

Częstość występowania wad stóp u dzieci w wieku przedszkolnym

Prevalence of feet defects in preschool-aged children

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Streszczenie:

Wstęp i cel pracy. Dzieciństwo – czas rozwoju człowieka – to bardzo istotny okres, podczas którego stopa zmienia się, aby w przyszłości być gotową na wiele lat ciężkiej i wytrwałej służby. Celem pracy jest ocena częstości występowania wad stóp w grupie dzieci przedszkolnych.

Materiał i metody. Do badań włączono 143 dzieci i przeprowadzono: pomiary ortopedyczne, pomiary antropometryczne, badanie plantokonturograficzne oraz badania podoskopowe. Rodzice dzieci wypełniali autorską ankietę dotyczącą rozwoju stóp dziecka, istniejących lub przebytych wad, noszenia obuwia oraz uprawiania sportu. Wyniki. Analiza wskaźnika kąтового Clarke'a ujawniła iż najczęstszą wadą w badanej grupie była stopa płaska (146 przypadków na 286 badanych stóp, ok. 50%), a także stopa o obniżonym wysklepieniu (102). Stopa w normie występowała w 37 przypadkach. Zanotowano także 1 stopę o podwyższonym wysklepieniu wg Clarke'a. Nie stwierdzono istotnych statystycznie różnic między występowaniem wad stóp, a stronami ciała. Wskaźnik KY nie wykazał istotnych statystycznie różnic pomiędzy występowaniem wad stóp, a stronami ciała. Płeć badanych dzieci nie miała istotnego wpływu na występowanie wad stóp wg tego wskaźnika, z wyjątkiem stopy płaskiej, której obecność u chłopców była istotnie wyższa niż u dziewczynek: $n=42$ (36%) vs $n=19$ (11%), $p<0,05$.

Wnioski. Na podstawie przeprowadzonej analizy wyników badanej grupy dzieci przedszkolnych, spośród wszystkich ocenionych parametrów najczęściej występującą wadą jest płaskostopie, najrzadziej zaś występuje stopa wydrążona. Odsetek dzieci aktywnych ruchowo i noszących odpowiednie obuwie w prewencji wad stóp jest niesatysfakcjonujący i powinno się skuteczniej promować świadomość aktywności ruchowej wśród rodziców i opiekunów dzieci w przedszkolu.

Słowa kluczowe:

wady stóp, wskaźniki kątowe, plantokonturografia

Abstract

Introduction and study aim. Childhood is known to be a very important period of life when the foot is gradually determining in order to become a strong support of the human body. The aim of the study is to assess the frequency of appearance of foot defects in preschool children.

Material and methods. The study group consisted of 143 preschool children, in which the following parts of examination were evaluated: orthopedic measurements, antropometric measurements, plantoconturographical examination and podoscopic examination. Parents were asked to fill out the questionnaire regarding to the development of their child's feet, defects as well as their child's habits and sports in which they participate.

Results. The analysis of Clarke's angular indicator revealed that flat foot was the most frequent defect in the study group (146/286 feet, circa 50%), and diminished foot was the second frequent problem in the examined group of children (102/286). The normal foot was established to be present in 37 cases. There was also 1 elevated foot due to Clarke's assessment. No statistical significance was observed between body sides and foot defects. Gender of patient was not statistically correlated to the examined children's defects besides flat foot, which was observed to be more frequently present in males: 42 males (36%) vs 19 females (11%), $p<0,05$.

Conclusions. The flat foot was observed to be the most frequently present defect of foot in preschool children. On the other hand, cored foot has been demonstrated to be the most rarely present defect in the study group. Percentage of children who participate in sport activities and wear comfortable shoes in order to prevent foot defects, is unsatisfactory. Motor activity should be more efficiently promoted among parents and caregivers of preschool children.

