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Evaluation of occurrence of hallux valgus based on images from podoscope in children

Paulina Sztandera[1], Beata Szczepanowska-Wołowiec[2, 3], Ireneusz Kotela[2, 4]

[1]Doctoral Studies, Faculty of Medicine and Health Science, Jan Kochanowski University, Kielce, Poland
[2]Department of Rehabilitation in Disease of the Locomotor, Institute of Physiotherapy, Faculty of Medicine and Health Science, Jan Kochanowski University, Kielce, Poland
Head of the Department: Prof. Ireneusz Kotela MD, PhD
[3]Rehabilitation Department, Regional Polyclinical Hospital, Kielce, Poland
Head of the Department: Grażyna Ściegienna-Zdeb MD
[4]Clinical Department of Orthopedics and Traumatology, Central Clinical Hospital of the Ministry of the Interior, Warsaw, Poland
Head of the Department: Prof. Ireneusz Kotela MD, PhD

Key word: podoscope, children, hallux valgus angle

Abstract

Inroduction and aim of the study. Hallux valgus is a deformity where there is a lateral deviation of the proximal phalanx of the big toe. The objective of the study was investigation of the occurrence of hallux valgus based on the image from a podoscope in children, examination of the effect of ill-fitted footwear on the development of this complaint.

Material and method

The study covered 184 children, aged 7-13. The children were examined in their underwear, without shoes and socks. Body weight and body height was measured. The image of the feet on a podoscope was done at full load. The hallux valgus angle α, the Clarke's angle and the Wejsflog's index were calculated. The software calculated the correct size of the footwear which should be worn by the children. This size was compared with the size of the shoes which a child had during the examination.

Results. The problem of hallux valgus affects 26% of the children. Hallux valgus more frequently concerned the left foot. In 8% of cases hallux valgus concerned both feet.

Conclusions. Hallux valgus in the examined group more often concerned girls than boys. The hallux valgus angle α increased with age. Children who had a normal hallux valgus angle α had higher values of the Clarke's angle. In the group

of children examined, no statistically significant relationship was found between hallux valgus angle α and the fitting of footwear, Wejsflog's index and the BMI.

Introduction

Hallux valgus is a pathological deformity where there is a lateral deviation of the proximal phalanx of the big toe with respect to the metatarsal bones, deviating medially, which is related with lateral displacement of the tendon of the flexor hallucis longus muscle. With time, there occurs pulling of the proximal phalanx of the big toe by the tendon of the extensor hallucis longus and abductor hallucis muscle. It occurs that the base of the head of the first metatarsal is pushed into adduction, and the deformity increases. The medial surface of the head of the first metatarsal becomes visible, the medial part of the joint capsule is stretched, and the lateral part contractures. The consequence of this may be the deformity of other toes [1]. In the etiology of this disease genetic predispositions may be observed – inheritance from the side of the mother. This complaint more often concerns females, and the hallux valgus angle increases with age [1, 2, 3]. Also, footwear and concomitant diseases, such as flat foot, generalized ligamentous laxity, systemic inflammatory diseases, contracture of the Achilles tendon or of the gastrocnemius muscle, may be of great importance in the development of the deformity [1, 4].

Hallux valgus may be diagnosed using an X-ray image, or a footprint from a podoscope. The normal value for the hallux valgus measured by the X-ray image is 15°, which is the angle between the axis of the proximal phalanx of the big toe and the axis of the base of the first metatarsal. The X-ray is performed at anterior-lateral projection at full load [5, 1]. The hallux valgus angle α is in the image of the foot performed using a podoscope; this is the angle formed between the tangent of the medial edge of the foot and the tangent running from the widest part of the forefoot to the external edge of the hallux, which should be within from 0-9°[6].

In the relevant literature, there are many reports dealing with this problem in adults [2, 3, 7, 8, 9, 10].

Objective

The objective of the study was investigation of the occurrence of hallux valgus based on the image from a podoscope in children from rural areas, and examination of the effect of ill-fitted footwear on the development of this complaint.

