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Wpływ nadmiernej masy ciała na ustawienie kończyn dolnych u dzieci 9-11-letnich

The influence of excessive body mass on the setting of the lower limbs in 9-11-year-old children

Streszczenie

Wstęp: Otyłość dziecięca nagatywnie wpływa na rozwój układu mięśniowo-szkieletowego. Celem badań była ocena korelacji pomiędzy nadmierną masą ciała oraz występowaniem koślawości kolan i wysokością łuków wysklepiających stopę u 9-11-latków.

Materiał i metody: W badaniu wzięło udział 160 dzieci z losowo wybranych szkół podstawowych. Oceniono wysokość i masę ciała, zawartość tkanki tłuszczowej w organizmie (BFP), wartość wskaźnika BMI, ustawienie kolan i wysklepienie podłużne stóp. Kolana koślawe diagnozowano, gdy odległość pomiędzy kostkami przyśrodkowymi w pozycji stojącej ze złączonymi kolanami była większa niż 5 cm. Wysklepienie stóp mierzono za pomocą wskaźnika wysklepienia Arch Index. Płaskostopie rozpoznawano, gdy obszar środkowej trzeciej części odbitki stopy był większa niż 28% całego obszaru kontaktowego bez palców.

Wyniki: Nadmierną masę ciała obserwowano u prawie 27% badanych. Kolana

koślawe były typowe dla 5% dzieci z prawidłową masą ciała i prawie 56% dzieci z nadwagą i otyłością. Częstość występowania płaskostopia była również większa u dzieci z nadwagą i otyłością i było to wyraźniej widoczne w lewej stopie. Badani z prawidłową masą ciała częściej mieli stopy wydrążone.

Wnioski: Ponad jedna czwarta badanych 9-11-latków miała nadwagę lub otyłość. Nadmierna masa ciała zwiększała ryzyko koślawości kolan i płaskostopia. Aktywność fizyczna zalecana otyłym dzieciom powinna zawierać ćwiczenia kształtujące nawyk prawidłowego ustawienia kończyn dolnych.

Słowa kluczowe: otyłość dziecięca, stopa płaska, kolana koślawe

Abstract

Introduction: Childhood obesity adversely affects the development of the musculoskeletal system. The purpose of the study was to find out correlation between excessive body weight, the knee misalignment and the height of foot arches in the 9-11-year-olds.

Materials and methods: A total of 160 children from randomly selected schools participated in the study in which their body weight, height and the body fat percentage (BFP) were measured, and BMI and foot arching and knee alignment were observed. Genu valgum was assessed when the intermalleolar distance in the standing position with the knees in contact was larger than 5 cm. The height of the longitudinal arch of each foot was measured by Arch Index. Pes planus was diagnosed when the area of the middle third of the footprint was bigger than 28% of the entire footprint area.

Results: Excessive body weight was discovered in almost 27% of participants. Genu valgum was typical of 5% of children with healthy body weight and almost of 56% of children with overweight and obesity. The incidence of pes planus was also greater in overweight and obese participants and it was more prevalent in the left foot. Participants with healthy body weight more often had hollow feet.

Conclusions: More than a quarter of 9-11-year-old participants were overweight or obese. Excessive body weight increased the risk of developing by them genu valgum and pes planus. Physical activity recommended to obese children should consist of body posture correction exercises including improvement of lower extremities alignment.

Keywords: childhood obesity, pes planus, genu valgum

Abbreviations: AI – Arch Index, BMI – Body Mass Index, IMD – Intermalleolar distance, SD – Standard Deviation, BFP – Body Fat Percentage

Introduction

Obesity has been one of the most vital global health issues facing children [6, 11] since the moment of finding out relationship between excessive body weight and insulin resistance and development of metabolic syndrome [10]. It is also well known that children with overweight and obesity more frequently complain of knee [21] and back pain [5, 13] and are less physically active than their peers [9, 16]. Moreover, they experience social exclusion and negative effects of some stereotype thinking [23]. Unfortunately, the adverse effect of overweight and obesity on the quality of body posture and the need for undertaking specialist corrective exercises to improve posture are not emphasised strongly enough.

The purpose of the study was to discover the effect of excessive body weight on genu valgum and pes planus in 9-11-year-old children. The selection of the above mentioned age group was made due to the fact that in that period of time foot arches are already stable [20] and knee alignment, after the stage of infant varus and valgus knee deformities typical of pre-school age, should have become neutral [19].