Key words:

foot defect, angular indicator, plantoconturography

Introduction

People spend most of their life in the vertical position, supporting body weight with their feet. Feet are the load bearing foundation, from the moment when a man moves on from Crawling to walking. Beginning with first steps, feet become an active element of the locomotor system. Already in the sixteenth century, Leonardo da Vinci called feet a masterpiece of machinery and a work of art. The human foot is a complex structure, which in the course of evolution, and the gradual verticalization of the body, has undergone a very complicated process of changes. The foot may be called a unique and highly functional support-bearing tool, which is however particularly vulnerable to damages and diseases [1].

Childhood – the time of intensive growth – is a very important period, during which the foot develops and prepares for the many years of heavy and persistent work. Child's feet are delicate and easy to form. The forming of lower limbs and feet is slightly different at different periods of a child's life. Knowledge of the physiological deviations is necessary for the proper diagnostics. It also allows to recognize the initial stages of a defect. In infants, the sign of normal development are the bow legs, as well as the flexed position of knee joints and hip joints, caused by the predominance of the flexor muscles over the extensor muscles – which is the effect of the intrauterine positioning of a baby. The bow legs condition persists, up until around the third year of life, when it turns into the physiologic valgus.

In seven year-olds, the legs should already be straight. Infants' feet have no arch, and their plantar sides are filled with a soft adipose tissue. At the beginning, the foot grows lengthwise, and only later it continues to grow breadthwise [2, 3, 4, 5, 6].

The primary factors contributing, to a large extent, to the formation of foot defects – are the congenital genetic disorders [7, 8].

Although the vast majority of children are born with the healthy feet, often in their childhood the defects occur. Neglected at the early stages, they may become the cause of the locomotor system malfunctions, and quite often lead to the degenerative changes and the instability of the knee joints, knock knees, bowl legs, degeneration processes within the spine and the hips. For the above reasons it is essential to prevent the foot deformations in children and to proceed with the ongoing assessment of their feet status. This is particularly important during the pre-school period, when the child's feet grow, develop and change shape [7, 9, 10, 11, 12]. Capturing any abnormalities in the foot development of a preschooler is important for the prevention and correction of the possible defects, and helps to avoid complications during the child's adult life. The ongoing control of the foot development should be the essential part of the prophylaxis procedures, performed by both the parents and the guardians of a child in the kindergarten [11, 13].

The aim of this study has been to assess the prevalence of foot defects among the group of preschool-aged children.

Research Materials and Methods

In the research participated 143 children, aged 3 to 7 years, from the kindergarten called "Bajkowy Dworek" ("Fairytale Manor") and the municipal kindergarten number 1 in Mława.

In the examined group of children, the mean age was 5 ± 1 year. The gender distribution has been as follows – girls constituted almost 60% of the group ($n=85$), boys 40% ($n=58$). The detailed data for the age, weight and height parameters of the whole group, the girls and the boys, present Tables 1, 2 and 3.

Table 1. Demographic profile of all study subjects

	N valid	Mean	SD	Minimum	Maximum
Age	143	5	1	3	7
Weight	143	19	5	11	45
Height	143	110	9	89	139

Table 2. Demographic profile of the subgroup of girls

	N valid	Mean	Standard deviation	Minimum	Maximum
Age	85	5	1	3	7
Weight	85	19	5	11	45
Height	85	109	9	89	139

Table 3. Demographic profile of the subgroup of boys

	N valid	Mean	Standard deviation	Minimum	Maximum
Age	58	5	1	4	7
Weight	58	19	4	2	32
Height	58	111	10	93	130

To examine the children, there had been used: orthopedic measurements, anthropometric measurements, plantoconturographic examination and podoscope foot assessment. The parents of the children had also completed our in-house questionnaire, regarding the development of their children feet, the existing or past defects, the footwear being worn and the sports activities performed.