Material and method

The study was conducted during the period from September 2015 – March 2016, and the consent for carrying out research was obtained from the Bioethical Committee. The study covered 184 children attending schools located in the Masłów commune, aged 7-13, including 100 girls and 84 boys. Among the examined children there were 8 7-year-olds, 12 9-year-olds, 31 9-year-olds, 52 children aged 10, 38 – aged 11, 42 aged 12, and 1 child aged 13; mean age 10 years.

The criterion for enrolment into the study was obtaining consent from a parent or legal guardian of the child, and lack of chronic diseases. The criterion for exclusion from the study was the lack of consent from a parent or legal guardian to perform examinations, and concomitant chronic diseases occurring in the children.

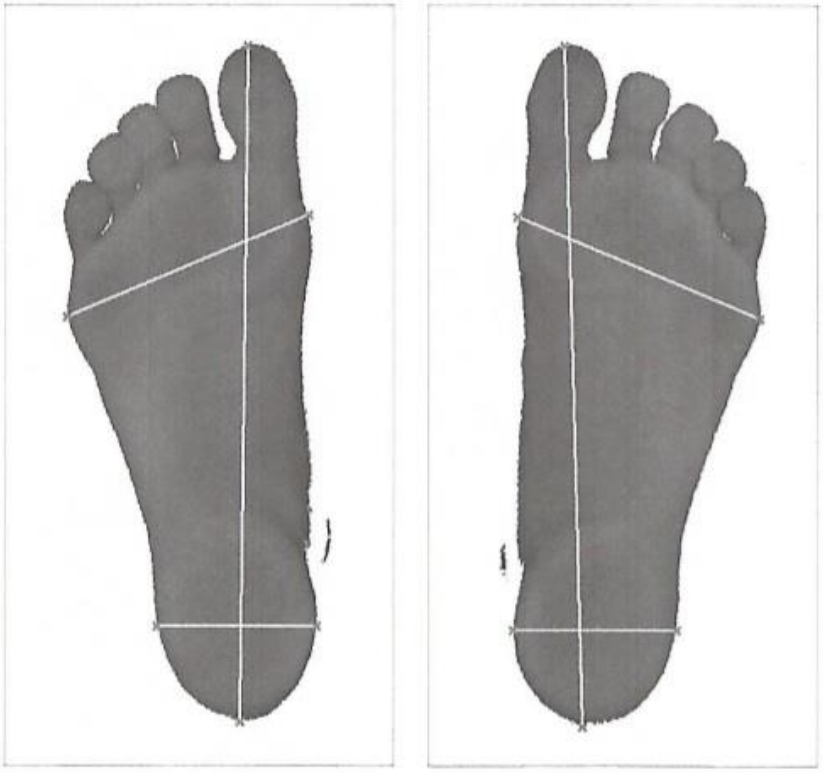
The children were examined in their underwear, without shoes and socks. Their body weight was measured using the Tanita BC-418MA scale, while body height by means of a stadiometer SECA 213. The accuracy of measurement of body weight was 0,1 kg, body height – 0,01m. Based on the parameters obtained the BMI was calculated. The subsequent stage of the study was the performance of the image of the feet (Fig. 1) on a podoscope at full load. It was used computer podocop 2D with software FreeStep Basic. Using computer software, based on the image of the feet performed, the hallux valgus angle α and the Clarke's angle were determined, and the Wejsflog's index calculated. The software calculated the correct size of the footwear which should be worn by the children. This size was compared with the size of the shoes which a child had during the examination.

The hallux valgus angle α is the angle formed between two tangents - the tangent of the medial edge of the foot and the tangent running from the widest part of the forefoot to the external edge of the hallux, the normal value for this angle is within 0-9°[6].

The Clarke's angle is the angle evidencing the longitudinal foot arch, formed between two lines – the tangent of the medial edge of the foot and the line running from the deepest part to the edge of the forefoot.

The Wejsflog's index is used for assessment of transverse flatfoot and is the foot length to foot width ratio. The value of this index remains within 2 and 3, and transverse flatfoot may be diagnosed when the value of this index is closer to 2, while it is normal when this number is closer to 3 [6].

