EARLY VERTICALIZATION AND OBESITY AS RISK FACTORS FOR DEVELOPMENT OF FLAT FEET IN CHILDREN

Zikrija Hodžić [1], Gjuro Bjeković [2], Branimir Mikić [3] and Vesna Radovčić [4]
[1]*Memići Elementary School, Kalesija, BiH*
[2]*Faculty of Physical Education, University of East Sarajevo, BiH*
[3]*Faculty of Physical Education and Sports, University of Tuzla, BiH*
[4]*Faculty of Educational and Rehabilitational Sciences, University of Tuzla, BiH*

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Summary
The foot is one of the most important parts of human body, but it is also the one that is given the least attention. The number of population with feet deformities is on increase, and this is especially true for children. Therefore, it is evident that there is need for early detection and timely prevention of such deformities. The most frequent deformity of feet is flat feet. An acquired flat foot can be developed as a consequence of a number of different causes. Among these, obesity and early verticalization are the most usual. The primary goal of this research was to control the condition of feet and body mass index in elementary school children (grades 1 to 4) and to interview parents in order to acquire data on presence of various risk factors (obesity and early verticalization) for the development of deformities (flat foot), and to establish the significance in difference among the tested groups.

Key words: *early verticalization, obesity, development, feet, deformities*

Introduction
One of the common muscular and bone deformities in young children is the so-called insufficient foot. The normal shape and function of the foot is the result of normal structure and relation of its bones, muscles and ligaments. The foot consists of 26 bones and it has a changeable number of smaller bones, connected or free, spurs and sesamoids, and their functioning is very complicated and prone to various influences. The normal foot supports the body weight on a triangle with two long sides that could be drawn from the heel bone (calcaneum**)** to the tip of the first and the fifth bone of metatarsus. The short line could be drawn alnogside the tips of all the bones of metatarsus. The inner side of this triangle is very arched, and the outer side and transversal a bit less.The early start of school attendance is characterized, among other things, by burdens - pedagogical requirements of education on the organism and adaptational capacity of functional systems of organs. Coordination of these relations can be of crucial importance for the occurence of functional disorders and deformities of locomotive apparatus**,** including flat foot. Static deformity is a term used to describe the sum of all anomalies of feet characterized by physiological giving in of arches. The disorder of feet statics occurs if there is a disproportion between the active strenght of feet and the strain. This happens when eg. the child gains a lot of weight or grows quickly. Ethiopathogenesis of static flat foot has not been fully explained yet, but the causes are often connected to: certain developmental stages, sex characteristics, muscular stress and occurence of weariness, and indirect influence of rickets as a result of myopathy. The foot is, therefore, one of the most important segments of human body, but it also receives the least attention. The number of population with feet deformities is on the increase, and this is especially true for children. Therefore, it is evident that there is need for early detection and timely prevention of such deformities.

Goal
The goal of this research is to establish relation between the level of limited functionality of feet (flat foot), bodily mass index and early verticalization as well as the level of limited functionality of feel by age and sex, in elementary school age children. In accordance with the main goal the following sub-goals have been set: to estimate the level of limited functionality of feet, to establish the relation between the bodily mass index with the level of limited functionality of feet (flat foot), to establish the correlation of causative factors acquired by conducting a survey (early verticalization) with the functional condition of feet, to establish the level of limited functionality of feet among the subjects by age and sex.

Methods

The testing has been conducted on a sample of 118 pupils, namely 57 pupils (27 girls and 30 boys) in grades 1 and 2 (6 and 7 years old) and 61 pupils (37 girls and 24 boys) in grades 3 and 4 (8 and 9 years old), in the municipality of Kalesija. In order to acquire data on early verticalization of children a questionnaire for parents was realized. While choosing variables, a special attention has been given to choose those variables that satisfied the basic metric characteristics (agility, reliability, objectivity, sensitivity, economical quality etc.), while at the same time they had to be appropriate in relation to the age of subjects, material and other conditions, that could affect the objectivity of the conducted procedure. The sample of antropometric variables consisted of: bodiliy height (AVISTL), bodily mass (ATLMAS) and bodily mass index (ITLMAS).

The variables' sample for estimation of early verticalization were found in 9 variables, including: did you lift your child from a lying positing into the standing position, holding the child by hands (SDPODR), how old was your child (in months) when you lifted the child from the lying position into standing position holding the child by hands (KSDPOD), at which month of age the child started standing up holding himself/herself on objects (KDPSPN), at which month of age the child started standing on his/her own (KDSPST), have you been putting your child into baby walker (DSDSHD), how old was the child when you started putting it in the baby walker (KDSPSH), when did the child start walking while being held by both arms (DPHVOR), when did the child start walking while being held by one arm (DPHVJR), when did the child start walking without any support (KDSMPR). The following variables were used in estimating the feet: normal feet (NORMST) and falling arches (SPUSST). The research was conducted using the plantography method, the presence of deformities was determined by Thomason's method, bodily mass was determined using the bodily mass index (ITLMAS).

