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Factors that cause flatfoot in school children

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ABSTRACT

Background: Flatfoot is a common disorder in children, although it often does not show serious symptoms. Over time, it will affect the development and growth of the arch of the foot. This study aimed to determine the factors that cause flatfoot in school children.

Methods: This study used the literature review method by utilizing databases containing research articles related to factors that could cause flatfoot in elementary school children. To search the databases, the author used Google Scholar and PubMed with the keywords "Child," "Factor," and "Flatfoot." Then, five journals were obtained that were relevant to the topic of discussion in the literature review.

Results: Based on the results of the review of journals and articles, it shows that the factors that influence the occurrence of flatfoot can be categorized into internal factors (age, gender, BMI, and heredity) and external (physical activity, footwear, environment)

Conclusion: Based on the results of the review, it can be concluded that flatfoot in school children has a high prevalence and is influenced by related factors. This study emphasizes the importance of early detection and preventive intervention.

Keywords: Age, child, factors, flatfoot, gender

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Introduction

School-age children are a group of individuals who are in the age range of around 6 to 15 years, which is an important transition period in physical, psychological, and social growth and development.[1] During this period, children begin to attend formal education and experience a significant increase in physical activity. Growth of the musculoskeletal system, including the structure of the foot, is also actively taking place.[2] The World Health Organization (WHO) estimates that hundreds of millions of people experience disruptions in their lives due to musculoskeletal problems. One common disorder is flat feet, or what is called pes planus/flatfoot.[3] The WHO also states that the prevalence of pediatric flatfoot is 20%-30%.[4]

In Indonesia, the Ministry of Health of the Republic of Indonesia (Kemenkes RI) recorded the prevalence of flatfoot in primary school-age children (7-12 years) reaching 27,574,728 cases.[5] The incidence rate in urban areas reaches 30% higher than in rural areas.[6] Based on research by Agung et al. stated that the prevalence of children experiencing flatfoot in Denpasar was 53.3% of 930 children.[4] Flatfoot is a medical condition characterized by an abnormality in the structure of the leg, namely the loss of the arch in the medial longitudinal arcus so that the foot is flat to the ground.[7] Generally, the growth of the arch of the foot is formed from the age of 2 - 5 th.[8] Failure to form the arch of the foot (>5 th) causes this pathological condition called flatfoot.[9]

The factors that cause flatfoot can be categorized into internal factors (age, weight, congenital / heredity and gender). In addition, external factors such as the use of footwear and excess activity.[10] The condition of flatfoot in school children is often considered physiological and will improve with growth, but in some cases this condition persists into adolescence and adulthood. If left untreated, it will potentially have a negative impact, such as the child's Activities of Daily Living (ADL).[11]

Disorders that arise include posture disorders, pain in the feet and lower legs, as well as functional obstacles such as walking and running, to decreased participation in physical activities, etc.[12] Children with flat feet can also have difficulty in choosing comfortable footwear, and are at risk of repetitive injuries due to biomechanical imbalances. [13] This

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condition of flatfoot in children can cause certain symptoms or clinical diagnoses. These include patellofemoral pain syndrome (PFPS), knee pain, foot pain, gastrocnemius spasm, etc.[14]

Other research also states that flatfoot is correlative with higher outcomes in decreased performance in aspects of motor development, long jump, and balance.[15] Therefore, detecting the presence of foot arch abnormalities in children is important in order to provide clinical intervention. [16] However, there is still much debate regarding the factors that can cause flatfoot in school children so that it can affect the prevalence of flatfoot. [17] Thus, this literature review is an attempt to further examine the factors that significantly influence the occurrence of flatfoot in children.

Methods

This study employed a literature review method by utilizing databases containing research articles related to factors that could cause flatfoot in elementary school children. To conduct the database search, the author used platforms such as Google Scholar and PubMed, applying the keywords "Child," "Factor," and "Flatfoot." The author established specific inclusion and exclusion criteria to ensure the relevance and quality of the selected studies. The inclusion criteria were as follows studies written in Indonesian or English, articles published between 2015 and 2025, and research designs classified as observational studies, including cross-sectional, case-control, or relevant clinical trials. The exclusion criteria were research articles written in languages other than Indonesian or English, articles without an abstract, and studies published more than ten years ago. After applying the predetermined inclusion and exclusion criteria, five journals that were considered relevant to the topic of discussion were selected for review.

