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Research Article

Prevalence of Flexible Flat Foot in Iranian Male School Children

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Abstract

Background: Flat foot is a deformity in which patients lack standard arches in the soles of the foot. Flat foot improves with age. This study was designed to determine the prevalence of flexible flat foot among male school children in Tehran, Iran.
Methods: A total of 1539 male school children were included in this study. Students were examined for the flatness of the sole of the foot as well as its degree and type. Flat foot was diagnosed on inspecting a poor formation of the arch. The severity of flatness was classified according to Denis criteria.
Results: Among 1512 children whose foot condition was recorded, 80.7% had normal/grade 1 sole, 16.7% had 2nd degree flat feet, and 2.6% had 3rd degree flat feet. Prevalence of genu varum was 16.1% and prevalence of genu valgum was 2.7% (P = 0.504). The prevalence of flat foot decreased significantly with age; in the group of 11-year-old boys and younger, 23.1% showed a grade 2 and grade 3 flat foot, whereas in the group of 12-year-old boys and older, only 13.6% had a grade 2 and grade 3 flat foot (P < 0.001).
Conclusion: In this study, a significant relationship was found between weight gain and body mass index (BMI) with flat feet. There is a significant association between passing the age of 12 years and a decrease in flat foot. Also, the association between flat foot with weight and height of children was examined separately, and it was found that weight could significantly be a poor predictor of flat feet.

Keywords: Flat Foot; Flexible Flat Foot; Children; Prevalence

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Background

A flat foot is an anomaly in which the longitudinal arch of the foot is reduced (1, 2). In the flexible form, the condition only exists in the standing position and it disappears when standing on the toes or lifting the foot off the ground (2, 3). The anatomical arch in the sole of the foot reduces the forces exerted on the body by the ground. In the flat foot, a large amount of these forces are applied to the body, which in the long-term, can lead to a series of complications in different joints, especially the spine (4, 5).

The most common symptom is pain, usually in the foot arch, calf, knee, lower back, and lower leg (6, 7), which can reduce the function of the lower limb (8). Most children may have flat feet between the ages of 1 and 5 (4), which is part of the natural growth and does not cause a problem in more than 95%. Although the development of the foot arch improves with age, it may fail in 5% (9-11).

Currently, the relation between flexible flat foot in children and long-term morbidity is unclear. The treatment is selected based on the physician's personal assessment and the clinical experience has shown unreliable and contradictory results (12, 13).

The prevalence of flat foot has been reported as 97% in 18-month-old toddlers and 4% in 10-year-old children (14). The flexible form has a prevalence of up to 44% in 3- to 6-year-old children (13). The prevalence is higher in boys and a deviation from the normal weight increases the risk of disease, as it has a prevalence of 62% in obese children, 51% in overweight children, and 42% in the normal population (13). In a study with 667 Iranian children between 7 to 14 years old, the prevalence of flat foot was 17.1%, which showed a decrease with age and an increase with weight (15).

To date, no big-scale study has been conducted in Iran regarding the prevalence of flat foot. In this study, we aimed to determine the prevalence of this condition in Iranian male school-age children.

Methods

Study Design: A total of 1539 male school-age children (6-20 years) (6 for some elementary students and 20 for whom failed some years in school) were included in this cross-sectional study. The sample population was randomly selected from boys' schools throughout the city of Tehran, Iran. This study was approved by the Ethical Committee of Tehran University of Medical Sciences.

A questionnaire containing birth information, flat foot history, and accompanying symptoms or other foot-related problems was prepared to be filled by the parents. The students were examined for the flat foot, its degree and type, and the presence of knee deformities (genu varum and genu valgum). The students' height and weight were also recorded.

Clinical Assessment: The diagnosis of flat foot was made based on clinical exam and detection of the poor formation of the foot arch. The examination was performed in a standing position with both legs carrying the weight equally. The following items were examined: the sole of the foot for the degree of flatness, the knees for genu varum or genu valgum, height, weight, and body mass index (BMI).

