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Implications of Footwear on Joint Hypermobility of the Foot: A Biomechanical Analysis

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Abstract

Background: Evidence regarding the relationship between footwear characteristics, foot–ankle flexibility, lower-limb hypermobility, and foot posture in children remains limited. **Objective:** To examine the association between habitual footwear type and foot–ankle flexibility, lower-limb hypermobility, and foot posture in school-aged children. **Methods:** A cross-sectional study included 165 children aged 4–13 years. Habitual footwear was classified as physiological, conventional, or foot-friendly based on structural characteristics and parental confirmation. Foot–ankle flexibility, lower-limb hypermobility, and foot posture were assessed bilaterally using the Foot and Ankle Flexibility Index (FAFI), Lower Limb Assessment Score (LLAS), and Foot Posture Index (FPI-6), respectively. Mean bilateral scores were analyzed using general linear models adjusted for age. **Results:** Eight participants (4.8%) wore physiological footwear, 66 (40.0%) conventional footwear, and 91 (55.2%) foot-friendly footwear. Age differed significantly across footwear groups ($p = 0.004$), whereas BMI did not ($p = 0.331$). After adjustment for age, footwear category was not significantly associated with FAFI ($p = 0.056$), LLAS ($p = 0.383$), or FPI-6 ($p = 0.489$). Age was significantly associated with FAFI and LLAS (both $p < 0.001$), but not with FPI-6 ($p = 0.855$). **Conclusions:** Footwear category was not significantly associated with foot–ankle flexibility, lower-limb hypermobility, or foot posture after adjustment for age. These findings highlight the importance of accounting for age in pediatric studies and do not support causal or therapeutic conclusions regarding footwear.

Keywords: foot; footwear; joint hypermobility; biomechanics; paediatrics

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1. Introduction

Joint hypermobility is characterized by a range of motion exceeding that expected in one or more joints and may occur as a physiological trait or in association with connective tissue disorders [1,2]. Although frequently asymptomatic, joint hypermobility may be associated with instability, pain, increased susceptibility to injury, and functional impairment [3,4]. In the lower limbs, joint hypermobility can be assessed using instruments such as the Lower Limb Assessment Score (LLAS), originally developed by Ferrari et al. [5]. Foot-specific assessments include the Foot and Ankle Flexibility Index (FAFI), developed by Martínez-Sebastián et al. [6] to assess foot and ankle flexibility and hypermobility, and the Foot Posture Index (FPI-6), developed by Redmond et al. [7] to evaluate static foot posture.

The foot comprises multiple joints and ligamentous structures that contribute to stability, load distribution, and gait. Increased joint mobility may be associated with changes in alignment, movement control, and plantar loading patterns [8,9]. Consequently, combining

measures of lower-limb hypermobility, foot–ankle flexibility, and foot posture may provide complementary information regarding different aspects of foot and lower-limb function [9].

Footwear represents an external factor capable of modifying the mechanical environment in which the foot functions. Characteristics such as sole flexibility, heel-to-toe drop, toe-box dimensions, cushioning, and structural support may influence gait and plantar loading [10,11]. In children, footwear has been shown to modify several gait parameters compared with barefoot walking. However, the extent to which different footwear characteristics are associated with foot–ankle flexibility, lower-limb hypermobility, or foot posture remains unclear [10].

Existing literature has largely examined joint hypermobility and footwear separately. Studies have investigated the relationship between ligamentous laxity and functional or loading characteristics [8,12], while others have examined the biomechanical effects of footwear [10,11]. Evidence specifically examining whether habitual footwear characteristics are associated with clinical measures of foot–ankle flexibility, lower-limb hypermobility, and foot posture remains limited, particularly in pediatric populations. In children and adolescents with joint hypermobility, podiatric interventions have also been investigated in relation to pain and quality of life [13].

Childhood is a period of ongoing musculoskeletal development in which joint mobility and lower-limb characteristics may vary with age [9]. This is particularly relevant when studying hypermobility, as its clinical presentation and assessment in pediatric populations require age-related considerations [9]. In addition, footwear represents an external factor capable of modifying functional parameters during gait in children [10]. Therefore, age is an important potential confounding factor when investigating relationships between footwear characteristics and foot and lower-limb measures across a broad pediatric age range.

Therefore, the aim of this study was to examine the association between habitual footwear type and foot–ankle flexibility, lower-limb hypermobility, and foot posture in school-aged children using validated clinical assessment instruments.