Results

The results of the 5 journals reviewed state that flatfoot is a condition that often occurs in school children with varying prevalence based on geographic regions and characteristics in the study (Table 1). The results of this literature review indicated that the development of flatfoot in elementary school children was influenced by a combination of internal and external factors. Internal factors included age, gender, body mass index (BMI), and heredity.

Age played an essential role in the formation of the medial longitudinal arch, which typically developed between the ages of seven and eight years as the fat pads on the soles decreased and the muscles and joints of the feet became stronger and more stable. Studies by Sadeghi et al. and Alsuhaymi et al. confirmed that this age range was a critical period for the proper development of the foot arch.

Conversely, a study by Biharnu et al. involving children aged 11–18 years found that only 10.27% experienced flatfoot, suggesting that age alone was not a significant determinant. However, the prevalence of flatfoot remained higher in younger children due to incomplete arch formation. Gender was also found to influence the occurrence of flatfoot. Research by Mien et al. reported that boys were more likely to develop flatfoot because of their thicker midfoot fat pads and slower arch development. Similarly, Abich et al. found that boys had twice the risk compared to girls. [9]

In contrast, studies by Biharnu et al. and Alsuhaymi et al. found no statistically significant differences between boys and girls, as both genders showed similar characteristics in joint laxity, hallux valgus, and torsional deformities. Despite these differences in findings, several studies consistently demonstrated a higher prevalence of flatfoot among male children.[9]

Another internal factor influencing flatfoot was BMI, where all four researchers agreed that obesity was associated with a higher prevalence. The increased body weight of obese children exerted excessive pressure on the midfoot, whose ligaments were relatively weaker, leading to overpronation and a reduction in the height of the plantar arch. This constant pressure could cause structural deformities, alter posture and balance, and affect the overall biomechanics of the foot. However, Alsuhaymi et al. reported contrasting findings, noting that only two out of thirteen obese children exhibited flatfoot.[8]

Furthermore, heredity also played a significant role, as Mien et al. found that children with a family history of flatfoot had a higher likelihood of developing the condition. Their study reported that eight out of fifteen children with flatfoot had at least one family member either a parent or sibling who also experienced the same condition.[10]

In addition to internal factors, external factors such as physical activity, footwear use, and environmental conditions also affected the occurrence of flatfoot. Adequate physical activity, defined as at least 180 minutes per week, was shown to play a protective role in maintaining the arch structure. Alsuhaymi et al. reported that children with insufficient physical activity were 8.78 times more likely to develop flatfoot compared to those who were physically active, particularly among obese children. [8]

Similarly, Abich et al. found that lack of physical activity doubled the risk of developing flatfoot, as inactivity weakened the muscles supporting the arch, preventing proper formation of the medial longitudinal arch.6 Footwear also had a significant influence; children who frequently wore closed shoes were found to have a higher risk of flatfoot. Studies by Biharnu et al. and Abich et al. revealed that wearing closed shoes increased the risk by approximately 2.33 times, as this type of footwear limited natural foot movement, hindered arch development, and potentially caused muscle imbalance and foot deformities. Environmental factors also contributed to flatfoot prevalence.18 Research in Ethiopia demonstrated that children living in highland areas (above 2,400 meters above sea level) had a higher prevalence, possibly due to limited sun exposure and lower vitamin D levels affecting bone development. Moreover, children living in urban areas were found to have twice the risk compared to those in rural

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Table 1. Characteristics of the 6 included studies

Author (year)	Study design	Population	Sample size	Methods	Main results
Sadeghi et al. (2015)[11]	Cross-sectional	7-14 years old	667 children	Multistage sampling	Age factor with high BMI correlates with flatfoot
Mien et al. (2017)[10]	Cross-sectional	6-10 years old	326 children	Quantitative descriptive	Factors of gender, age, overweight nutritional status, and family history are associated with flatfoot
Alsuhaymi. et al (2019)[8]	Cross-sectional	7-14 years old	403 children	Questionnaire, Anthropometric measurement, physical examination	Age factor associated with flatfoot
Abich et al. et al. (2020)[6]	Cross-sectional	11-15 years old	823 children	Questionnaire, Staheli plantar arch index	Age, gender, school type, body mass index, and footwear type factors associated with flatfoot.
Birhanu et. al (2023)[9]	Cross-sectional	11-18 years old	1072 children	Multistage sampling	Factors of residence, physical activity, use of closed shoes, obesity, foot pain associated with flatfoot.