The data processing was performed using parametric statistics method. Primary, central and dispersional parameters were calculated. The method of multiply analysis of variance (MANOVA) was used to establish the significance of difference between groups of subjects degree of deviation from the frequence by set characteristics, as well as significance of contribution of applied variables for the conducted classifications (multivariant and univariant f-test). Multiple regressional analysis was applied to establish the size of influence of the system of predictive variables (early verticalization, bodily mass index) on the criterion variable (presence of deformity – falling arches). The data in this paper were processed using statistical packages SPSS 14.0 and STATISTICA 5.0.

Results and discussion

Table 1 gives the basic, central and dispersion parameters of the applied variables. The skewness coefficient supplies the appropriate data on discriminatory values of the applied variables. Significantly noticeable values of this parametre can be found in the following variables: lifing up to a standing position (SDPODR), was the child been put into baby walker (DSDSHD), when did the child started walking being held by one hand only (DPHVJR), and when did the child start walking on its own (KDSMPR). The data on discriminative value of the applied variables has been acquired by checking the coefficients of elongation (Kurtosis).

The greatest values of this parameter can be found in the following variables: lifing up to a standing position (SDPODR), was the child put into a baby walker (DSDSHD), when was the child put into a baby walker (KDSPSH), when did the child start walking holding being held by one hand only (DPHVJR), when did the child start walking being held by both hands (DPHVOR), when did the child start walking on its own (KDSMPR), falling arches (SPUSST) and normal foot (NORMST). The arithmetic mean for the variable DSDSDH (was the child put in a baby walker) is 1.04 which points at the fact that most of the subjects from the sample have been putting their children into a baby walker, with average age of 5.3 months, which is the arithmetic mean for the variable KDSPSH (when was the child put into a baby walker). Arithmetic mean of 1.08 for SDPODR variable (lifting up to a standing position) and of 4.47 for KSDPOD (when was the child lifted into a standing position) variable implies that most parents have been putting their children into the standing up position very early. The arithmetic mean for SPUSST variable (falling arches) of 1.34 implies that most children in the sample had falling arches on one foot or both feet. The multivariant analysis of variance was used in order to establish the multivariant statistical significance of differences among the tests groups. It has been established that there is a statistically significant difference between boys and girls in the applied system of variables (P=.03) (table 3). This was established by calculating multivariant statistical significance of differences between boys and girls.

The analysis of results in table 4 can lead to a conclusion that variables ATLMAS (bodily mass) with (p=.00) and ITLMAS (bodily mass index) with (p=.00) contribute to distinguishing between the two groups, resulting in the favour of boys. The multivariant statistical significance of differences between the tested groups was calculated and it was established that there was a statistically significant difference (p=.00) (table 5) between the groups: first and second grade (6-7 years of age) and third and fourth grade (8-9 years of age).

There were statistically significant differences in two variables: AVISTL (bodily height) (p=.00) and ATLMAS (bodily mass) (p=.00) (table 6). It is obvious that there is significant difference in height and weight between the 6-7 year olds and 8-9 year olds, in favour of the latter group.

Table 1. Primary, central and dispersion parametres of the applied variables

Variables	Min	Max	X	SD	Skew	Ku
Bodily height	110.0	155.5	130.4	10.2	0.2	-0.8
Bodily mass	20.0	55.0	33.7	8.7	0.5	-0.7
Bodily mass index	12.0	31.7	19.5	4.1	0.6	-0.3
Lifting up to a standing position	1.0	2.0	1.1	0.3	3.2	8.6
When was he/she lifted to a standing position	0.0	10.0	4.5	2.1	-0.2	0.1
When did he/she start standing while holding on	4.0	13.0	8.1	1.8	0.3	-0.2
When did he/she start standing on his/her own	6.0	15.0	10.1	1.9	0.0	-0.3
Was he/she put into into a baby walker	1.0	2.0	1.0	0.2	4.6	19.5
When was he/she put into baby walker	0.0	13.0	5.3	2.1	0.2	1.7
When did he/she start walking holding on by two hands	0.0	14.5	9.2	2.3	-0.3	1.2
When did he/she start walking holding on by one hand only	6.0	36.0	11.5	3.2	4.1	28.7
When did he/she start walking on its own	8.0	48.0	13.1	4.2	5.4	41.1
Falling arches	0.0	3.0	1.3	1.4	0.2	-1.9
Normal feet	0.0	3.0	1.6	1.4	-0.1	-1.9