Figure 1. Image of the feet performed using a podoscope.



The results of the study were analyzed using MS Office Excel and statistical software R.3.3.1. It was calculated basic values of descriptive statistics (means, standard deviation, minimum and maximum) for all parameters.

The relationships between variables were investigated using the following nonparametric tests: Mann-Whitney-Wilcoxon, χ^2, test ANOVA, and Spearman correlation test. The level of significance was set at $p < 0,05$.

Results

Table 1 demonstrates the mean values of body height, body weight and the BMI. The mean body height of the children was 144.85 cm, the mean body weight – 38.84 kg, and the mean BMI – 16.6 (Tab. 1).

Table 1. Body height, body weight, and BMI in the group of children in the study – according to gender

Gender	Body height			Body weight			BMI		
	Mean	Min-Max	SD	Mean	Min-Max	SD	Mean	Min-Max	SD
Girls	144.92	113-170	12.62	39.29	16-80	11.89	16.9	12.0-29.6	3.7
Boys	144.77	109-180	12.12	38.30	17-86	12.25	17.9	13.3-32.0	3.9
Total	144.85	109-180	12.36	38.84	16-86	12.03	16.6	12-29.6	3.2

The mean values of hallux valgus angle α in the left foot were 6.23 degrees, and the right foot – 4.93 degrees. The minimum value was 0 and the maximum value 16 degrees in the left foot, while in the right foot the minimum value was 0 and maximum 17 degrees (Tab. 2).

Table 2. Hallux valgus angle α in the left and right big toe – according to gender

Gender	Hallux valgus angle in the left big toe			Hallux valgus angle in the right big toe		
	Mean	Min-Max	SD	Mean	Min-Max	SD
Girls	7.07	0-16	4.15	5.48	0-17	4.35
Boys	5.32	0-14	3.4	4.28	0-14	3.19
Total	6.23	0-16	3.93	4.93	0-17	3.90

The problem of hallux valgus, where its angle is over 9°, affects 26% of the young patients. Hallux valgus more frequently concerned the left foot. In 8% of cases, the situation was that hallux valgus concerned both feet (Tab. 3).

Table 3. Hallux valgus angle α

hallux valgus angle	left foot		right foot		both feet		at least one foot	
	n	%	n	%	n	%	n	%
beyond the normal value (over 9°)	40	22%	23	13%	15	8%	48	26%
normal (0-9°)	144	78%	161	88%	136	74%	169	92%

In order to investigate the presence of the relationship between the Clarke's angle and hallux valgus angle α the Mann-Whitney-Wilcoxon test was performed. The results (statistics W equal 7,518; $p < 0.01$) showed that this relationship was statistically significant.

It was observed that for patients in whom the hallux valgus angle α was within normal value, the Clarke's angle was higher (Tab. 4).

Table 4. Relationship between the Clarke'as angle and hallux valgus angle α

Hallux valgus angle	Clarke's angle			Mann-Whitney-Wilcoxon Test
	Mean	Standard deviation	No. of feet	
normal (0-9°)	43.41	5.53	305	W = 7518
beyond normal (over 9°)	40.48	8.75	63	$p < 0.01$

Hallux valgus was more frequently found in girls than boys – in 50 of the feet in girls the hallux was beyond normal, while in only 13 feet in boys (Tab. 5, Fig. 2).

Table 5. Relationship between hallux valgus angle α and gender

Gender	Hallux valgus angle				χ^2
	Beyond normal (over 9°)		Normal (0-9°)		
	No. of feet	%	No. of feet	%	$\chi^2 = 17.98$
Girls	50	25%	150	75%	$p << 0.01$
Boys	13	8%	155	92%	