Material and methods

A total of 160 children (70 girls and 90 boys) aged 9-11 years, students of two randomly selected primary schools, participated in the study. Prior to the research, consent of the local Bioethics Committee (Consent No 2/0177) and written informed consents of participants' parents and/or their legal guardians were obtained. The group of participants comprised neither children with a certification of the degree of disability nor such children who had experienced severe damage to their musculoskeletal system (e.g.: fracture, Perthes' disease, dislocation of the hip joint) in the past.

The study was conducted before the noon in nurse treatment rooms in the school attended by children. The rooms were warm, well lit and allowed participants to keep their privacy. Participants were measured undressed to their underwear and wore no footwear. Body weight was measured within 0.1kg (body composition analyzer bf-350 Tanita Corporation of America, Inc., Arlington Heights, Illinois, USA) and body height within 1mm (ZPH Alumet No 010208, Warsaw, Poland). Body height was taken in the standing position with participants' feet kept together and the sight

directed straight ahead. Girls wore no ornaments in their hair. Participants' BMI was calculated and their body weight status described as healthy body weight, overweight or obesity based on Cole's et al. norms. [4].

Genu valgum was measured by means of an anthropological sliding calliper within 0.5cm (ZPH Alumet No 030208, Warsaw, Poland) to assess the intermalleolar distance (IMD) in the standing position with the knees kept straight and slightly together. Genu valgum was diagnosed when the distance was larger than 5cm. The above measurement was easy to perform and reliable enough [3]. The arch of the right and left foot was measured in the standing position with both feet placed firmly on the baroresistive platform BTS P-walk (BTS Bioengineering Corp., NY, USA). The Arch Index (AI) was used in the above assessment in which the footprint, excluding toes, was divided into equal thirds. The AI was calculated as the ratio of the area of the middle third of the footprint to the entire footprint area. The natural arch of the foot was recognised when the AI equalled between 21% and 28%. The AI smaller than 21% denoted hollow foot and greater than 28% referred to flat foot. The AI measurement was easy to perform and provided reliable assessment of the medial longitudinal arch of the foot [17].

Results

Out of the total of 160 participants, excessive body weight was diagnosed in 20 girls and 23 boys (in 43 participants, i.e.: in 26,9% in total). Overweight was found out in 36 participants (17 girls and 17 boys) and obesity in 9 participants (3 girls and 6 boys, i.e.: in 7,5% of participants). BMI in participants with excessive body weight was greater by 5,35 kg/m^2 than in participants with healthy body weight (Table 1). The body fat percentage (BFP) was different in those groups by 13,4%. The IMD was significantly greater in participants with excessive body weight by 3,96 cm. The arch of the right and left foot was smaller in participants with excessive weight and obesity (greater AI) and that difference equalled 1,9% for the right and 3,05% for the left foot, which was of statistical significance.

Table 1.
Levels of variables in children of different weight status groups
(Mann-Whitney U Test)

Variable	Group	Mean	Median	Minimum	Maximum	SD	p
Age [years]	Healthy body weight	9,92	10,00	9,00	11,00	0,86	0,86
	Overweight or obesity	9,95	10,00	9,00	11,00	0,90	
Body height [cm]	Healthy body weight	142,05	142,30	127,50	160,20	6,70	0,0007*
	Overweight or obesity	146,21	146,50	128,10	160,00	6,85	
Body weight [kg]	Healthy body weight	35,41	35,80	24,10	49,00	5,48	0,0000001*
	Overweight or obesity	49,88	48,20	38,10	71,10	8,44	
BMI [kg/m^2]	Healthy body weight	16,62	16,71	13,51	19,98	1,54	0,0000001*
	Overweight or obesity	21,97	21,33	19,11	29,48	2,55	
Body fat [%]	Healthy body weight	13,98	13,10	1,10	28,10	5,68	0,0000001*
	Overweight or obesity	27,33	27,70	20,40	38,60	6,46	
IMD [cm]	Healthy body weight	1,24	0,50	0,00	8,00	1,61	0,0000001*
	Overweight or obesity	5,20	5,00	0,00	13,50	3,71	
AI right foot [%]	Healthy body weight	22,48	23,89	1,18	47,00	7,28	0,1
	Overweight or obesity	24,38	24,71	10,46	35,97	6,01	
AI left foot [%]	Healthy body weight	21,81	23,57	1,99	50,30	7,26	0,02*
	Overweight or obesity	24,86	25,30	12,28	38,40	4,63	