2. Materials and Methods

2.1. Study Design

An observational, analytical, cross-sectional study was conducted to examine the association between habitual footwear type and foot–ankle flexibility, lower-limb hypermobility, and foot posture in children aged 4–13 years. The cross-sectional design allowed these variables to be assessed at a single time point and associations between footwear categories and clinical outcomes to be explored without implying causal relationships.

2.2. Participants and Procedure

The study was conducted between June and July 2025 during regular school hours at a private school located in Lomas de Chapultepec, Mexico City, Mexico. Approximately 380 schoolchildren enrolled at the participating school were invited to participate. Written informed consent was obtained from the parents or legal guardians of 185 children, who were subsequently assessed for eligibility. Sixteen children were excluded because they presented medical conditions or were receiving treatments that could potentially affect musculoskeletal function, and four additional participants were excluded because of incomplete data. Consequently, 165 schoolchildren aged 4–13 years were included in the final statistical analyses.

Participants were recruited using a non-probability convenience sampling approach. No formal sample size calculation was performed, and the final sample consisted of all eligible schoolchildren whose parents or legal guardians provided written informed consent during the recruitment period. Given the single-center, non-probability sampling approach,

the representativeness of the sample regarding the general pediatric population cannot be assumed.

Eligibility criteria were predefined to ensure a clinically appropriate and relatively homogeneous study population and are summarized in Table 1.

Table 1. Inclusion and exclusion criteria of the study participants.

Participant Inclusion Criteria	Participant Exclusion Criteria
Age withing the range established by the study (4–13 years).	Neurological, rheumatological, or musculoskeletal conditions affecting foot or lower limb mobility.
Ability to stand and walk without assistive devices.	History of foot, ankle, or knee surgery in the past 12 months.
Habitual use of footwear classifiable as physiological, conventional, or foot-friendly.	Recent ankle sprain, fracture, or traumatic injury (<3 months).
Absence of acute pain at the time of evaluation.	Habitual use of orthopaedic footwear intended to treat a foot condition.
Written informed consent provided by a parent or legal guardian.	Inability to properly complete the assessment tests.

Given the potential influence of age on joint mobility and foot characteristics during musculoskeletal development, age was considered a potential confounding variable and was included as a covariate in the adjusted statistical analyses.

Participants' habitual footwear was classified into three categories: physiological, conventional, and foot-friendly footwear. Physiological footwear included models designed to partially accommodate natural foot biomechanics, characterized by moderately flexible soles, low heel-to-toe drop, and a relatively wide toe box. Conventional footwear included models presenting one or more structural characteristics such as relatively rigid soles, higher heel-to-toe drop, narrower toe boxes, rigid heel counters, or non-removable insoles. Foot-friendly footwear was characterized by highly flexible soles, zero or minimal heel-to-toe drop, a wide toe box, absence of rigid heel counters, and a lightweight design allowing relatively unrestricted foot movement.

Footwear classification was based on direct inspection of the shoes worn by each child on the day of assessment. Parents or legal guardians were asked to confirm that the assessed footwear was representative of the type habitually worn by the child. They were also asked about footwear replacement frequency and reported that shoes were generally replaced every 3–5 months, or earlier when worn or damaged. These categories were operationally defined according to the structural and biomechanical characteristics of the footwear and should not be interpreted as classifications of footwear quality or as therapeutic versus non-therapeutic footwear. None of the categories represented orthopaedic or therapeutic footwear prescribed for the treatment of a specific foot condition.

The data collection procedure began with the recording of basic sociodemographic characteristics and habitual footwear type. Subsequently, bilateral assessments were performed using the FAFI, LLAS, and FPI-6. All assessments were performed barefoot following the standardized assessment procedures for each instrument. Measurements were obtained bilaterally by the same trained evaluation team. During data processing, the mean of the right and left scores was calculated for each instrument and used in subsequent statistical analyses to avoid arbitrary selection of a single limb and to provide a bilateral measure for each participant.