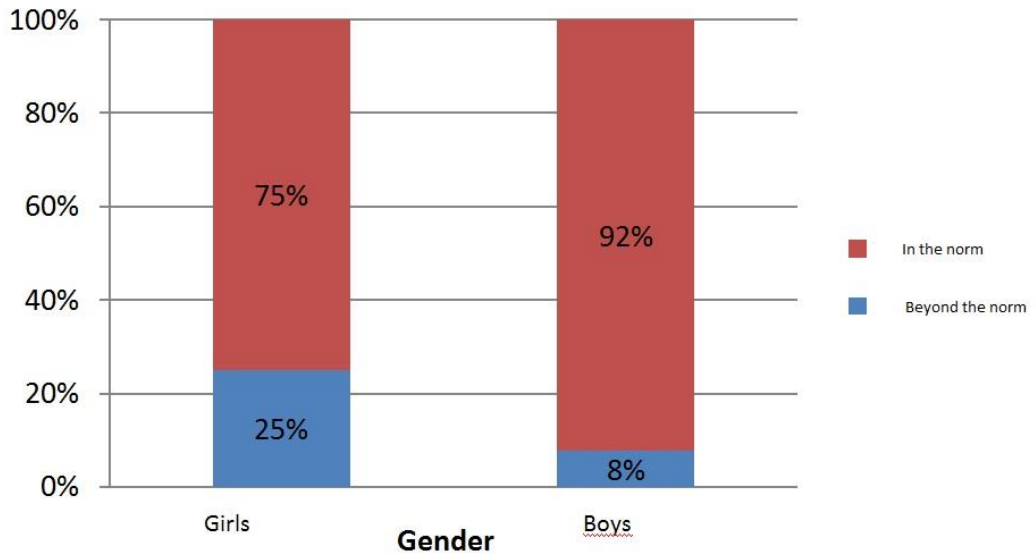


Figure 2. Hallux valgus angle according to gender

In order to investigate whether there is a statistically significant relationship between the hallux valgus angle and gender, the χ^2 test was performed (the value of test statistics was 17.98; $p < 0.01$). This showed that in girls, a considerably higher percentage had problems with hallux valgus.

The statistical analyses performed did not confirm any statistically significant relationship between hallux valgus angle and the BMI.

Table 6 demonstrates that the hallux valgus angle increased with age.

Table 6. Occurrence of hallux valgus according to the age of children in the study

Age	Mean	Standard deviation	No. of feet
7-8 years	3.93	3.22	40
9-10 years	3.87	3.87	166
11-13 years	6.35	4.06	162

In the group of 7 - 8-year-olds, the mean value of the hallux valgus angle was 3.93, whereas among 11 - 13-year-olds this value was as high as 6.35.

For comparing the mean values ANOVA test was performed, the results of which suggested that the mean values of the hallux valgus angle differed between groups, and this was statistically significant ($p<0.01$).

In order to investigate the presence of relationships between the hallux valgus angle and the Wejsflog's index, the Spearman correlation analysis was performed (Tab. 7). The results ($\rho = 0.02$; $p = 0.76$) allows the presumption that in the

sample in the study there was no statistically significant relationship between the examined variables.

Table 7. Relationship between hallux valgus angle α and Wejsflog index and fitting of footwear

Feet parameters		ρ Spearmana	p
Hallux valgus angle α	Wejsflog index	0.02	0.76
	Fitting of footwear	0.04	0.49

In order to investigate the relationship between the fitting of footwear and hallux valgus angle, the fitting of footwear was defined as follows: as an indicator called fitting of footwear was adopted the ration between the size of the shoes worn to that recommended by the podoscope (Tab. 8). Value 1 means exactly the size which should be worn, whereas the values below 1 meant that the shoes were too small, while the values higher than 1 – that they were too big. The Spearman correlation test performed showed (ρ^2=0.04; p = 0.49) the lack of a relationship (Tab. 7).

Table 8. Hallux valgus angle and fitting of footwear

	hallux valgus angle						χ^2
	beyond normal (over 9°)		normal (0-9°)		total		
Fitting of footwear	n	%	n	%	n	%	
Well fitted	11	14%	68	86%	79	100%	χ^2=0.76; p = 0.69
Too big	38	18%	176	82%	214	100%	
Too small	14	19%	61	81%	75	100%	

Ill-fitting footwear is when the size of shoes recommended by the podoscope differs from that declared. The χ^2 analysis of the above-presented Table 8 also leads to the conclusion about the lack of the relationship between the examined variables (χ^2=0.76; p = 0.69).