The children were categorized into three groups based on height: short (below the 5th percentile), normal (between the 5th and 95th percentiles), and tall (above the 95th percentile). Similarly, there were three weight groups: underweight (below the 5th percentile), normal weight (between the 5th and 95th percentiles), and overweight (above the 95th percentile). The qualitative groups for BMI included lean (below the 5th percentile), normal (between the 5th and 95th percentiles), and obese (above the 95th percentile) (16).

The severity of flat foot was classified into 3 grades using the Denis method:

In the first grade, the support of the lateral edge of the foot is half of that of the metatarsal support. In the second grade, the forefoot and the central zone have the same amount of support and in the third grade, the central zone of the foot has greater support than the width of the metatarsal support (17).

Without the footprints, it is difficult to differentiate a normal foot from a grade 1 flat foot. Therefore, we assigned them to the same group. Those with deformities or a history of severe trauma to the foot were excluded from the study. In case of a difference between the arches of the feet, we considered the flatter foot for classification of the severity (18). The patients with third-degree flat foot or rigid flat foot were referred to the orthopedic clinic (Imam Khomeini Hospital, Tehran University of Medical Sciences) for further examination.

Statistical Analysis: Descriptive statistics were used to provide an overview of the collected data and to present the prevalence of flat foot subsets and related factors. Chi-square test compared the frequency of flat foot subsets in different groups based on age, weight, BMI, height, lateral knee angle, and birth season. The statistical analyses were carried out using SPSS software (version 26, IBM Corporation, Armonk, NY, USA) and the level of significance was set at 0.05.

Results

The mean age of 1539 male school-age participants was 11.16 ± 3.03 years (11.36 years in normal/grade 1, 10.13 years in grade 2, and 10.90 years in grade 3). There was no significant relationship between the flat foot and age (P = 0.427).

27 children were excluded from the study due to incomplete information. Among 1512 children whose foot condition was recorded, 1220 (80.7%) were normal/grade 1, 252 (16.7%) were grade 2, and 40 (2.6%) were grade 3.

The prevalence of grade 2 and 3 flexible flat foot was 29.3%. The prevalence of flat foot decreased significantly with age. In children with 11 years old and younger, 23.1% (209 cases) showed a grade 2 or 3 flat foot, while in older children, only 13.6% (82 cases) were grade 2 or 3 (P < 0.001).

The percentage of patients with grade 2 flat foot in 11 years old children and younger was 23.1% (209 cases), which was reduced to 13.6% (82 cases) in 12 years old children and older, while the opposite was true in patients with normal foot. Grade 1 occurred from 76.9% (695 cases) in the first group to 86.4% (521 cases) in the second group; however, the percentage of people with grade 3 filtration did not change significantly [from 2.5% (23 cases) in the first group to 2.7% (16 cases) in the second group].

The prevalence of genu varum was 16.1% (244 cases) and prevalence of genu valgum was 2.7% (42 cases). There was no significant relationship between the grade of flat foot and the knee alignment disorders (P = 0.504).

We divided the children into three weight groups: underweight, normal, and overweight. Of the total number of participants, 30.4% (390 cases) were overweight. Prevalence of flat foot was different between overweight children and normal-weight/underweight children (P < 0.001). The prevalence of flat foot in grade 2 and 3 increased with weight [15.2% in the underweight group (7 cases), 18.1% (193 cases) in the normal-weight group, and 23.1% (90 cases) in the overweight group]. Among these, the prevalence of grade 2 flat foot in the overweight group was clearly higher than the other two groups [20.3% (79 cases) in the overweight group versus 15.2% (7 cases) and 15.4% (165 cases) in the underweight and normal weight groups, respectively]. The risk of grade 2 and 3 flat foot in overweight group was 1.28 times higher than that of other groups [odds ratio (OR) = 1.28].