To assess the functional and postural characteristics of the foot and lower limbs, three main instruments were used:

1. Foot and Ankle Flexibility Index (FAFI): The FAFI was used to assess foot and ankle joint hypermobility. It is derived from the foot- and ankle-specific components of the Lower Limb Assessment Score (LLAS) and uses a dichotomous scoring system based on whether predefined mobility criteria are met. Higher scores indicate greater foot and ankle joint hypermobility. A cut-off score of ≥4 has been proposed to identify foot and ankle joint hypermobility in children. The assessment was performed bilaterally, and the mean bilateral score was subsequently calculated and used for statistical analysis.
2. Lower Limb Assessment Score (LLAS): The LLAS was used to assess lower-limb joint hypermobility through 12 standardized joint mobility tests involving the hip, knee, ankle, and foot. Each criterion is scored dichotomously, with 1 point assigned when the predefined hypermobility criterion is met and 0 points when it is not met. Scores are summed for each lower limb, yielding a score ranging from 0 to 12, with higher scores indicating greater lower-limb joint hypermobility. A score of ≥7/12 has been proposed as the cut-off for lower-limb joint hypermobility. LLAS was included to characterize lower-limb hypermobility as part of the clinical profile of the participants, rather than on the assumption that footwear directly modifies generalized joint laxity. Bilateral measurements were obtained, and the mean bilateral score was used for statistical analysis.
3. Foot Posture Index (FPI-6): The FPI-6 was used to assess static foot posture under weight-bearing conditions. It comprises six clinical criteria: talar head palpation, supra- and infra-lateral malleolar curvature, calcaneal frontal plane position, talonavicular joint prominence, congruence of the medial longitudinal arch, and forefoot abduction/adduction relative to the rearfoot. Each criterion is scored from −2 to +2, yielding a total score ranging from −12 to +12 for each foot. Negative scores indicate a more supinated posture, whereas positive scores indicate a more pronated posture. Scores from 0 to +5 are classified as normal, +6 to +9 as pronated, +10 to +12 as highly pronated, −1 to −4 as supinated, and −5 to −12 as highly supinated. The FPI-6 is widely used in clinical and biomechanical settings to characterize foot posture and classify feet along a continuum from supinated to pronated posture. Both feet were assessed, and the mean bilateral score was used for statistical analysis. FPI-6 was included to characterize static foot posture and to explore whether postural characteristics differed across footwear categories, rather than to infer structural changes caused by footwear.

2.3. Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics (version 31.0; IBM Corp., Armonk, NY, USA). Continuous variables were summarized using means and standard deviations, and categorical variables using absolute and relative frequencies.

Bilateral symmetry was initially assessed using the Wilcoxon signed-rank test to compare right and left foot scores. As no significant bilateral differences were identified, and to avoid arbitrary selection of a single limb, the mean of the right and left scores was calculated for FAFI, LLAS, and FPI-6 and used in subsequent analyses.

A paired comparison between mean bilateral FAFI and LLAS scores was also performed using the Wilcoxon signed-rank test. This analysis was conducted to explore differences in the distribution of scores obtained with the two clinical assessment instruments within the same participants. Given that FAFI and LLAS assess related but distinct constructs and use different scoring systems, this comparison was interpreted descriptively and not as evidence that one instrument reflects a greater degree of hypermobility than the other.

Age and body mass index (BMI) were compared across footwear categories using the Kruskal–Wallis test, with Bonferroni-adjusted pairwise comparisons when appropriate. Given the significant differences in age across footwear groups and its potential influence on musculoskeletal development, general linear models were subsequently performed to examine the association between footwear type and mean bilateral FAFI, LLAS, and FPI-6 scores, with footwear category entered as a fixed factor and age as a covariate.

Estimated marginal means with 95% confidence intervals were calculated for each footwear category, and Bonferroni-adjusted pairwise comparisons were performed. Partial eta squared (ηp^2) was reported as a measure of effect size. Homogeneity of variance was assessed using Levene's test. Statistical significance was set at $p < 0.05$.

2.4. Ethical Considerations

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and received approval from the Ethics Committee of the University of Extremadura (*Nº 98/2025*), ensuring compliance with institutional standards for research safety and ethics. Prior to participation, written informed consent was obtained from the parent or legal guardian of each child, detailing the objectives and procedures of the study. Furthermore, all collected data were treated confidentially, strictly adhering to current regulations on data protection.