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settings, likely due to differences in footwear habits, physical activity levels, and overall lifestyle.[19]

Overall, the synthesis of findings from five studies indicated that both internal factors such as age, gender, BMI, and heredity and external factors such as physical activity, footwear type, and environmental conditions played a crucial role in the development of flatfoot among school-aged children. These results highlighted the need for early identification, parental awareness, and preventive interventions to promote healthy foot development and prevent long-term musculoskeletal complications that could affect posture, mobility, and quality of life in children.

Discussion

Based on the results of the five journals reviewed, the factors influencing the occurrence of flatfoot in children could be categorized into internal and external factors. Internal factors included age, gender, body mass index (BMI), and heredity, while external factors consisted of physical activity, footwear use, and environmental conditions. Age played an important role in the development of the medial longitudinal arch (MLA), as this structure was still in the process of maturation during childhood.

The prevalence of flatfoot was found to be higher among younger children because, physiologically, infants and toddlers are born with a thick plantar fat pad that conceals the foot arch, while the bones, ligaments, and intrinsic muscles of the foot remain immature. The elasticity of the ligaments and the weakness of the arch-supporting muscles reduced their ability to support body weight effectively. Moreover, the process of bone ossification and joint stabilization continued until approximately ten years of age, making children more prone to arch flattening, especially when physical activity was insufficient or when body weight was excessive.[20]

As children grew older, the ligaments became stronger, the intrinsic foot muscles developed, and the medial arch became more defined. Therefore, flatfoot at an early age was often considered physiological; however, it still required monitoring to prevent it from progressing into a pathological condition later in life.[21]

Gender differences also influenced the development of the MLA. Physiologically, boys and girls experienced different rates of musculoskeletal maturation. Girls tended to develop stronger and more stable arches earlier due to faster musculoskeletal maturation, whereas boys had more elastic ligaments and thicker midfoot fat pads, which made their arches less stable during early growth. Excess ligament flexibility in boys led to decreased stability of the passive structures supporting the arch. Furthermore, boys typically experienced more rapid weight gain during growth periods, which increased the axial load on the soles and medial arches of the feet, contributing to a higher prevalence of flatfoot compared to girls. [18]

BMI was another important factor that influenced the formation of the MLA. An increase in body weight placed excessive mechanical stress on the foot arch, leading to its collapse, especially when the intrinsic muscles, such as the abductor hallucis and flexor hallucis brevis, were weak due to inadequate physical activity. Overweight and obese children were found to have a higher risk of flatfoot compared to those of normal weight. Excess body mass not only increased axial pressure on the foot but also altered motor performance, caused pain, and led to uneven weight distribution across the feet, further contributing to the collapse of the arch.[17]

Heredity was also identified as a significant internal factor. The formation of the MLA was influenced by genetic predispositions such as ligamentous laxity and tarsal deformities, including navicular bone protrusion or tarsal coalition, which could result in a flatter or unstable arch. Children with a family history of flatfoot were at greater risk due to the inheritance of biomechanical and structural characteristics that made their feet more susceptible to arch collapse. Genetic factors influenced both the passive structural components—such as bones and ligaments—and the neuromuscular systems that supported the foot's anatomy, thereby increasing the likelihood of flatfoot development from early childhood. [10]

In addition to internal influences, several external factors also contributed to the incidence of flatfoot. Physical activity was found to have a strong impact on foot development. Activities such as walking, running, and playing stimulated the intrinsic foot muscles that supported and maintained the MLA. Children who engaged in less than 180 minutes of physical activity per week were reported to be 8.78 times more at risk of developing flatfoot. Inactivity weakened the intrinsic muscles, such as the abductor hallucis and flexor digitorum brevis, reducing their ability to maintain the arch structure when bearing body weight. Regular physical activity also enhanced proprioceptive and neuromuscular stimulation, which helped strengthen the muscles and improve coordination of the foot's support structures. Thus, sufficient physical activity during early childhood was crucial to developing a strong, stable arch capable of withstanding daily biomechanical stress.[9]