Table 2. Multivariant significance of differences between boys and girls (Summary of all Effects)

MAIN EFFECT: SEX		
1 – SEX	Value	Q
Wilks' Lambda	.791	
Rao R Form 2 (14,103)	1,926	.03
Pillai-Bartlett Trace	.209	
V (14,103)	1,926	.03

Table 3. Differences between groups

Variables	Boys	Girls	F(df1.2)	P - level
Bodily height	128.96	131.66	2.10	0.15
Bodily mass	34.53	30.74	2.40	0.00
Bodily mass index	20.98	17.39	15.59	0.00
Lifting up to a standing position	1.09	1.07	16.33	0.65
When was he/she lifted to a standing position	4.23	4.69	0.23	0.63
When did he/she start standing while holding on	8.14	8.12	1.17	0.28
When did he/she start standing on his/her own	10.21	9.99	0.03	0.86
Was he/she put into into a baby walker	1.04	0.04	0.41	0.52
When was he/she put into baby walker	5.24	5.32	0.13	0.72
When did he/she start walking holding on by two hands	9.37	9.12	0.02	0.88
When did he/she start walking holding on by one hand only	11.39	11.62	0.52	0.47
When did he/she start walking on its own	13.10	13.12	0.14	0.99
Falling arches	1.61	1.08	3.86	0.05
Normal feet	1.32	1.82	3.47	0.07

Table 4. Multivariant significance of differences among the school ages (Summary of all Effects)

MAIN EFFECT: 1 - GRADE		
	Value	Q
Wilks' Lambda	.369	
Rao R Form 2 (14,103)	12.480	.00
Pillai-Bartlett Trace	.631	
V (14,103)	12.480	.00

Table 5. Differences between grades

Variables	Grades 1 & 2	Grades 3 & 4	F(df1.2)	P – level
Bodily height	122.13	138.00	182.26	0.00
Bodily mass	29.03	36.78	32.03	0.00
Bodily mass index	19.12	19.19	0.01	0.93
Lifting up to a standing position	1.12	1.05	1.25	0.27
When was he/she lifted to a standing position	4.43	4.54	0.08	0.78
When did he/she start standing while holding on	8.11	8.19	0.07	0.79
When did he/she start standing on his/her own	10.11	10.08	0.01	0.93
Was he/she put into into a baby walker	1.07	1.02	2.05	0.16
When was he/she put into baby walker	5.11	5.47	0.85	0.36
When did he/she start walking holding on by two hands	9.25	9.28	0.01	0.95
When did he/she start walking holding on by one hand only	11.91	11.13	1.68	0.20
When did he/she start walking on its own	13.65	12.62	1.76	0.19
Falling arches	1.44	1.22	0.72	0.40
Normal feet	1.11	1.70	0.75	0.39

Table 6: The influence of the system of predictory variables on the criterion variable – falling arches
Model Summary

R	R Square	Adjusted R Square	Std. Estimate Error
.652	.417	.403	.767

Table 7: ANOVA

Model	Sum. of Squares	df	Mean Square	F	Sig.
Regression	27.41	12	2.284	1.168	.00
Residual	207.04	105	1.931		
Total	243.44				

Table 8: Analysis of individual influences of predictory variables

VARIABLES	BETA	S.ER. BETA	T (105)	p-level
AVISTL	-0.22	0.49	-0.45	0.66
ATLMAS	-0.05	0.83	-0.06	0.57
ITLMAS	0.23	0.51	0.46	0.00
SDPODR	-0.21	0.13	-1.61	0.03
KSDPODR	-0.04	0.14	-0.32	0.02
KDPSPN	-0.09	0.15	-0.63	0.53
KDSPST	0.21	0.15	1.43	0.16
DSDSHD	-0.05	0.12	-0.47	0.01
KDSPSH	-0.03	0.12	-0.26	0.05
DPHVOR	-0.03	0.12	-0.22	0.83
DPHVJR	-0.13	0.24	-0.56	0.58
KDSMPR	0.01	0.22	0.07	0.95

Regresional analysis was used in order to establish the significance of relations and the size of influence of predictory set of variables and the criterion variable. In this regresional analysis, the criterion was represented by SPUSST (falling arches variable). The following variables were used as predictory variables: bodily height (AVISTL), bodily mass (ATLMAS), bodily mass index (ITLMAS), was the child lifted from the lying position into standing position while being held by the hands (SDPODR), at how many months of age was the child lifted from the lying position into standing position while being held by the hands (KSDPODR), when did the child start standing up while holding himself/herself onto furniture (KDPSPN), when did the child start standing on his/her own (KDSPST), was the child put into a baby walker (KDSPSH), when did the child start walking while holding on by both hands (DPHVOR), when did the child start walking while holding on by one hand only (DPHVJR) and when did the child start walking on his own (KDSMPR).