3. Results

A total of 165 participants were evaluated, of whom 80 were female (48.5%) and 85 male (51.5%). Foot joint mobility and general hypermobility were assessed using the FAFI, LLAS and FPI scales and the type of footwear habitually used by each participant was recorded. Analyses were performed bilaterally, initially verifying potential differences between the right and left foot. The mean age of the participants was 8.45 ± 2.40 years, and the mean BMI was 16.26 ± 2.40 kg/m^2**.** The age distribution was as follows: 12 participants (7.3%) were aged 4 years, 19 (11.5%) 5 years, 9 (5.5%) 6 years, 5 (3.0%) 7 years, 31 (18.8%) 8 years, 27 (16.4%) 9 years, 25 (15.2%) 10 years, 24 (14.5%) 11 years, 11 (6.7%) 12 years, and 2 (1.2%) 13 years.

Regarding footwear distribution, 8 participants (4.8%) were classified in the physiological footwear group, 66 (40.0%) in the conventional footwear group, and 91 (55.2%) in the foot-friendly footwear group.

To further characterize the age distribution across footwear categories, participants were grouped into three age categories (4–6, 7–9, and 10–13 years). The distribution of participants according to age group and habitual footwear category is shown in Table 2.

Table 2. Distribution of participants by age group and habitual footwear category.

Age Group	Conventional Footwear, *n*	Foot-Friendly Footwear, *n*	Physiological Footwear, *n*	Total, *n*
4–6 years	19	15	6	40
7–9 years	24	37	2	63
10–13 years	23	39	0	62
Total	**66**	**91**	**8**	**165**

Mean age differed across footwear groups, with participants in the physiological footwear group being younger (5.75 ± 1.49 years) than those in the Conventional (8.32 ± 2.60 years) and foot-friendly (8.79 ± 2.15 years) groups. The overall difference in age was statistically significant (Kruskal–Wallis H(2) = 11.137, $p = 0.004$). Bonferroni-

adjusted pairwise comparisons showed significant differences between the physiological and conventional footwear groups (adjusted $p = 0.016$) and between the physiological and foot-friendly groups (adjusted $p = 0.003$), whereas no difference was observed between the Conventional and foot-friendly groups (adjusted $p = 0.824$). In contrast, BMI did not differ significantly across footwear groups ($H(2) = 2.212$, $p = 0.331$). Mean BMI was 14.93 ± 1.60 kg/m^2 in the physiological footwear group, 16.33 ± 2.34 kg/m^2 in the conventional footwear group, and 16.30 ± 2.49 kg/m^2 in the foot-friendly footwear group.

No statistically significant differences were observed between right and left scores for FAFI ($p = 0.253$) or LLAS ($p = 0.131$).

Following the assessment of bilateral symmetry, mean bilateral FAFI and LLAS scores were compared using the Wilcoxon signed-rank test. A statistically significant difference was observed between the scores obtained with the two instruments ($p = 0.023$). Mean FAFI and LLAS scores were 2.87 (SD = 1.876) and 4.88 (SD = 2.695), respectively. As FAFI and LLAS assess related but distinct constructs and use different scoring systems, this comparison should be interpreted as a descriptive difference between instrument scores rather than as evidence of a greater degree of hypermobility measured by one instrument (Table 3).

Table 3. Relationship between FAFI and LLAS.

Clinical Assessment	Mean	SD	*p*-Value
FAFI	2.87	1.876	0.023
LLAS	4.88	2.695	—

After adjustment for age, footwear type was not significantly associated with mean bilateral FPI-6 scores ($F(2,161) = 0.719$, $p = 0.489$, $\eta p^2 = 0.009$). Age was also not significantly associated with FPI-6 scores ($F(1,161) = 0.034$, $p = 0.855$, $\eta p^2 < 0.001$). The age-adjusted estimated marginal means were 7.20 (95% CI: 5.36–9.04) for physiological footwear, 6.44 (95% CI: 5.82–7.06) for conventional footwear, and 6.33 (95% CI: 5.80–6.86) for foot-friendly footwear. Bonferroni-adjusted pairwise comparisons showed no statistically significant differences between footwear categories (all adjusted $p > 0.05$) (Table 4).

Table 4. Age-adjusted estimated marginal means and 95% confidence intervals for bilateral Foot Posture Index (FPI-6) scores according to footwear category.

Footwear Type	Adjusted Mean FPI-6	95% CI
Physiological	7.20	5.36–9.04
Conventional	6.44	5.82–7.06
Foot-friendly	6.33	5.80–6.86

After adjustment for age, the general linear model showed that footwear type was not significantly associated with mean bilateral FAFI scores ($F(2,161) = 2.942$, $p = 0.056$, $\eta p^2 = 0.035$). In contrast, age showed a significant association with FAFI scores ($F(1,161) = 42.680$, $p < 0.001$, $\eta p^2 = 0.209$). The age-adjusted estimated marginal means were 2.10 (95% CI: 0.95–3.25) for physiological footwear, 3.18 (95% CI: 2.80–3.57) for conventional footwear, and 2.67 (95% CI: 2.33–3.00) for foot-friendly footwear. Bonferroni-adjusted pairwise comparisons showed no statistically significant differences between footwear categories (all adjusted $p > 0.05$) (Table 5).

