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An analysis of longitudinal and transverse arches of children from świętokrzyskie voivodship

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Abstract

Introduction and purpose of the work. Sedentary lifestyle being promoted at present is negatively affecting health and physical fitness of young people. Flat feet is a defect of lower limbs which consists in lowering arches shaping feet. The foot, under normal conditions, rests with three points on the ground: a calcaneal tuber, the head of the first and fifth metatarsals. The purpose of the work was to evaluate longitudinal and transverse arches of children from świętokrzyskie voivodship.

Material and methods. The study involved 184 children from świętokrzyskie voivodship. The majority of the respondents were female – 100, whereas the male respondents - 84 people. The MS Excel program and the statistical program R.3.3.1 were applied therefor. The Clarke's angle index and the Wejsflog index were was used to assess the foot arch. The relationships between these parameters and gender, age, and BMI were investigated as well.

Results. As a result of the conducted studies, the correct structure of both feet was found in 51% of the examined children. Flat feet of both feet was found in 4 children, whereas 34 children demonstrated a reduced arch of both feet. The problem of a reduced arch in one foot concerned 48 children, while 5 children had one foot with an elevated arch.

Conclusions. Children with higher BMI index tend to have a decreased feet arch. With age, the Clarke's angle values decrease.
Key words: foot, podoscan, children.

Introduction and objective

Sedentary lifestyle being promoted at present is negatively affecting health and physical fitness of young people. Suspected flat feet in children is one of the most common orthopedic or physiotherapeutic consultations. Flat feet is a defect of lower limbs which consists in lowering arches shaping feet. The foot, under normal conditions, rests with three points on the ground: a calcaneal tuber, the head of the first and fifth metatarsals. There are foot arches between these points: medial longitudinal, lateral longitudinal and transverse. In consequence, lowering of these arches results in developing flat feet. Disorder of body statics in children and adolescents leads to overuse syndromes, and eventually, it may lead to dysfunctions of the foot function, degenerative changes and pain problems in adulthood. One must note that feet, more than any other parts of the motor organs, are exposed to adverse effects of external environment factors. [1,2,3]

The pre-school and school age is generally considered as a period sensitive to the development of the architecture of the foot and the entire posture. During this period special attention is paid to two critical periods of posturogenesis, conducive to the formation of postural abnormalities. The first primary phase of school, i.e. the age of 6-7 years old is, associated with a change in lifestyle resulting from taking up compulsory schooling. The second phase is spread over the age of 11-13 in girls, 13-14 in boys, and is related to the puberty leap. Early detected irregularities are often of a functional nature and their correction can be relatively easy. [1]

The purpose of the work was to evaluate longitudinal and transverse arches of children from świętokrzyskie voivodship.

Materials and methods

The study involved 184 children from świętokrzyskie voivodship. The majority of the respondents were female – 100, whereas the male respondents - 84 people. The study group involved: 8 7-year-olds, 12 8-year-olds, 31 9-year-olds, 52 10-year-olds, 38 11-year-olds, 42 12-year-olds, and one 13-year-old child (Fig. 1).