The orthopedics examination led to determination, to which of the three major groups belong the feet of the examined child: the pes cavus (high instep), the normal foot or the flat foot. The evaluation had been of subjective nature, as the feet had been visually inspected by a specialist. Therefore the evaluation result strictly depended on the specialist's experience. The examination had been done in both, the seated position (to define the range of motion of the foot joints) and in the standing position, feet elevated on the toes.

The anthropometric measurements were taken with a compass and a metric tape. Using these tools, the length of the foot was measured, from the point farthest to the rear of the tuber calcanei to the

furthest point on the front of the foot, located on the pulp of the longest toe, as well as the width of the foot, from the most para-central point of the head of the first metatarsal bone, on the inside edge of the foot, to the most laterally located point on the head of the fifth metatarsal bone, on the outside edge of the foot. Further, a measurement of the forefoot circumference was taken [14, 15, 16]. In all the study participants there had been a plantocontourogram made, which is an impression of the plantar surface of the foot with its drawn around contour. On the basis of the plantocontourogram, the foot evaluation had been made, marking the angles and indicators which characterize the foot structure. For the purpose of this study, we have used four of them: Clarke's Angle, Sztriter-Godunov Indicator, Wejsflog Indicator, and the heel angle [8, 17, 18, 19, 20].

Another method used when examining the feet of the children, was the podoscope assessment. The patient stood with the bare feet on a special, illuminated piece of equipment, called a podoscope. Assessed was the appearance of the foot surface in contact with the ground [12, 15, 16].

For the statistical evaluation of the results, the software package Statistica, version 9.1PL (WUM academic license) has been used. To analyze the correlations between the quantities of the questionnaire answers, the chi-square independence test was used. The significance threshold of $\alpha = 0.05$ was adopted. This means, that all the obtained results of the parameter $p < 0.05$, indicate the existence of the statistically significant correlations.

Research Results

Clarke's angle indicator

In the examined group, the most commonly found foot defect was the flat foot (146 cases, approx. 50%), as well as the foot with the lowered arch (102). The normal foot occurred in 37 cases. There was also 1 foot with the higher arch, according to the Clarke's indicator (Table 4). There were no statistically significant differences in the incidence of the foot defects, in relation to the side of the body (Table 5). The comparison of the results obtained in the group of girls and in the group of boys, made it possible to establish the statistically significant differences in the number of defects. Flat foot (acc. to Clarke's indicator) occurred in the majority of boys ($n=82$, 70%). In the case of the girls the foot defects had spread more evenly: the most common – the lowered foot arch ($n=80$, 47%) and the flat foot ($n=64$, 38%) amounted to 85% of this sub-group (Table 6).

Table 4. Number and percentage of foot deformities by Clarke Index

	Clarke Index						p
	Total		Left side		Right side		
	Number	%	Number	%	Number	%	
Płaska Flat	146	51.04895	75	52.44755	71	49.65035	Ns
Obniżone wysklepienie Lowered Arch	102	35.66434	51	35.66434	51	35.66434	Ns
Norma Normal	37	12.93706	17	11.88811	20	13.98601	Ns
Podwyższone wysklepienie Higher Arch	1	0.34965	-	-	1	0.6993	-

Table 5. Comparison of Clarke Index Values for the right and the left foot (Mann-Whitney U test)

	rank-sum right	rank- sum left	U	Z	P
Clarke's Angle Indicator	21376	19665	9369	1.222587	0.22
Heel Angle Gamma Indicator	20457	20584	10161	-0.090085	0.93
KY Indicator	20227.5	20813.5	9931.5	-0.418253	0.68
Wejsflog Indicator	20636	20405	10109	0.164442	0.87

Tab. 6. Number and percentage of foot deformities by Clarke Index and gender

	Girls		Boys		p
	Number	%	Number	%	
Flat	64	37.64706	82	70.68966	0.001
Lowered Arch	80	47.05882	22	18.96552	0.006
Normal	25	14.70588	12	10.34483	ns
Higher Arch	1	0.58824	-	-	-

Heel Angle Gamma

The analysis of the results of the heel angle measurements had shown 161 cases of the normal foot (about 56%), 72 cases of the flat foot (25%) and 53 cases of the high arched foot (19%) (Table 7). Also in the case of the above indicator, there were no statistically significant differences in the incidence of the foot defects, in relation to the side of the body (Table 5).