*differences statistically significant ($p < 0,05$), SD – standard deviation, AI – arch index

Genu valgum was disclosed in merely 5% of participants with healthy body weight and in almost 56% of participants with overweight or obesity (Table 2). The excessive arch of the right foot was discovered in 38,5% of participants with healthy body weight and in 22,2% of participants with excessive body weight. Similarly, the excessive arch was more often seen in the left foot in participants with healthy body weight (the difference was 8,3%). The proper arch of the right foot was found out in 49,6% of participants with healthy weight and in the left foot in 53% of participants from that group. The proper arch of the right foot was disclosed in 69,8% of participants with excessive body weight and in 51,1% in the left foot. Flat feet prevailed more often in the right and left foot in participants with overweight and obesity. The difference in the incidence of flat feet between participants with healthy and excessive weight equalled 2% for the right and 10,2% for the left foot.

Table 2.
The prevalence of genu valgus and pes planus in children with healthy and excessive body weight

Variable	Status	Healthy body weight (n=117, 100%)	Overweight or obesity (n=43, 100%)
Knee alignment	Neutral	112 (95,7%)	19 (44,2%)
	Valgus	5 (4,3%)	24 (55,8%)
Right foot arching	Hollow	45 (38,5%)	7 (16,3%)
	Neutral	58 (49,6%)	30 (69,8%)
	Flat	14 (11,9%)	6 (13,9%)
Left foot arching	Hollow	37 (31,6%)	10 (23,3%)
	Neutral	62 (53%)	22 (51,1%)
	Flat	18 (15,4%)	11 (25,6%)

Pearson's linear correlation disclosed significant positive relationship between BMI and body fat and IMD. Significant correlation was also revealed between BMI and AI for the left foot and body fat and AI for both feet. In that case, positive correlation denoted that the height of the medial longitudinal arch of the foot decreased with the increased BMI and BFP (Table 3).

Table 3.
Relationships between variables (Pearson's linear correlation)

Correlated variables	Intermalleolar distance [cm]		Arch Index – right foot [°]		Arch Index – Left foot [°]	
	r	p	r	p	r	p
BMI [kg/m^2]	0,67	0,0001*	0,19	0,6	0,28	0,006*
Body fat [%]	0,64	0,0001*	0,24	0,01*	0,31	0,002*

* statistically significant correlation (p <0,05), BMI – body mass index

Discussion

Excessive body weight prevailed in 28,6% of female participants and in 25,5% of male participants. Overweight and obese participants had lower longitudinal arches of the foot and genu valgum was more often disclosed in them. The above findings were similar to the findings of other researchers. Among others Villaroya et al. [22], Mickle et al. [15], Ezema et al. [7] and Chang et al. discovered a tendency to develop flexible flatfoot by obese children [2]. Jimenez-Ormeno et al. [12] revealed that the structure of the foot during the time of child's growth developed differently in obese children and differently in children with healthy body weight. Correlation between excessive body weight and knee misalignment was also confirmed by Taylor et al. [21], De Sa Pinto et al. [5] and Bout-Tabaku et al. [1].

It results from the above-mentioned that obesity adversely affects the structure of lower extremities [18]. Unfortunately, more than 50% of the 9-11-year-olds spend approximately eight hours daily sitting, which considerably increases the risk of excessive weight gain [14]. Sedentary free-time activities should rather be limited to two hours a day at most [24]. It seems self-evident that obese children should be encouraged to spend their free time actively. However, on the other hand it was proved that physical activity in persons with knee misalignment (varus or valgus knee deformity) increased the risk of developing degenerative changes in the knee joint [8]. That is why postural assessment, including the lower extremities alignment, should constitute an integral part of medical care of children with excessive body weight. Exercises correcting misalignment of lower extremities should be incorporated into the intervention programmes in overweight and obese children with diagnosed knee misalignment or flat feet.

Conclusions

Excessive body weight prevails in almost a quarter of the 9-11-year-olds.

Overweight and obesity increase the risk of prevalence of genu valgum and pes planus in schoolchildren.

Physical activity recommended to children with excessive body weight should incorporate exercises correcting misalignment of lower extremities.

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