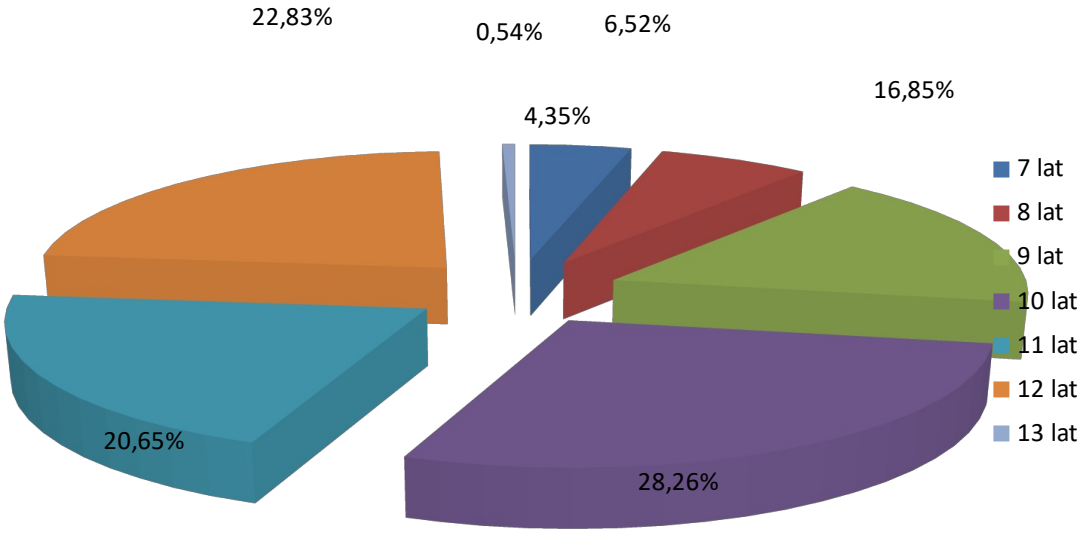

Figure 1. The age structure of the respondents

The research was conducted after obtaining the consent of the Bioethical Commission located at the Jan Kochanowski University in Kielce. The research was carried out in schools located in Masłów district after obtaining the consent of parents or legal guardians of children. The MS Excel program and the statistical program R.3.3.1 were applied therefor. The Clarke's angle index and the Wejsflog index were was used to assess the foot arch. The relationships between these parameters and gender, age, and BMI were investigated as well. In order to evaluate it, the authors conducted the Wilcoxon test and the Pearson correlation test.

Subjective and objective methods are applied to assess the body posture. The application of a 2D computer podoscope computer in the study determines non-invasive and complete objectivity thereof. The children wore sport clothes without shoes for the examination. The body height, and subsequently, the body weight of the children were measured using the Tanita device. Then, a picture was taken with the use of a 2D podoscanner. The angles in the statistical program were determined in a manual manner.

Results

Table 1. The evaluation of the foot structure took account of the Clarke's angle index, and the Wejsflog index.

The Clarke's angle index	Left foot		Right foot		Both feet		At least one foot	
	n	%	n	%	n	%	n	%
Flat foot	7	4%	4	2%	4	2%	7	4%
Lower arch foot	44	24%	72	39%	34	18%	82	45%
Normal foot	128	70%	108	59%	93	51%	143	78%
High arch foot	5	3%	0	0%	0	0%	5	3%

The correlation between the Clarke's angle and gender
In order to check the relationship between the Clarke's angle and gender, the Wilcoxon test was conducted for two groups. It did not show the existence of a statistically significant relationship (p-value = 0.11). The average value of the Clarke's angle in the group of girls amounts to 43.29, and in the group of boys 42.45.

The correlation between the Clarke's angle and BMI (Fig. 2)
In order to check the existence of a relationship between the Clarke's angle and BMI, a scatter graph of the relationship with a regression line was used, which indicates a negative direction of dependence. To confirm the relevance thereof, the Pearson correlation test was performed (the correlation coefficient is -0.237, p-value <0.01).