Sztriter-Godunov Indicator (KY)

The KY measurements divided the whole group in the following manner: 126 cases of the 2nd degree lower arch foot (44%), 61 cases of the flat foot (21%), 58 cases of the normal foot (20%), 28 cases of the 1st degree lower arch foot (10%) and 13 cases of the hollow foot – pes calvus (5%) (Table 8).

The KY indicator showed no statistically significant differences in the incidence of the foot defects, in relation to the side of the body (Table 5). Gender of the examined children had no significant impact on the occurrence of foot defects – according to this indicator (Table 9), with the exception of the flat foot, which prevalence among the boys was significantly higher than among the girls: n=42 (36%) vs n=19 (11%), $p<0.05$.

Tab. 7. Number and percentage of foot deformities by the heel angle Gamma

	Heel angle Gamma						p
	Total		Left side		Right side		
	Number	%	Number	%	Number	%	
Normal	161	56.29371	79	55.24476	82	57.34266	ns
Normal	53	18.53147	27	18.88112	26	18.18182	ns
Flat	72	25.17483	37	25.87413	35	24.47552	ns

Table 8. Number and percentage of foot deformities by Sztriter-Godunov Index (KY)

	wskaźnik Sztritera-Godunowa (KY)/Sztriter-Godunov Index (KY)						p
	Razem/Total		Lewa strona/Left side		Prawa strona/Right side		
	Liczba/number	%	Liczba/number	%	Liczba/number	%	
Lower 2°	126	44.05594	58	40.55944	68	47.55245	ns
Flat	61	21.32867	34	23.77622	27	18.88112	ns
Normal	58	20.27972	30	20.97902	28	19.58042	ns
Lower 1°	28	9.79021	15	10.48951	13	9.09091	ns
Hollow	13	4.54545	6	4.19580	7	4.89510	ns

Tab. 9. Comparison of the four angle indices: girls vs boys (Mann-Whitney U test)

	rank-sum – right	rank-sum – left	U	Z	P
Clarke Index	28288.5	12752.5	5966.5	5.66866	<0.0001
Heel angle Gamma	24986	16055	9269	0.85984	0.39
Sztriter-Godunow Index (KY)	20403	20638	5868	-5.81209	<0.0001
Wejsflog scale	25198.5	15842.5	9056.5	1.16926	0.24

Wejsflog Indicator

The Wejsflog indicator evaluation showed the vast majority of the normal foot cases (n=246, 86%), 38 cases of the flat foot (13%) and only 2 feet (approx. 1%) with the high arch.

In the case of the Wejsflog indicator, no statistically significant differences were established in the incidence of the foot defects, in relation to the side of the body (Table 5). Gender related differences were not evident, in the statistically significant manner – in the case of this indicator (Table 9). A comparable number of the cases was noted in both, the girls and the boys groups.

Correlation between the feet and the knees position

For the whole group (n=143), the analysis was made of the tarsus and the knee joint position. A significant correlation between the simultaneous knee and tarsal valgus was observed (n=63, 76%). On the other hand, the majority (n=39,65%) of normal foot positioning matched the normal knee positions. Analysis of the same correlation among the girls confirmed the same statistically significant correlation, as was the case for the whole examined group. However, in the case of the boys there was observed absence of the same correlation in such intensity, even though there was found the incidence of the knee and tarsal valgus in the vast majority of the cases.

