

# FACTORS WHICH AFFECT THE OCCURRENCE AND PREVALENCE OF FLAT FEET IN PRESCHOOL CHILDREN: A SYSTEMATIC REVIEW

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## Abstract

This article summarizes systematic reviews of the literature related to foot deformities. The aim of this review is to analyze the feet of preschool children and to identify the factors that lead to the accommodation of this deformity. All data sources have been selected from relevant sources from websites, journals and original scientific articles. In this paper, seventeen papers addressing the problem have been analyzed. Systematic review of the papers presented here is consistent with the PRISMA consensus. What has so far revealed is a strong correlation between body weight gained by gender with the onset of flat foot deformity. All the studies conducted allowed for a positive association between body weight and the frequency of flat foot occurrence. The results of the study examining the association were found with the occurrence of deformation and concluded that the flat foot in the highest frequency occurred in children aged 3 to 5 years, and after that age the frequency often suddenly decreased. A gender difference was also observed. Specifically, in observing the girls and boys of the same age, there is a higher incidence of flat feet in boys. The childhood period is a period of rapid growth, and accordingly, it takes time for the skeleton, musculature and ligaments to adapt to increasing daily challenges. What still remains underexplored and needs more attention is to assess the period during which the foot structures connections are finally established in order to decide which period of flat foot emergence represents the ultimate pathological condition to be treated seriously.

**Key words:** deformities, preschool age, foot

## Introduction

The foot is the main support of the locomotor system and has a fundamental role in the realization of all forms of bipedal movement. It represents one of the most complicated anatomical segments of the human body and a very critical point in body posture (Krsmanović, 1995, Nićin, 2000). The foot represents the final part of the lower extremities where the joint with the lower leg via the talocrural joint is at an angle of 90 degrees. To accurately determine certain foot deformities, it is necessary to do a "golden triassic" (anamnesis, examination and diagnostic methods). It consists of elements that should provide two important functions of the foot, namely: standing - static function and walking - dynamic function, (Jovičić, 2007). This means that it should be statically strong enough to carry the entire weight of the body and must dynamically adapt to the surface, allowing it to stand,

walk, run and absorb shocks (Jovović, 1999). The opinions of the authors are divided when it comes to the development of the longitudinal arch, i.e. the age when its formation is finally completed. Most agree that the development of the longitudinal arch of the foot takes at least 5-6 years (e.g., Riddiford-Harland; Rose, 1990), although some believe that development takes place later (Gould, 1989; ACFAS). The formation of the longitudinal arch in boys is considered slower than in girls (Pfeiffer, Kotz, Ledl, Hauser, & Sluga, 2006; Mickle, Steele, & Munro, 2008). The internal longitudinal arch is especially important for optimal foot mechanics. Its descent is denoted as a straight or lowered foot (pes planus). A lowered foot can be flexible or rigid. The flexible flat foot is characterized by a lowered (low) inner longitudinal arch in the standing position (under load), the heel in the valgus position,

the front part of the foot most often in abduction and supination. The arch exists in a position without load, and it is also formed when climbing on the toes or pulling the big toe upwards.

Deformities of the feet have a huge impact on the complete functional state of the locomotor system of the lower extremities. In a large number of the population, in about 60% of cases, mostly children, some of the deformities of the feet are present, most often flat feet. This deformity is manifested in the loss of normal, physiological arches of the feet to a greater or lesser degree. According to the etiology, pes planus can be congenital and acquired.

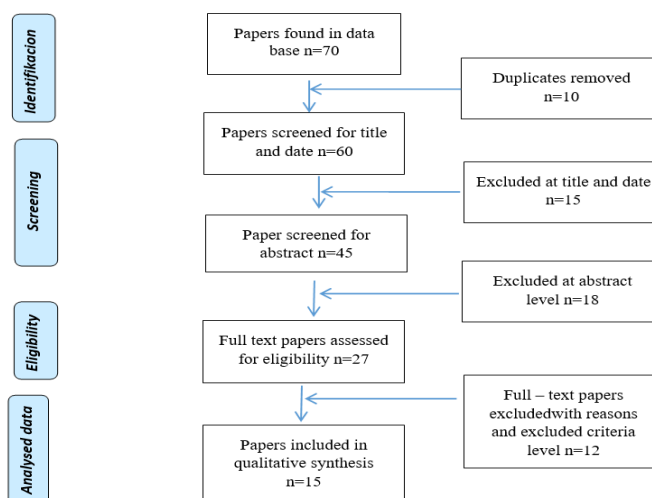
A large number of researchers (Videmšek, et al. 2006, Protić-Gava, Krneta, 2010, Bogdanović & Marković, 2010) point out that flat feet are the most common disorder of the lower extremities and that they are present in a large percentage in children and are characterized by lowered feet arches and loss of physiological properties (Jovović, 1999). In preschool and school age, children are increasingly experiencing deformities on the skeletal system, especially on the spine, extremities and feet. This is a very important issue and should be addressed by everyone in the chain of education and supervision of children of this age. The consequences of late detection and inadequate treatment are severe most often in terms of improper growth, improper posture and decreased physical fitness. The aim of this review is to analyze the feet of preschool children, and to determine the factors that cause this deformity.