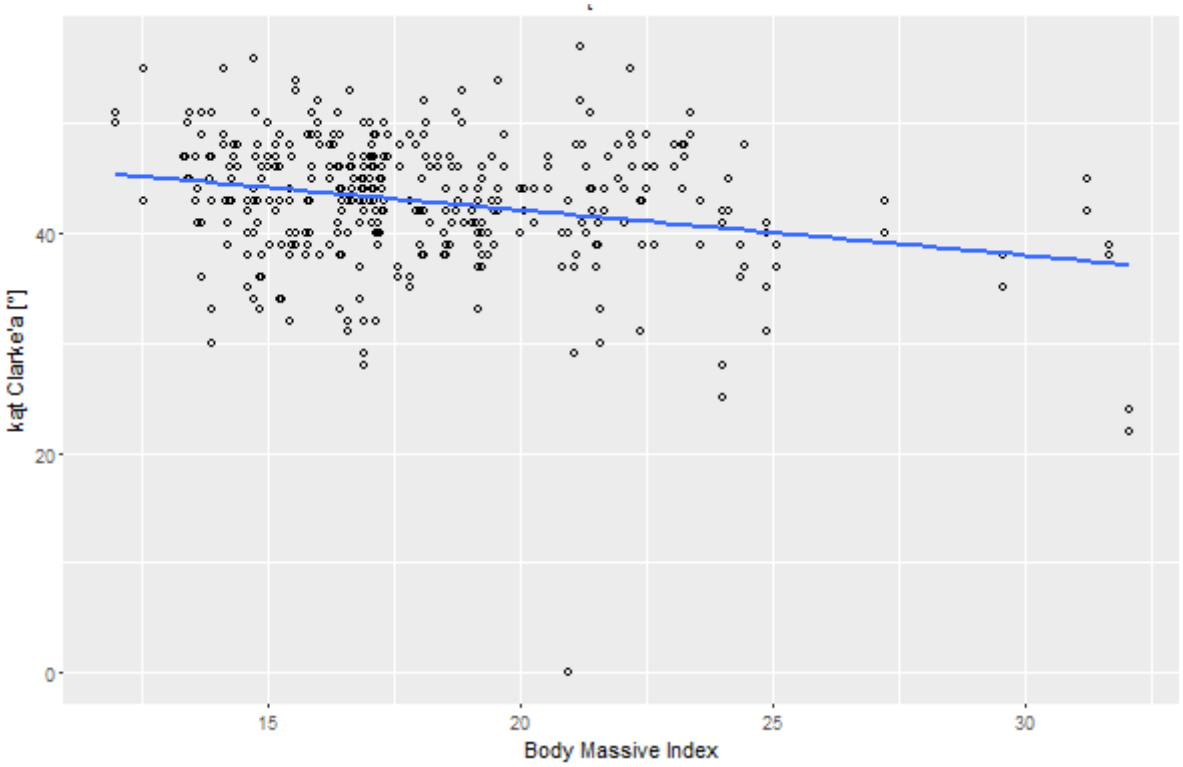

Figure 2. The correlation between the Clarke's angle and BMI

In people with a higher BMI lower values of the Clarke's angle are observed.
After classifying the feet based on the Clarke's angle, the following graph of dependencies was derived.