Table 5. Age-adjusted estimated marginal means and 95% confidence intervals for bilateral Foot and Ankle Flexibility Index (FAFI) scores according to footwear category.

Footwear Type	Adjusted Mean FAFI	95% CI
Physiological	2.10	0.95–3.25
Conventional	3.18	2.80–3.57
Foot-friendly	2.67	2.33–3.00

After adjustment for age, footwear type was not significantly associated with mean bilateral LLAS scores ($F(2,161) = 0.965$, $p = 0.383$, $\eta p^2 = 0.012$). In contrast, age showed a significant association with LLAS scores ($F(1,161) = 42.279$, $p < 0.001$, $\eta p^2 = 0.208$). The age-adjusted estimated marginal means were 4.59 (95% CI: 2.93–6.25) for physiological footwear, 5.21 (95% CI: 4.66–5.76) for conventional footwear, and 4.72 (95% CI: 4.25–5.19) for foot-friendly footwear. Bonferroni-adjusted pairwise comparisons showed no statistically significant differences between footwear categories (all adjusted $p > 0.05$) (Table 6).

Table 6. Age-adjusted estimated marginal means and 95% confidence intervals for bilateral Lower Limb Assessment Score (LLAS) according to footwear category.

Footwear Type	Adjusted Mean LLAS	95% CI
Physiological	4.59	2.93–6.25
Conventional	5.21	4.66–5.76
Foot-friendly	4.72	4.25–5.19

4. Discussion

The present study aimed to examine the association between habitual footwear type and foot–ankle flexibility, lower-limb hypermobility, and foot posture in children. The main finding was that, after adjustment for age, footwear category was not significantly associated with mean bilateral FAFI, LLAS, or FPI-6 scores. In contrast, age was significantly associated with both FAFI and LLAS scores, highlighting the importance of considering developmental differences when examining joint mobility in pediatric populations.

No significant differences were observed between right and left FAFI and LLAS scores, suggesting a broadly symmetrical pattern of mobility within the study population. Guarnieri and Castori [14] and Juul-Kristensen et al. [15] have described generalized joint hypermobility in relation to systemic connective tissue characteristics and heritable factors rather than exclusively unilateral mechanical influences. Given the absence of significant bilateral differences, mean scores from both sides were used in the present analyses. This approach avoided arbitrary selection of a single limb and provided a more representative bilateral measure of foot and lower-limb characteristics.

LLAS was included to characterize lower-limb hypermobility and to explore whether its distribution differed across footwear categories, rather than on the assumption that footwear directly modifies generalized joint laxity. Mean bilateral LLAS and FAFI scores differed significantly. However, this finding should be interpreted cautiously because the two instruments assess related but distinct constructs and use different scoring systems. Therefore, differences in their absolute scores should not be interpreted as indicating a greater degree of hypermobility measured by one instrument. Rather, their combined use may provide complementary information regarding different aspects of lower-limb and foot–ankle mobility.

FPI-6 was included to characterize static foot posture and to explore potential differences across footwear categories. After adjustment for age, no significant association was

observed between footwear category and mean bilateral FPI-6 scores. This absence of association is clinically relevant because the FPI-6 is commonly used to characterize static foot posture and to distinguish between more pronated and more supinated foot types. Age was also not significantly associated with FPI-6 in the present sample. Given the cross-sectional design and the absence of objective information on cumulative footwear exposure, these findings should not be interpreted as evidence that footwear does or does not modify foot posture over time. Foot posture undergoes developmental changes during childhood [7], and longitudinal studies incorporating detailed measures of footwear exposure would be required to determine whether footwear characteristics are associated with changes in foot posture during growth.

Importantly, the unadjusted analyses initially suggested differences in FAFI and LLAS scores across footwear categories. However, participants in the physiological footwear group were substantially younger than those in the conventional and foot-friendly groups, and age differed significantly among footwear categories. After age was included as a covariate, footwear category was no longer significantly associated with either FAFI or LLAS. At the same time, age showed a significant association with both outcomes. These findings suggest that age-related developmental differences may account, at least in part, for the associations observed in the unadjusted analyses and emphasize the importance of controlling for age when studying joint mobility in pediatric populations.