Footwear use was another external factor affecting flatfoot prevalence. The use of closed, rigid shoes limited natural foot movement and reduced the activation of intrinsic muscles responsible for maintaining the MLA. Compared to sandals or walking barefoot, closed shoes restricted flexibility, particularly in the midfoot region, and reduced the movement of the toes. This limitation weakened the active support of the medial arch, resulting in suboptimal arch development. Additionally, thick, cushioned shoes diminished proprioceptive stimulation from ground contact, which is vital for neuromuscular control and postural adaptation. Conversely, children who frequently walked barefoot or wore open footwear tended to have stronger, more active foot muscles and developed more stable arches naturally.[6]

Environmental factors also played a significant role in the development of flatfoot. Geographical and lifestyle differences influenced the prevalence rates across

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populations. Children living in highland areas (above 2,400 meters above sea level) were more likely to experience flatfoot, possibly due to vitamin D deficiency resulting from lower sunlight exposure. Vitamin D is essential for bone mineralization and the optimal growth of tarsal and metatarsal bones that form the foot arch. Furthermore, children living in urban environments had a 2.34 times higher prevalence of flatfoot compared to those in rural areas. This difference was associated with sedentary lifestyles, increased gadget use, reduced physical activity, and frequent use of closed shoes in urban settings. Interestingly, school type also influenced prevalence, as children attending public schools who commonly wore shoes as part of the uniform showed higher rates of flatfoot compared to those in private schools. These findings indicated that environmental factors indirectly affected the structure, strength, and stability of the feet by influencing daily activity patterns, footwear habits, and nutritional status.[5]

Overall, the synthesis of these findings demonstrated that the occurrence of flatfoot in children was a multifactorial condition resulting from the interaction between internal and external influences. Factors such as age, gender, BMI, heredity, physical activity, footwear, and environment collectively determined the development and stability of the medial longitudinal arch. Understanding these factors is essential for designing early detection programs, health education, and preventive interventions to support optimal foot development and prevent the long-term functional consequences of flatfoot in children.[3]

This literature review has several limitations. First, most of the studies reviewed were cross-sectional in design, which restricts the ability to determine causal relationships between the identified factors and the development of flatfoot in children. Second, there was considerable variability in the diagnostic criteria and assessment tools used across studies, ranging from visual inspection to footprint analysis and radiographic measurements, which may affect the comparability of results. Third, many studies were conducted in specific regions or among limited populations, reducing the generalizability of the findings to children in different cultural, environmental, or socioeconomic contexts. Fourth, several studies relied on self-reported data for factors such as physical activity levels and footwear habits, which may introduce recall bias. Additionally, some potentially important variables such as genetic factors, nutritional status, and detailed biomechanical analyses were underexplored or inconsistently addressed in the reviewed literature.

Future research should aim to overcome these limitations by adopting standardized and validated diagnostic methods to assess flatfoot consistently across studies. Longitudinal designs are recommended to clarify causal relationships between risk factors and the development or progression of flatfoot. Expanding research to include diverse populations from different geographical and socioeconomic backgrounds would enhance generalizability. Moreover, integrating objective measures such as radiographic imaging, 3D foot scanning, and gait analysis could provide more accurate assessments of foot structure and function. Researchers should also explore the interaction between genetic predisposition, body composition, muscle strength, and environmental influences such as footwear and physical activity. Finally, systematic reviews and meta-analyses focusing on high-quality evidence would be valuable in synthesizing findings and guiding preventive or corrective strategies for flatfoot in school-aged children.

Conclusions

Based on the results of the literature review, it can be concluded that flatfoot is influenced by internal and external factors. Internal factors are age, gender, BMI/ nutritional status (obesity), and heredity. While external factors are low physical activity, the use of non-ergonomic footwear and the environment. The measurement tools used, such as the Plantar Staheli Arch Index and footprint analysis, proved effective for screening. For future research, further studies are needed regarding these factors on the incidence of flatfoot.

Ethical clearance

This review study utilized publicly available published articles, so informed consent and ethical approval were unnecessary.

Conflict of interest

The authors declare that there are no potential conflicts of interest, financial or otherwise, that could be construed as influencing the research, the preparation of the manuscript, or the publication and dissemination of this manuscript. All authors affirm that their participation in this study and the preparation of this manuscript were conducted with the highest scientific integrity and without external pressures or personal interests that could compromise the objectivity or validity of the reported findings.

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Author contributions

NSAJ developed the study design, conducted data collection, and prepared the initial manuscript; AAGESU and AW were responsible for data collection and provided revisions to the manuscript.

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