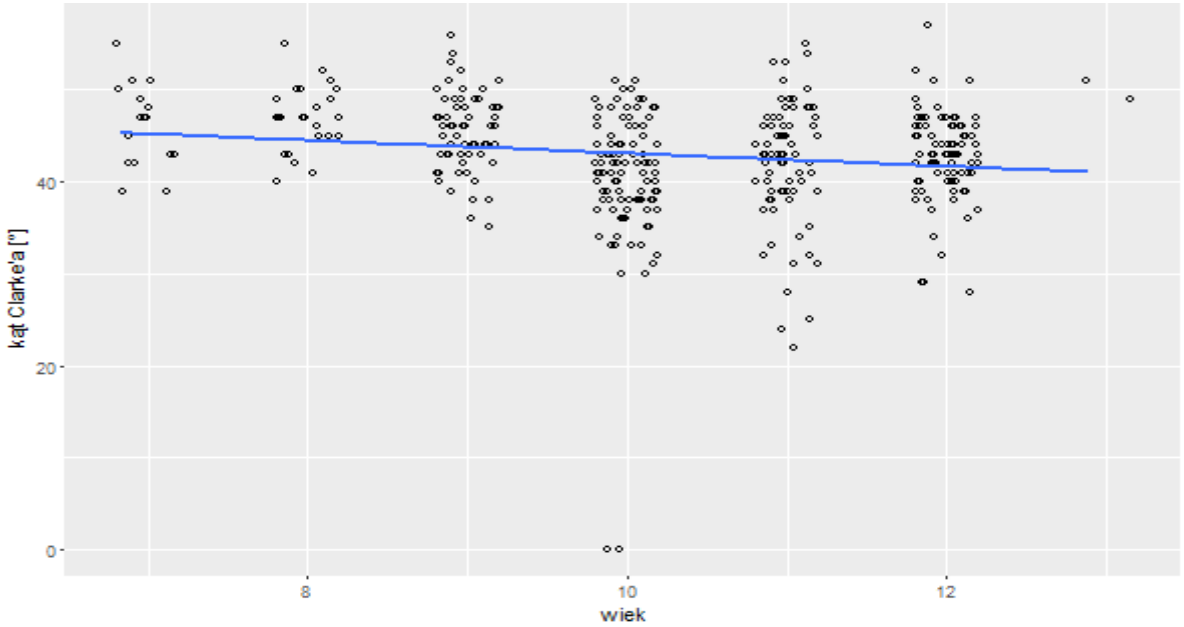

Figure 3. The correlation between the Clarke's angle and age

An analysis of the Pearson's correlation indicates the existence of a statistically significant relationship between the Clarke's angle and age (the correlation coefficient is -0.166, p-value <0.01). (Fig. 3).

A very distinct difference in the average value of the Clarke's angle can be observed by comparing a group of children under the age of 10 years old (the average value of the Clarke's angle is 45.8) and 10 years and more (the average value of the Clarke's angle is 41.8).

The correlation between the Wejsflog index and gender
No correlation between the Wejsflog index and gender was found. In the group of girls, the average index value amounts to 2.67, and among boys to 2.64.
The conducted analyzes showed the dependence between the Wejsflog index and BMI (Fig. 4). The Pearson's correlation coefficient amounts to -0.29 (p-value << 0.01). The scatter graph with a regression line presented below shows the direction of dependencies between the f features under consideration.

