Abolarin, T., Aiyegbusi, A., Tella, A., & Akinbo, S. (2011). Predictive factors for flatfoot: The role of age and footwear in children in urban and rural communities in South West Nigeria. *The Foot*, *21*(4), 188–192. https://doi.org/10.1016/j.foot.2011.07.002
3. Adegoke, B. I., Alumona, C. J., Adeyemo, A. A., & Adeyinka, A. O. (2021). Flatfoot and balance performance among junior secondary school students in Ibadan, Nigeria. *New Zealand Journal of Physiotherapy*, *49*(2), 82–88. https://doi.org/10.15619/NZJP/49.2.04
4. Alsuhaymi, A. M., Almohammadi, F. F., Alharbi, O. A., Alawfi, A. H., Olfat, M. M., Alhazmi, O. A., & Khoshhal, K. I. (2019). Flatfoot among school-age children in Almadinah Almunawwarah: Prevalence and risk factors. *Journal of Musculoskeletal Surgery and Research*, *3*, 204. https://doi.org/10.4103/jmsr.jmsr_89_18
5. Birhanu, A., Nagarchi, K., Getahun, F., Gebremichael, M. A., & Wondmagegn, H. (2023). Magnitude of flat foot and its associated factors among school-aged children in Southern Ethiopia: An institution-based cross-sectional study. *BMC Musculoskeletal Disorders*, *24*(1), 966. https://doi.org/10.1186/s12891-023-07082-6

6. Bordin, D., De Giorgi, G., Mazzocco, G., & Rigon, F. (2001). Flat and cavus foot, indexes of obesity and overweight in a population of primary-school children. *Minerva Pediatrica*, *53*(1), 7–13.
7. Brody, D. M. (1982). Techniques in the evaluation and treatment of the injured runner. *The Orthopedic Clinics of North America*, *13*(3), 541–558. https://doi.org/10.1016/s0030-5898(20)30252-2
8. Buldt, A. K., Murley, G. S., Butterworth, P., Levinger, P., Menz, H. B., & Landorf, K. B. (2013). The relationship between foot posture and lower limb kinematics during walking: A systematic review. *Gait & Posture*, *38*(3), 363–372. https://doi.org/10.1016/j.gaitpost.2013.01.010
9. Chang, J.-H., Wang, S.-H., Kuo, C.-L., Shen, H. C., Hong, Y.-W., & Lin, L.-C. (2010). Prevalence of flexible flatfoot in Taiwanese school-aged children in relation to obesity, gender, and age. *European Journal of Pediatrics*, *169*(4), 447–452. https://doi.org/10.1007/s00431-009-1050-9
10. Chibuzom, C. N., Egele, C. S., & Ndukwu, C. U. (2022). The prevalence of flat foot among school-aged children in a Nigerian population. *Tropical Journal of Medical Research*, *21*(1), 113–120. https://doi.org/10.5281/zenodo.6970370
11. Chou, L.-W., Chen, F.-F., Lo, S.-F., Yang, P.-Y., MengNai-Hsin, N.-H., Lin, C.-L., Liao, F.-Y., & Kao, M.-J. (2009). The prevalence of four common pathomechanical foot deformities in primary school students in Taichung county (Pt 1-9). *Mid Taiwan Journal of Medicine*, *14*(1).
12. Dabholkar, T., & Agarwal, A. (2020). Quality of Life in Adult Population with Flat Feet. *International Journal of Health Sciences and Research*, *10*(2), 193–200.