## Methods

Data bases used for this paper are PubMed, Medline, ResearchGate, Google Scholar and EBSCO. When searching, key words that were searched were: flat feet, deformity, preschool age, factors influencing the appearance of flat feet. All articles and abstracts were reviewed in order to consider the potential of the studies to be included in the



PRISMA IPD Flow Diagram



systematic review. In addition to this, we also analyzed the reference lists of the previously considered original studies. A literature review was made by one author. Relevant studies were obtained after a thorough review, and as such used for this review. After that, research papers that met the following criteria were analyzed and presented: (1) papers had to be published between 2003 and 2018, older papers weren't considered (date criterion), (2) papers had to be written in English language (language criterion), (3) papers focused only on preschool children were used for analysis (participants criterion), (4) papers had to represent original researches (type of publication criterion), (6) articles that didn't meet inclusion criterion were excluded from further analysis (exclusion criterion).

## Results

Scheme 1 shows the detailed process of creating a systematic review. After using keywords in databases, 70 publications were found. All duplicates were removed (n=10), so 60 papers were screened for title and date criteria. During this phase 15 papers were excluded. Total of 18 papers were excluded in the next phase for not meeting interest criteria. After reading total of 27 papers, 12 of them were excluded for not meeting deeper type of publication criteria and language criteria.

Scheme 1. Elaboration of selection of papers by PRISMA methodology

Table 1 presents information about selected research papers (authors, aim and conclusion). Analysis of table 1. shows that papers had different goals and that they included different segments which are significant for this paper.

Table 1. List of papers with aims and conclusions

Authors	Aim	Conclusion
Echarri JJ. et al. (2003)	Objective of this study was to investigate the occurrence of flat feet among urban children who wore shoes and children from rural areas.	At the ages of 3 and 4 years, most feet were morphologically flat, but the proportion of flat feet decreased with age in both sexes. Boys had greater tendency for flat feet. As in previous studies in western populations, the girls had a higher inner arch than the boys and footwear had very little influence on the morphology of the foot.
Pfeiffer et al. (2006)	The aim of this study was to establish the prevalence of flat foot in a population of 3- to 6-year-old children to evaluate cofactors such as age, weight, and gender and to estimate the number of unnecessary treatments performed.	The data demonstrate that the prevalence of flat foot is influenced by 3 factors: age, gender, and weight. In overweight children and in boys, a highly significant prevalence of flat foot was observed; in addition, a retarded development of the medial arch in the boys was discovered. At the time of the study, > 90% of the treatments were unnecessary.
Videmšek et al. (2006)	The aim of this study was to examine the arches of the feet in three-year-old children.	Authors are of the opinion that one of the main reasons for such a high percentage of flat feet is that the development of the arch of the foot in some three-year-old children has not yet been completed. Despite that, it is important to note that we must enable children to perform a variety of movement activities on a daily basis since the development of motor skills is an important contributor to the locomotor system development, part of which are the feet.
Mickle K.J. et al. (2006)	The purpose of this study was to determine whether the flat feet displayed by young obese and overweight children are attributable to the presence of a thicker midfoot plantar fat pad or lowering of the longitudinal arch relative to that in non-overweight children.	The lower plantar arch height found in the overweight/obese children suggests that the flatter feet characteristic of overweight/obese preschool children may be caused by structural changes in their foot anatomy. It is postulated that these structural changes, which may adversely affect the functional capacity of the medial longitudinal arch, might be exacerbated if excess weight bearing continues throughout childhood and into adulthood.
Đorđić V. (2007)	The aim of this study is to determine the prevalence of flat feet in girls and boys from kindergartens in Vojvodina.	The study identified significant differences between age groups in following parameters: shoulders alignment, scapulae, spine, and abdomen. Positive developmental trend could be noticed for shoulders alignment and abdomen, while negative trend exists for lateral spinal deviations and scapulae. Stable increase in "good posture" category has been noticed for feet status, although there were no significant differences between age groups. For following parameters: head alignment, chest and legs, a particular developmental trend could not be identified, and differences between age groups are not statistically significant.
Mauch M. et al. (2008)	Purpose of this study was to investigate the influence of body mass on the development of a child's foot based on a foot type classification.	The influence of excess, as well as deficient mass could be verified for the comprehensive foot morphology based on a foot type classification. However, there is still a lack of information regarding these relationships, which needs to be determined. This knowledge may help prevent orthopedic foot problems and injuries.
Onodera et al. (2008)	The aim of this study was to characterize the longitudinal arch of children between 3 and 10 years and compare the applicability of five evaluation methods.	The longitudinal arch acquires an adult-like shape progressively, being statistically notorious the moment of medial longitudinal arch's formation between 4 and 5 years old. The Chipaux-Smirak Index is the best index to assess children's feet; it provides a better classification for lower arches and is easily calculated.
Chang et al. (2009)	The objective of this study was to determine the prevalence of flexible flatfoot in elementary school children in Taiwan and evaluate the relationship between flatfoot and obesity, gender, and age.	The results of this study indicate that the prevalence of flexible flatfoot is highest among males who are obese and overweight, particularly in the age range of 7 to 8 years.
Mihajlović I. et al. (2011)	The aim of the research is to determine the frequency of disorder of postural status of the spine (kyphosis, lordosis and scoliosis) and deviation from the normal status of the foot, and the analysis of the differences between boys and girls.	Quantitative results indicate the need for corrective gymnastic to correct but also prevent postural deformities by introducing of the same as an everyday directed activity of preschool population.
Bjeković G. et al. (2011)	The target of this study was to confirm real factors of intensity and level of foot deformity at children preschool stature, and to confirm difference of presence of this deformity between sexes.	Final results of the study show relatively high percent of foot deformity.