Discussion

Hallux valgus is the problem relatively rarely undertaken by researchers dealing with the structure and architecture of the foot in children. Usually, this defect is described with respect to adults [2, 3, 7, 8, 9, 10]. In the relevant literature, many reports may be found concerning the surgical treatment of hallux valgus, both in adults [11, 12] and in children [13]. The problem of hallux valgus in children with various dysfunctions is frequently undertaken, such as: Down syndrome [14], or cerebral palsy [15].

In meta-analysis of studies concerning the occurrence of hallux valgus in the total population performed by Nix et al. [3], it was observed that this complaint occurs 2.3 times more often in females, compared to males, and it was also found that the hallux valgus angle increased with age.

Pita-Fernandez S et al. [2], while examining individuals aged over 40, noticed that hallux valgus occurred in 38% of the persons examined; this value increased with age, and was higher in females.

While investigating children from Nigeria, Owoeye BA et al. [16] observed that this problem concerned 15.4% of children, more frequently girls, the values of hallux valgus increased with age, and in 3.7% of children this problem concerned both feet.

Demarczuk-Włodarczyk et al. [17] found that hallux valgus more frequently occurred in girls with higher body weight. However, Kędra [18], based on the conducted study, drew the conclusion that this defect more often concerned boys.

In the studies conducted among children and adolescents from Krakow, Bac [19] confirmed that the problem of hallux valgus twice as often concerned girls than boys, and this problem occurred in 4% of the examined children.

Among 345 10-13-year-old children examined by Jeroshl et al. [20], the defect in the form of hallux valgus was observed in 17.1%, and no relationship was found between body height and body weight, and feet defects.

Klein et al. [4], while examining children aged 3 – 6.5, noted that the hallux valgus angle was related with improperly fitted footwear, and too small shoes resulted in an increase in this angle.

In own studies, similar to the majority of studies concerning hallux valgus, both in adults and children it was observed that hallux valgus more often concerned the examined girls, and this relationship was statistically significant. However, a

higher percentage of children with bilateral hallux valgus was noted, compared to other researchers [19]. In 8% of children, the problem of hallux valgus concerned both feet, at least one foot with bilateral hallux valgus occurred in 26% of the children examined. This percentage of children is higher than in previously discussed studies. It was observed that when the hallux valgus angle was normal, the Clarke's angle was higher, it may be presumed that the hallux valgus concerned children with a lowering of the longitudinal arch of the foot. In turn, no relationship was found with transverse arch of the foot, which was measured using the Wejsflog's index.

Similar to the studies concerning hallux valgus in adults [1, 2, 3], in own study it was observed that the hallux valgus angle increased with age. In own study, a higher percentage of children was found in whom hallux valgus in at least one big toe was observed, than Bac[19] czy Jeroshl [20].

In own study, opposite to the study by Klein et al. [4], no relationship was found between the fitting of footwear in children and hallux valgus. Also, no relationship was found between hallux valgus and the child's BMI.

The problem of hallux valgus in children is noteworthy because the hallux valgus angle increases with age. Early diagnostics would enable the implementation of physiotherapeutic actions which would decrease the negative exacerbating of the defect in the future. Therefore, it seems justifiable to continue studies and monitor the occurrence of the problem among children.

Conclusions

1. Hallux valgus in the examined group of children more often concerned girls than boys.
2. The hallux valgus angle α increased with age.
3. Children who had a normal hallux valgus angle α had higher values of the Clarke's angle.
4. In the group of children examined, no statistically significant relationship was found between hallux valgus angle α and the fitting of footwear, Wejsflog's index and the BMI.