Although age was not significantly associated with FPI-6 scores in the present sample, developmental factors should be considered when interpreting foot posture in pediatric populations. Therefore, potential relationships between footwear characteristics and foot posture may be better examined through longitudinal designs and in age-specific pediatric populations, particularly during periods of active musculoskeletal development.

The absence of statistically significant associations after adjustment for age does not establish that footwear characteristics are unrelated to foot function. Wegener et al. [10], Huang et al. [11], Peters-Dickie et al. [16], and Miller et al. [17] have reported biomechanical differences associated with footwear characteristics, including changes in gait, plantar loading, and muscular function. However, these biomechanical responses should not be interpreted as evidence that habitual footwear causes changes in joint laxity or hypermobility. In the present study, no significant association between footwear category and FAFI or LLAS remained after adjustment for age. Therefore, the present findings do not support the hypothesis that a specific footwear category increases or reduces foot–ankle flexibility or lower-limb hypermobility.

The potential relationship between footwear and joint mobility may also be bidirectional. Children with pre-existing joint laxity, perceived instability, discomfort, or other foot characteristics may preferentially use particular types of footwear, potentially because parents or caregivers perceive them as providing greater stability or comfort. Smith et al. [4] and Scheper et al. [12] have reported associations between joint hypermobility and alterations in proprioception and functional performance, which could potentially influence movement patterns and footwear selection. Consequently, the direction of any relationship between footwear characteristics and joint mobility cannot be established from the present cross-sectional study.

The study presents several methodological limitations that should be considered when interpreting the results. Its cross-sectional design prevents establishing causality between footwear type and hypermobility levels. Furthermore, the recruitment of participants from a single private school using convenience sampling may limit the generalizability of the findings to the broader pediatric population. Additionally, footwear group sizes were markedly unbalanced, with only eight children (4.8%) in the physiological footwear group. This small subgroup reduces statistical power and precision for comparisons involving

physiological footwear and warrants caution when interpreting between-group differences. Daily footwear exposure and physical activity levels were not objectively quantified and may represent additional sources of variability, particularly given the broad age range of the sample. Furthermore, the broad age range of the sample (4–13 years) encompasses different stages of musculoskeletal development, during which foot posture and joint mobility may vary. Although age was included as a covariate in the adjusted analyses, residual developmental differences across age groups cannot be completely excluded.

After adjustment for age, footwear type was not significantly associated with mean bilateral FAFI, LLAS, or FPI-6 scores. These findings suggest that the differences observed in the unadjusted analyses may have been influenced, at least in part, by age-related differences between footwear groups. Given the cross-sectional design, the direction of any potential relationship between footwear characteristics and joint mobility cannot be established. It is also possible that footwear selection is influenced by pre-existing characteristics of the child, such as perceived instability or joint laxity, rather than footwear itself producing changes in mobility. Therefore, the present findings should be interpreted as exploratory associations and do not support causal or therapeutic conclusions regarding specific footwear categories. Longitudinal and prospective studies with balanced footwear groups and detailed assessment of footwear exposure are needed to clarify these relationships.

5. Conclusions

In this cross-sectional study of school-aged children, footwear category was not significantly associated with mean bilateral foot–ankle flexibility (FAFI), lower-limb hypermobility (LLAS), or foot posture (FPI-6) after adjustment for age. Age was significantly associated with FAFI and LLAS scores, highlighting the importance of considering developmental differences when examining joint mobility in pediatric populations. Although unadjusted differences were observed between some footwear groups, these associations were attenuated after accounting for age, suggesting that age may partly explain the initially observed differences. Given the cross-sectional design, the imbalance in footwear group sizes, and the lack of objective quantification of cumulative footwear exposure, no causal or therapeutic conclusions regarding footwear can be drawn. Prospective longitudinal studies with more balanced groups and detailed assessment of footwear exposure are needed to clarify whether footwear characteristics are associated with changes in foot and lower-limb function during childhood.

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Data Availability Statement: The data presented in this study are available on reasonable request from the corresponding author.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

LLAS	Lower Limb Assessment Scale
FAFI	Foot and Ankle Flexibility Index
FPI	Foot Posture Index
SD	Std. Deviation

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