Based on the data displayed in tables 7 and 8, it can be concluded that the coefficient of multiple correlation, i.e. the connection between the predictory system and the criterion, is (R=.652) completely explained with the variablity of 41% (R square=.417), which is at the degree of significance of .01 (Sig .00).Through analysis of individual influences of predictory variables (table 9), it can be concluded that the following variables have significant individual influence: bodily mass index (ITLMAS) (P=.04), has the child been lifted from the lying position into standing position while being held by hands (SDPODR) (p=.03), with how many months of age was the child lifted from lying position into standing position while being held by hands (KSDPODR) (p=.02), has the child been put into a baby walker (DSDSHD) (p=.01) and how old was the child when he/she was put into a baby walker **(**KDSPSH) (p=.05), which was realistically expected in the results of the research.

Conclusion

The primary goal of this research was to establish the relation between the degree of limited functionality of feet (flat feet), bodily mass index and rearly verticalization, as well as the degree of limited functionality of feet by sex and age in school-age children (grades 1 to 4). Using multivariant statistical significance in differences between boys and girls, it was established that there is a statistially significant difference between boys and girls in the applied system of variables (p=.03). Through analysis of results, it can be concluded that the following variables contribute to differentiation between groups: bodily mass (ATLMAS) (p=.00) and bodily mass index (ITLMAS) (p=.00), in favor of boys. By calculating multivariant statistical significance in diferences between the tested groups, grades 1 and 2 (ages 6-7) and grades 3 and 4 (ages 8-9), it was established that there is statistically significant difference in the whole system of variables (p=.00).

There were statistically significant differences in two variables: bodily height (AVISTL) (p=.00) and bodily mass (ATLMAS) (p=.00). It is evident that there is a significant difference in height and weight between the two groups of children (6-7 year-olds and 8-9 year-olds) in favor of children of older age. In the regressional analysis, the whole system of predictory variables has been proved to be significant in results prediction in the criterion.

By analysing individual influences of predictory variables, it can be concluded that the following variables have significant individual influence on the criterion: bodily mass index (ITLMAS) (p=.04), has the child been lifted from the lying position into standing position by being held by hands (SDPODR) (p=.03), with how many months of age has the child been lifted from the lying position into standing position while being held by his/her hands (KSDPODR) (p=.02), has the child been put into a baby walker (DSDSHD) (p=.01) and how old was the child when he/she was put into a baby walker (KDSPSH) (p=.05).Based on the results acquired using regressional analysis, it was established that early verticalization, bodily mass and bodily mass index have a significant influence on the degree of limited functionality of feet (flat foot) in subjects. This research has shown that there is a need for greater engagement of a number of experts, among which a pivotal role is that of physical education teachers, especially in systematic tracking of the condition of feet in primary school children. This is especially true for obese children. There is also need for education of parents about obesity and early verticalization and their consequences on the structure of feet and the condition of spine.This research opens up new possibilities for new research related to this issue, including the estimation of the spine condition.

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RANO USPRAVLJANJE I GOJAZNOST KAO FAKTORI RIZIKA ZA RAZVOJ STOPALA KOD DJECE

Sažetak

Stopalo je jedan od najvažnijih segmenata ljudskog tijela, ali je također i segment kojemu se daje posebna pozornost. Broj osoba u populaciji s deformitetom stopala stalno raste, što je posebno slučaj s djecom. Štoviše, evidentno je da postoji potreba za ranom detekcijom i prevencijom takvih deformiteta. Najčešći takav deformitet je ravno stopalo. Postojanje ravnog stopala može se razviti kao posljedica većeg broja različitih uzroka. Među njima, gojaznost i rano uspravljanje su uglavnom uobičajeni. Primarni cilj istraživanja bio je nadzor uvjeta stopala i indeksa tjelesne mase djece u osnovnoj školi (od 1. do 4. razreda), kao i razgovor s roditeljima kako bi se prikupili podaci o prisustvu različitih faktora rizika (gojaznosti i ranog uspravljanja) koji dovode do razvoja deformiteta (ravnog stopala), te kako bi se ustanovila značajnost u razlikama između testiranih grupa.

Ključne riječi: *rano uspravljanje, gojaznost, razvoj, stopalo, deformiteti*

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Correspondence to:
Prof. Branimir Mikić, Ph.D.
University of Tuzla
Faculty of Physical Education and Sport
Muharema Fizovića Fiska 6, 75000 Tuzla, BiH
Phone: +387(0)35 278 537
E-mail: branimir.mikic@untz.ba