Sports activity and defects (both feet together)

The hypothesis concerning the effects of sports activity on the occurrence of foot defects has been confirmed by the analysis of 2 out of 4 indicators. In the case of the Clarke's angle and the KY indicator, in the examined group there has been statistically significant correlation observed, in relation to the reduction in prevalence of the foot defects where the sports activities were being performed. Also with regard to the other indicators (heel angle and Wejsflog) a similar tendency has occurred, however it was not statistically significant (Table 10).

Tab. 10. Comparison of the four angle indices: sports participation vs non-participation (Mann-Whitney U test)

	rank sum – right	rank-sum – left	U	Z	P
Clarke Index	11908.5	29132.5	5122.5	-6.89763	<0.0001
Heel angle Gamma	15886.5	25154.5	9100.5	-1.10519	0.27
Sztriter-Godunow Index (KY)	21329	19712	5177	6.81827	<0.0001
Wejsflog scale	16563	24478	9777	-0.12013	0.90

Footwear and defects

We have also examined correlations between the footwear being worn and the occurrence of the foot defects. The Clarke's angle indicator has shown, that there is a significant correlation between the wearing of the soft slippers and the flat foot ($n=89$).

On the basis of the heel angle indicator, no significant correlation has been established between wearing of the various types of footwear and the occurrence of foot defects – according to the aforementioned indicator.

In turn, on the basis of the KY indicator, similarly like in the case of the Clarke's angle, there has been found a significant increase in the prevalence of the flat foot and the

2nd degree lowered arch foot in the case of wearing the footwear of the "soft slippers" type. Again, in the data analysis on the basis of the Wejsfloga indicator, no significant correlations between the type of the footwear and the occurrence of the foot defects have been established.

Discussion

Issues related to the foot defects in children and in young people add up to a comprehensive knowledge domain, and are being discussed in the scientific literature. Often the research involves a larger group of participants (100 to 1000), in the various age groups (3-20 year-olds) [18, 21].

The results of our in-house research have shown, that according to the Clarke's angle, 50% of the children have had flat foot, 70% of which are boys. 35% of the preschool children examined, have had the lowered foot arch. In the case of the girls, the defects spread more evenly: 47% have had lowered foot arch, 38% - flat foot.

Similar results has obtained P. Lizis, who has examined the development of the foot longitudinal arch in children. He also indicates, that the girls – due to their faster development, and thus the earlier pubertal growth spurt – faster achieve the mature longitudinal foot arch [22].

The research carried out in the context of our work, as well as the P. Lizis' study, has shown slight differences between the arches of left and right feet. It means, that this particular information is statistically irrelevant, and therefore should not be taken into account for the purpose of this research (22).

When taking the heel gamma angle measurements, different results have been obtained than with the Clarke's angle indicator. The normal foot, according to this examination, has had more than half of the participants – 56% of the children, 25% of them has had the flat foot, and the high arch cases amounted to 1%. The examination has not shown significant differences between the boys and the girls. Also there have been no significant differences between the right and the left feet [22].

Different results have obtained A. Bac, R. Woźniacka and T. Szaparow, in their pedoscope assessment of the feet of the preschool and the early school-aged children in Cracow. They have observed, that the heel gamma angle has been outside of the normal status in more than half of the children, and the flat foot has been the less frequently occurring defect. Further they state, that with age, the percentage of the pathological foot changes increases, and that the most commonly occurring defect becomes the hollow foot (pes calvus) [23].

Contrary to the above statement have been our results of the heel gamma angle examination and the measurements of the KY indicator. In the KY examination, the highest percentage rate have attained the feet lowered in the 2nd degree – 44%. The flat and the normal feet have been on, more or less, the same level: 21% - flat, 20% - normal. There have been 10% of the feet lowered in the 1st degree, while the hollow feet amounted to only 5%.

Such a significant difference between our own research and this of A. Bac, R. Woźniacka and T. Szaparow, may be caused by the age of the examined children. The mean age of the children in Mława was 5 years, and therefore it could have been young persons whose feet did not, as yet, mature in terms of the longitudinal and the transversal foot arch [23].