References

1. DiGiovanni Ch, Greisber J. Stopa i staw skokowo goleniowy. Elsevier Urban & Partner; Wrocław 2010.

2. Pita-Fernandez S, Gonzalez-Martin C, Seoane-Pillado T, Perteqa-Diaz S, Lopez-Calvino B. Podiatric medical abnormalities in random population sample 40 years or older in Spain. J Am Podiatr Med Assoc. 2014; 104(6): 574-582.
3. Nix S, Smith M, Vicenzino B. Gait parameters associated with hallux valgus: a systematic review. J Foot Ankle 2013; 6:9. doi: 10.1186/1757-1146-6-9.
4. Klein Ch, Groll-Knapp E, Kundi M, Kinz W. Increased hallux angle in children and its association with insufficient length of footwear: A community based cross-sectional study. BMC Musculoskelet Disord. 2009; 10:159. Doi: 10.1186/1471-2474-10-159.
5. Green WB (red.) Ortopedia Nettera. Elsevier Urban & Partner; Wrocław 2007.
6. Kasperczyk T. Wady postawy ciała. Kasper; Kraków 2002.
7. Sferra J, Arndt S. The crossover toe and valgus toe deformity. Foot Ankle Clin. 2011; 16(4): 609–620.
8. Havlicek V, Kovanda M, Kunovsky R. Surgical management of hallux valgus by techniques preserving the first metatarsophalangeal joint: long-term results. Acta Chir Orthop Taumatol Cech. 2007; 74(2):105-110.
9. Menz HB, Roddy E, Marshall M, Thomas MJ, Rathod T, Peat GM, Croft PR. Epidemiology of Shoe Wearing Patterns Over Time in Older Women: Associations With Foot Pain and Hallux Valgus. J Gerontol A Biol Sci Med Sci. 2016; 71(12):1682-1687.
10. Dufour AB, Casey VA, Golightly YM, Hannan MT. Characteristics Associated with Hallux Valgus in a Population-Based Study of Older Adults: The Framingham Foot Study. Arthritis Care Res. 2014; 66(12): 1880-1886.
11. Giannini S, Faldini C, Nanni M, Di Martino A, Luciani D, Vannini F. A minimally invasive technique for surgical treatment of hallux valgus: Simple, effective, rapid, inexpensive (SERI). Int Orthop. 2013; 37(9): 1805-1813.
12. Badekas A, Georgiannos D, Lampridis V, Bisbinas I. Proximal opening wedge metatarsal osteotomy for correction of moderate to severe hallux valgus deformity using a locking plate. Int Orthop. 2013; 37(9):1765-1770.

13. Grawe B, Parikh S, Crawford A, Tamai J. Hallux valgus interphalangeus deformity: a case series in the pediatric population. Foot Ankle Surg. 2012; 18(1): 4–8.
14. Lim PQX, Shields N, Nikolopoulos N, Barrett JT, Evans AM, Taylor NF, Munteanu SE. The association of foot structure and footwear fit with disability in children and adolescents with Down syndrome. J Foot Ankle Res. 2015; 8:4. Doi: 10.1186/s13047-015-0062-0
15. Sees JP, Miller F. Overview of foot deformity management in children with cerebral palsy. J Child Orthop. 2013; 7(5): 373-377.
16. Owoeye BA, Akinbo SR, AL., Ogunsola MO. Prevalence of hallux valgus among youth population in Lagos, Nigeria. Niger Postgrad Med J. 2011; 18(1): 51-55.
17. Demczuk-Włodarczyk E, Zaręba A, Kassolik K, Andrzejewski W. Masa ciała a budowa morfologiczna stóp. Fizjoterapia 2001, 1(16): 21–24.
18. Kędra A, Górniak K, Lichota M. Charakterystyka wysklepienia stóp dziecka przedszkolnego. W: Górniak K. (red.). Korektywa i kompensacja zaburzeń w rozwoju fizycznym dzieci i młodzieży. Biała Podlaska; 2005. 166–171.
19. Bac A. Budowa morfologiczna stóp dzieci i młodzieży krakowskiej z uwzględnieniem wybranych czynników wpływających na ich kształtowanie. AWF Kraków; 2013.
20. Jeroschl J, Mamsch H. Deformities and misalignment of feet in children – a field study of 345 students. Z. Ortop Ihre Grengeb. 1998; 136(3): 215-220.