We also examined the qualitative BMI and divided them into three groups: lean, normal, and obese. The children with lean BMI were 1.42 times more likely to have grade 2 or 3 flat foot than those with normal BMI (OR = 1.42). However, this was not statistically significant (P = 0.067). Obese children were 1.38 times more likely to have grade 2 or 3 flat foot than those with normal BMI (P = 0.006). A summary of BMI can be found in table 1.

Table 1. Prevalence of flat foot by grades in terms of three body mass index (BMI) groups

BMI	Normal/grade 1	Grade 2/grade 3
Lean	86 (76.1)	27 (23.9)
Normal	777 (83.2)	157 (16.8)
Obese	351 (76.8)	106 (23.2)

BMI: Body mass index
Data are presented as number and percentage

For height analysis, children were divided into three groups of short, normal, and tall (Table 2).

Table 2. Prevalence of flat foot by grade in terms of three height groups

Classification	Normal/grade 1	Grade 2/grade 3	Grade 3
Short	38 (90.5)	3 (7.1)	1 (2.4)
Normal	1032 (80.8)	214 (16.7)	32 (2.5)
Tall	145 (78.4)	34 (18.4)	6 (3.2)

Data are presented as number and percentage

In children with short stature, the prevalence of normal/grade 1 flat foot was about 10% higher than the two other groups. The probability of flat foot in the short group was 50% lower than the normal and tall groups (OR = 0.487). However, our findings did not show statistical significance (P = 0.465) (Table 3).

Table 3. Prevalence of flat foot by grade in terms of three weight groups

Classification	Normal/grade 1	Grade 2/grade 3	Grade 3
Lean	39 (84.8)	7 (15.2)	0 (0)
Normal	875 (81.9)	165 (15.4)	28 (2.6)
Obese	300 (76.9)	79 (20.3)	11 (2.8)

Data are presented as number and percentage

Discussion

The flat foot is common in school-age children. In this study, the prevalence of grade 2 and 3 flexible flat foot was 29.3% among school-age boys. El et al. reported a prevalence of 17.2% for flexible flat foot among primary school children (2) and Pourghasem et al. demonstrated a similar prevalence of 16.1% (19).

According to previous studies, flat foot is resolved in the majority of children at the age of 12 years (20). In other words, there is a significant correlation between the age of 12 and a decrease in flat foot. This result is completely consistent with the study of Garcia-Rodriguez et al. (20).

We examined the association between flat feet and height of children, but no significant relationship was found (P = 0.465). A significant difference was observed in the prevalence of flat foot and weight (P < 0.001).

However, Pfeiffer et al. showed that any deviation from the normal weight may increase the risk of flat foot (13). Although we found a 50% higher risk of flat foot in children with short stature, it failed to show statistical significance, which can be due to the small sample size of this group (the total number of 42 participants).

According to our findings, it seems that being in the overweight group can be a low risk factor for flat foot [the risk of grade 2 and 3 flat foot in overweight group was 1.28 times higher than that of other groups (OR = 1.28), but as a single variant, weight is a low risk factor for flat foot] which is also consistent with the Bordin et al. study (21). In contrast, Pfeiffer et al. demonstrated that overweight children had higher incidence of flat foot (13).

In this study, the mean BMI showed an increase in higher grades of flat foot (from 19.1 and 18.8 in normal/grade 1 and grade 2 to 20.9 in grade 3 group). Gijon-Nogueron et al. found no significant relationship between high BMI and flat foot (22). The risk of grade 2 and 3 flat foot was higher in obese children compared to children with normal BMI (OR = 1.38).

The risk of obese people with grade 2 and 3 flat foot was about 1.32 times higher than the risk of other groups having the same degree of flat foot.

We had some limitations. The gender was limited to boys as a result of sex separation in Iranian schools. Also, the study had a small sample size and it was limited to one city.

Conclusion

The frequency of grade 2 and 3 flexible flat foot was about 29.3% among Iranian male school children between 6 and 20 years old. We found a relatively significant relationship between weight or BMI and flat foot prevalence.

Conflict of Interest

The authors declare no conflict of interest in this study.

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