13. Eluwa, M. A., Omini, R. B., Kpela, T., Ekanem, T. B., & Akpantah, A. O. (2008). The Incidence of Pes planus amongst Akwa Ibom State students in the University of Calabar. *The Internet Journal of Forensic Science*, *3*(2). https://ispub.com/IJFS/3/2/5228
14. Evans, A. M., & Karimi, L. (2015). The relationship between paediatric foot posture and body mass index: Do heavier children really have flatter feet? *Journal of Foot and Ankle Research*, *8*(1), 46. https://doi.org/10.1186/s13047-015-0101-x
15. Ezema, C. I., Abaraogu, U. O., & Okafor, G. O. (2014). Flat foot and associated factors among primary school children: A cross-sectional study. *Hong Kong Physiotherapy Journal*, *32*(1), 13–20. https://doi.org/10.1016/j.hkpj.2013.05.001
16. Giuca, G., Marletta, D. A., Zampogna, B., Sanzarello, I., Nanni, M., & Leonetti, D. (2025). Correlation between the severity of flatfoot and risk factors in children and adolescents: A Systematic Review. *Osteology*, *5*(2). https://doi.org/10.3390/osteology5020011
17. Henry, J. K., Shakked, R., & Ellis, S. J. (2019). Adult-Acquired Flatfoot Deformity. *Foot & Ankle Orthopaedics*, *4*(1), 2473011418820847. https://doi.org/10.1177/2473011418820847
18. Hrysomallis, C. (2011). Balance ability and athletic performance. *Sports Medicine*, *41*(3), 221–232. https://doi.org/10.2165/11538560-000000000-00000
19. Hyong, I. H., & Kang, J. H. (2016). Comparison of dynamic balance ability in healthy university students according to foot shape. *Journal of Physical Therapy Science*, *28*(2), 661–664. https://doi.org/10.1589/jpts.28.661
20. Ibeabuchi, M., Obun, C., Olabiyi, O., Oluwabusola, E., & Adebayo, A. (2020). Prevalence of flat foot among 6 -15 Year Old Nigerian school children resident in Lagos. *Journal of Anatomical Sciences*, *11*(2). https://www.asnng.com/journal/article/1602717324

21. Jannini, S. N., Dória-Filho, U., Damiani, D., & Silva, C. A. A. (2011). Musculoskeletal pain in obese adolescents. *Jornal de Pediatria*, *87*, 329–335. https://doi.org/10.2223/JPED.2111
22. Kim, J., Lim, O., & Yi, C. (2015). Difference in static and dynamic stability between flexible flatfeet and neutral feet. *Gait & Posture*, *41*(2), 546–550. https://doi.org/10.1016/j.gaitpost.2014.12.012
23. Mickle, K. J., Steele, J. R., & Munro, B. J. (2006). The Feet of Overweight and Obese Young Children: Are They Flat or Fat? *Obesity,* 4(11), 1949-1953 https://doi.org/10.1038/oby.2006.227
24. Minaie, A., Shlykov, M., Hosseinzadeh, P., & Mosca, V. (2020). Painful Flatfoot in Children and Adolescents: They're Not All the Same. *Journal of the Pediatric Orthopaedic Society of North America*, *2*(2), 112. https://doi.org/10.55275/JPOSNA-2020-112
25. Mosca, V. S. (2010). Flexible flatfoot in children and adolescents. *Journal of Children's Orthopaedics*, *4*(2), 107–121. https://doi.org/10.1007/s11832-010-0239-9
26. Ojukwu, C. P., Anyanwu, E. G., & Nwafor, G. G. (2017). Correlation between Foot Arch Index and the Intensity of Foot, Knee, and Lower Back Pain among Pregnant Women in a South-Eastern Nigerian Community. *Medical Principles and Practice*, *26*(5), 480–484. https://doi.org/10.1159/000481622
27. Pfeiffer, M., Kotz, R., Ledl, T., Hauser, G., & Sluga, M. (2006). Prevalence of flat foot in preschool-aged children. *Pediatrics*, *118*(2), 634–639. https://doi.org/10.1542/peds.2005-2126
28. Razeghi, M., & Batt, M. E. (2002). Foot type classification: A critical review of current methods. *Gait & Posture*, *15*(3), 282–291. https://doi.org/10.1016/S0966-6362(01)00151-5
29. Sadeghi-Demneh, E., Jafarian, F., Melvin, J. M. A., Azadinia, F., Shamsi, F., & Jafarpishe, M. (2015). Flatfoot in school-age children: Prevalence and associated factors. *Foot & Ankle Specialist*, *8*(3), 186–193. https://doi.org/10.1177/1938640015578520
30. Takata, Y., Matsuoka, S., Okumura, N., Iwamoto, K., Takahashi, M., & Uchiyama, E. (2013). Standing balance on the ground—The influence of flatfeet and insoles. *Journal of Physical Therapy Science*, *25*(12), 1519–1521. https://doi.org/10.1589/jpts.25.1519
31. Tanos, B. (2020). Asymptomatic Flexible Flatfoot. https://hdl.handle.net/20.500.12512/107132
32. Tenenbaum, S., Hershkovich, O., Gordon, B., Bruck, N., Thein, R., Derazne, E., Tzur, D., Shamiss, A., & Afek, A. (2013). Flexible pes planus in adolescents: Body mass index, body height, and gender—An epidemiological study. *Foot & Ankle International*, *34*(6), 811–817. https://doi.org/10.1177/1071100712472327
33. Ueki, Y., Sakuma, E., & Wada, I. (2019). Pathology and management of flexible flat foot in children. *Journal of Orthopaedic Science*, *24*(1), 9–13. https://doi.org/10.1016/j.jos.2018.09.018
34. Volpon, J. B. (1994). Footprint analysis during the growth period. *Journal of Pediatric Orthopaedics*, *14*(1), 83.
35. Yeagerman, S. E., Cross, M. B., Positano, R., & Doyle, S. M. (2011). Evaluation and treatment of symptomatic pes planus. *Current Opinion in Pediatrics*, *23*(1), 60. https://doi.org/10.1097/MOP.0b013e32834230b2