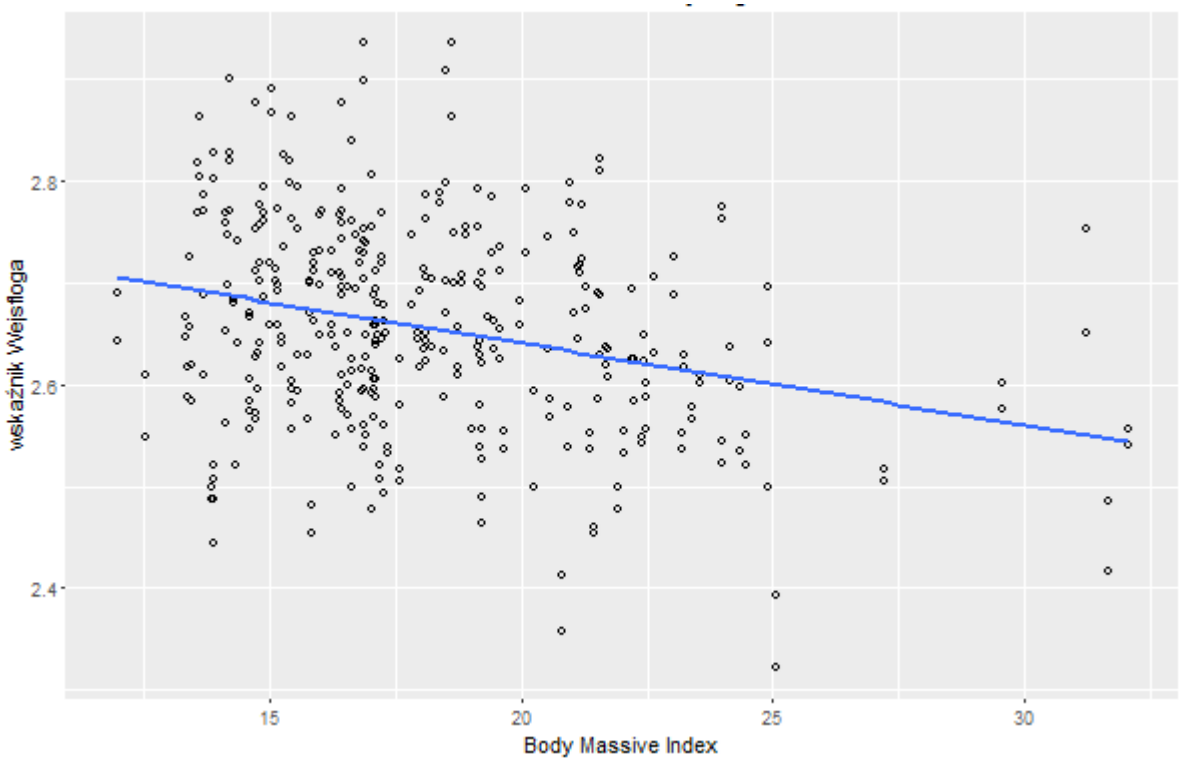

Figure 4. The correlation between the Wejsflog index and BMI

Among overweight people lower values of the Wejsflog index are observed.

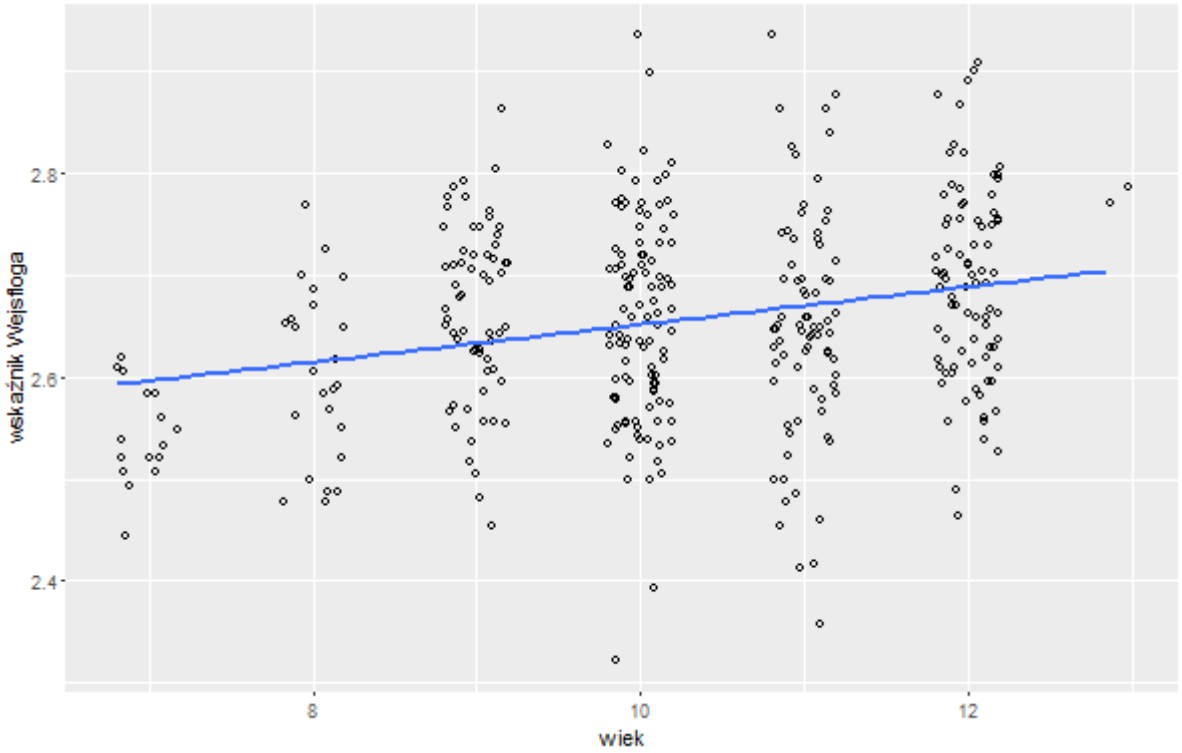

Figure 5. The correlation between the Wejsflog index and age

The correlation analysis demonstrated a statistically significant relationship between the Wejsflog index and age (the Pearson's correlation coefficient amounts to 0.26, p-value << 0.01) (Fig. 5).