E. Demczuk-Włodarczyk examining children and youngsters aged 3 to 20 years, has observed that the risk of developing a flat foot decreases, while the frequency of the occurrence of the hollow foot increases. So this statement stays somewhat in line with the results of the studies by A. Bac, R. Woźniacka and T. Szaparow [23].

E. Demczuk-Włodarczyk has also established, that there is the decrease of the longitudinal flat foot risk, in both feet, in the boys older than 3 years, while the transversal flat foot defect occurs more often in girls than in boys. With age in both groups, after the children are over 3 years old, there is the increased incidence of this defect: in girls in the right, and in boys in the left foot [24].

A. Gawroń and M. Janiszewski, evaluating the flat foot defect in children aged 4 to 16 years, have found that the prevalence of the flat foot in the studied population is high and amounts to 34%. 60% of the children with the above mentioned foot defect were boys, and 40% girls.

To actually relate to the research by both, E. Demczuk-Włodarczyk and A. Gawroń and M. Janiszewski, one should carry out tests not only on the preschool-aged children, but also on the older children. On the basis of the data in hand concerning the preschoolers from Mława, it may not be unequivocally concluded, that the children living in this area have their feet significantly different, or significantly similar, in comparison with the feet of children living in other towns [24].

In this work, we have also examined the correlation between the occurrence of the tarsal bones defects and the defects of the knee. In 76% of the children there have been found concurrently knocked, both the knees and the tarsal bones. With the correct positioning of the feet, even 65% of the children have not had the knocked knees defect. Among the girls this correlation has been at the same level, as in the case of the whole group. Among the boys the intensity of this correlation has been lower.

The comparison of the results obtained in the group of children, who had engaged in sports activities, with the results of the children whose level of physical activity had been low, has shown the existence of the significant correlation of the decrease in the foot defects frequency of occurrence, in the case of sports activities being performed in leisure time. The above has been also confirmed by the results of the Clarke's angle and the KY indicator examinations. The results derived from the measurements of the heel gamma angle, and the Wejsflog index – have shown similar correlations, but to a lesser degree.

Identical results has obtained in her research K. Walicka-Cupryś,

comparing the foot arch in children from kindergarten in Rzeszów, who were 4 to 6 years old, . The author of the study has compared the shape of the longitudinal foot arch before the children had attended corrective exercises, and after the period of 10 months, during which the children had performed the exercises. Using the plantocontourography and the Clarke's angle measurement, she has observed the reduction of the Clarke's angle value in the second examination. She has found no significant differences, however, which would show the improvement of the longitudinal arch of the foot [25].

One can only assume, that the period of 10 months may have been too short a time to separate the two examinations. In view of the above, in order to expect better results the tests should be repeated with the longer time intervals.

Civilizational changes, non-physiology-agreeable lifestyle, or the use of the improper footwear – can lead to the progressive degeneration of human feet. The foot, which is composed of 26 bones, reflects the state of the person's health. For the experienced orthopedic surgeon or the podiatrist, the foot is rich and a chronological record of information about the condition of the whole body. From a small child to an adult human being, the condition of feet reflects the functioning of the whole body.

Conclusions

1. Based on the analysis of the results in the study group of preschool children, from all the evaluated parameters the most commonly occurring defect is the flat foot, and the least frequent is the hollow foot (Pes cavus).
2. The percentage amount of the children physically active, and wearing the footwear proper for the foot defects prevention, is less than satisfactory, and so the awareness of the need for the sports activity among the parents and the guardians of the preschoolers should be more effectively promoted.



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3. Neglected in the early stages foot defects, may contribute to the knee joints instability and cause the knocked knee or the bow leg disorders.
4. During the preschool years, the feet develop, they change their shape, making it the important period for any preventive and corrective actions.
5. For preschoolers, the important element of prevention against the foot defects are the corrective exercises.

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