Chen et al. (2011)	The aim of this study was to discuss the influence of age, gender, obesity status, joint laxity, and the W-sitting habit on flatfoot in preschool-aged children.	This study demonstrates significant correlation between age, gender, obesity status, joint laxity, as well as the W-sitting habit and the bilateral flatfoot in preschool-aged children. Children with unilateral flatfoot differ from those with normal feet and bilateral flatfoot. It is suggested that the unilateral flatfoot deserves special attention in future studies.
Vegara – Amador E. et al. (2012)	The aim of this study was to determine the prevalence of flatfoot in two different populations with different social, cultural and geographically characteristics in Colombia.	Authors found a bigger prevalence of flatfoot in the population of Bogota compared to Barranquilla suggesting an influence of social, cultural and racial factors in development of flatfoot. The diminished prevalence of flatfoot in children over 6 years of age suggests that therapeutic measures before this age are not recommended.
Woźniacka R. et al. (2013)	This study had two objectives. First, to determine the prevalence of hollow (high-arched) and flat foot among primary school children in Cracow (Poland). Second, to evaluate the relationship between the type of medial longitudinal arch (MLA; determined by the Clarke's angle) and degree of obesity.	High-arched foot is the most common foot defect among children 3–13 years old regardless of gender. Flat foot is least frequently observed in children 3–13 years old. A statistic correlation between MLA and adiposity is observed. Stronger correlation is observed among girls.
Sadeghi E et. al. (2015)	The purpose of this study was to investigate the effects of excess weight on the structure and function of developing foot in students aged 7-14 years.	This study indicated that childhood obesity is associated with structural foot and ankle deformities and activity-related foot pain.
Bhattacharjee N., Goswami M. (2017)	This study envisages the morphological differences in anthropometric measurements on footprints among the preschool children and analyzes its manifestation in the different weight category. This study also focuses on the diagnosis of flatfoot among the studied population.	The results thus provide a platform for complex studies in the future. Timely prognosis of flatfoot in children can instigate early rectification of flat-footedness.

## Discussion

Deformities of foot, as one of the most complex anatomical structures, represent a major risk for the development of deformities of the other elements of the skeleton as well as the system of muscles, tendons and ligaments. Researches exposed in the reviewed articles are trying to find all the possible causes of flat feet in preschool children in order to prevent the same. What has been discovered so far indicates strong correlation between body weight, age and sex with the appearance of deformities flat foot. All conducted studies have found positive correlation between weight gain and incidence of flat feet. In children, it would mean that the foot that is not fully formed should transfer most of the weight to the surface. Due to the simple laws of physics, the anatomical structures of the feet suffer more pressure and deform accordingly. The results of studies examining the association of age with the occurrence of this deformity led to the conclusion that a flat foot occurs in the highest frequency in children aged 3 to 5 years, after which the frequency decreases sharply. So, it is a fact that the development of children's feet needs a period of at least five years. Out of that reason, the appearance of a flat foot before the 5th year of life is today tried to get corrected by certain exercises, because most of the changes previously occurred disappear around the 5th year of life and exercise can speed up this process. In general, the period of childhood is a period of rapid

growth and development and a period of increasing use of one's own muscles. Consequently, it takes time for the skeleton, musculature, and ligaments to adapt to the increasing daily challenges. What is important to emphasize is the observed gender difference. It was noted that among the girls and boys of the same age there is a higher incidence of flat feet in boys. The primary ways to correct flat feet are weight loss, the performance of different types of exercises that strengthen the muscles that support the arch of the foot, long walking on uneven ground. Today's practice implies the increasing exclusion of the use of orthopedic aids in terms of shoe insoles. The use of these aids puts the foot in a passive position, namely it prevents its active involvement in performing static and dynamic function, and consequently slows down the development of muscles and ligaments. One of the mentioned researches speaks in support of the stated statement. The results of this study showed that children from urban areas who wear shoes with insoles have a higher frequency of flat feet than children from rural areas who perform most of the movement without shoes.

## Conclusion

What still remains insufficiently researched and needs more attention is related to the assessment of the period during which the foot structures establish their definite shape in order to be able to decide in which

period the appearance of a flat foot represents an extreme pathological condition which requires more serious treatment.

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