As a result of the conducted studies, the correct structure of both feet was found in 51% of the examined children. Flat feet of both feet was found in 4 children, whereas 34 children demonstrated a reduced arch of both feet. The problem of a reduced arch in one foot concerned 48 children, while 5 children had one foot with an elevated arch.

The research showed that 51% of the children from Masłów district during the research had no problems with the construction of lower limbs, while 4% of the respondents have flat feet, and in 45% of the examined children there is a low arch in at least one foot.

Discussion

The occurrence of foot defects among children is a very common phenomenon, which justifies the relevance of the study of this problem. Feet condition determines a correct gait and the body posture of children, and then adult people. The assessment of the correct foot shape is of diagnostic importance. Deviations in the feet construction may be caused by postural errors or may lead to these errors. However, it should be noted that the foot formation is a long-term process - the authors mention that it can last even up to the age of 10-14, 15 years old. [1,4,5]. During the ontogenetic development, the child's foot undergoes a series of changes. Serious deformities might occur which, if not treated, cause defects, not only feet defects. Therefore, implementing preventive measures when the child's foot is still plastic enough is justified. Appropriate selection of physical exercises can prevent defects from deepening, and if practised systematically, they will strengthen the ligament-muscular system, prolonging its full efficiency. [1, 6]

Screening studies of the population of children in the Świętokrzyskie Voivodship will make it possible to evaluate the correct structure and occurrence of pathologies in particular age groups, and therefore, it will contribute to get a clear understanding of the exact construction of children's feet in our voivodship together with the analysis of the body posture, as well as indicate the direction of preventive activities.

Garcia et all [7], while examining children aged 4 to 13 from Spain, observed that flat feet was found only among 2.7% of the children, representing a significantly lower percentage than in the examined group of children. In the studies of Bordin et al.[8], flat feet was found among 16.4% of the children aged 8-10 years old, and more often in boys than girls. 27.3% of those children suffered from obesity or overweight. Excessive body weight was more common among children with flat feet. The study conducted on 1.158 children at the age of 6-18 years old from Babol by Portughasem et al.[9] demonstrated that the majority of children - 89% had normal feet, whereas flat feet was observed in 16.1% of the respondents. The boys had flat feet more often, but it was not a statistically significant dependence. It was observed in these studies that higher BMI increases the occurance of flat feet. While examining 2.083 children in Taiwan aged 7-12, Chang et al. [10] stated that 59% of children had flat feet. The respondents with overweight or obesity have flat feet more often. The authors also noticed that boys developed flat feet more often than girls. The number of children with flat feet increases with age.
In the studies conducted by Evans [11], where 140 children from Australia aged 7-10 were examined, no correlation between improper foot construction and obesity/overweight was found. The same author [12], while examining a larger group consisting of 728 children at the age of 3-15 years old, confirmed her previous research and found no statistically significant relationship between the increased BMI and flat feet. Woźnicka et al. [13], while examining 1.115 children aged 3-13 from Kraków, observed on the basis of the Clarke's angle that the majority of children had a high foot arch - the foot with an elevated arch. In own study such a foot structure was found in less than 3%. They noticed that the number of children with flat feet increases with age. The correlation between body weight and flat feet was also clearly visible - more visible among girls than boys.

Different percentages regarding the occurrence of flat feet or low arched feet may result from the use of various research tools assessing the feet construction in children by the above authors. As in most of the publications in the presented study, changes in the feet formation are visible along with age, and the Clarke's angle values decrease - it reflects a decreasing longitudinal arch, while the Wejsflog index values increase. In this paper, increasing BMI reduces the longitudinal and transverse arch which is also visible in the majority of authors [8, 9, 10].

Conclusion

1. Children with higher BMI index tend to have a decreased feet arch.
2. With age, the Clarke's angle values decrease.

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