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Original Article

OVERWEIGHT AND BALANCE IN SCHOOLCHILDREN: A CASE-CONTROL STUDY

EXCESSO DE PESO E EQUILÍBRIO DE ESCOLARES: ESTUDO DE CASO CONTROLE

Lukas de Paula Cardoso[1], **Karina Pereira**[2], **Dernival Bertoncello**[2], **Shamyr Sulyvan de Castro**[3], **Luiza Lara Moreira Fonseca**[2] and **Isabel Aparecida Porcatti de Walsh**[2]

[1]Universidade Federal de Uberlândia, Uberlândia-MG, Brasil.
[2]Universidade Federal do Triângulo Mineiro, Uberaba, MG, Brasil.
[3]Universidade Federal do Ceará, Fortaleza, CE, Brasil

RESUMO
O objetivo do estudo foi avaliar a influência do índice de massa corporal no equilíbrio de escolares. Estudo de caso controle em que participaram 128 escolares de seis a nove anos, divididos em grupo caso (excesso de peso) e controle (eutróficos), cada um com 64 pessoas. Na avaliação de equilíbrio estático e dinâmico foi utilizada a Bateria Psicomotora. O IMC foi utilizado como indicador do estado nutricional. Para a análise estatística usou-se números absolutos, frequências e porcentagens e o teste de Qui Quadrado para comparação entre os grupos, com nível de significância de 5%. A maioria dos escolares apresenta melhor perfil psicomotor para o fator equilíbrio dinâmico do que no estático. Foram encontradas diferenças significativas apenas na subtarefa de ficar na ponta dos pés no equilíbrio estático (p<.05) sem diferenças significativas em outras variáveis.
Palavras-chave: Índice de Massa Corporal. Equilíbrio postural. Criança.

ABSTRACT
The aim of this study was to evaluate the influence of body mass index (BMI) on the postural balance of schoolchildren. This was a case-control study involving 128 students aged 6 to 9 years, divided into a case group (overweight) and a control group (eutrophic) of 64 subjects each. Static and dynamic balance was assessed using Fonseca's Psychomotor Battery. BMI was used as an indicator of nutritional status. Simple and relative frequencies, absolute numbers and the chi-square test were used for statistically analysis, with a level of significance of 5%. Most students performed better in dynamic than in static balance. Significant differences were only found for the subtask of standing on tiptoes in the static balance assessment (p<.05), with no significant differences in the other variables.
Keywords: Body mass index. Postural balance. Child.

Introduction

Balance is the ability to maintain orientation through the integration of sensory information captured by the visual, vestibular and somatosensory systems, muscle activities and biomechanics of the body[1,2]. It is defined as the result of all the forces that act on the body. When we tend to be in the desired position and orientation we say that we are in static balance, whereas when we move in a controlled manner, we are in dynamic balance, which represents the basis of all dynamic global coordinations[3].

When performing motor actions there should be interaction between the person who executes them and the environment during a maintained posture[4]. Thus, during the development of the child, the control of balance will ensure postural stability and permit the execution of successful movements[5]. Alterations in balance can interfere with the child's capacity to perform daily motor activities and to easily execute multiple tasks when adults[6], with consequent quality of life concerns. In this respect, Rodrigues et al.[7] found that functionality was affected in children with hearing loss and balance alterations, since balance is fundamental for the child to independently perform daily activities such as playing, running, manipulating objects and exploring the environment at home and in school, with possible repercussions on his quality of life.

Balance is a mechanical variable that can be altered by excess weight[8,9]. Childhood obesity can lead to changes in body posture that directly influence balance, since obesity can cause mechanical disadvantages such as an increase in body mass, altering the moment of inertia and modifying the expression of movement. These factors impose a new situation on the central nervous system, creating greater difficulty in locomotor activities[10].

Obesity is today one of the leading nutritional problems[11] and its prevalence among children and adolescents has increased in Brazil and in the world[12,13]. In Brazil, Reis, Vasconcelos and Oliveira[14] showed that overweight tends to be more common in urban than in rural areas, particularly in the North, Northeast and Center-West, and that the prevalence of obesity, at a lower magnitude, accompanies the geographic distribution observed for overweight. Overweight can influence postural balance, with a consequent impact on the quality of life of children. In this respect, studies evaluating possible associations between postural balance and body mass index (BMI) in schoolchildren will increase our knowledge and could result in health benefits for this population group by providing indicators for public health policies or school-based interventions, such as programs promoting the adoption of healthy eating habits and regular physical activities.

Therefore, the objective of this study was to evaluate the association between BMI and static and dynamic balance in schoolchildren.

Methods

Participants

The study was conducted at a state school in the city of Uberaba, MG. The school was chosen for convenience since it is located in an area covered by a Basic Health Unit linked to the Work Education Program in Health (PET Saúde in the Portuguese acronym) of the Federal University of Triângulo Mineiro (UFTM). This school had approximately 252 students in the selected age range (6 to 9 years). All students were invited to participate in the study and 239 composed the sample. Children with conditions that prevented them from standing for a long time and those whose responsible person did not sign the free informed consent form were excluded.

Procedures

The study was approved by the Research Ethics Committee of UFTM (Approval No. 1731).

Five evaluators were trained in the data collection. Next, one subject was evaluated by all of them, considering an inter-rater agreement higher than 80%.

First, all schoolchildren answered a short questionnaire about personal data including name, sex, date of birth, age, and grade. Next, the children were sent one by one to a large, airy and well-lit room where body weight, height and static and dynamic balance were measured.

The anthropometric measurements were made using standard techniques according to World Health Organization (WHO) recommendations[15]. Body weight was measured with a portable digital platform scale with a capacity of 150 kg and precision of 50 g. The child was weighed barefoot and wearing light clothing. Height was measured with the child standing barefoot, with the neck, buttocks and heels aligned, using a portable stadiometer.

The height, body weight, age and sex data were used to calculate the BMI-for-age. The nutritional status was evaluated by calculating Z-scores for BMI-for-age according to the standards proposed by the WHO[15]. Children with a Z-score > +2SD for BMI-for-age in relation to the reference population of the WHO were classified as overweight[15,16].

Balance was evaluated using Fonseca's Psychomotor Battery[17], with the children performing the tasks only once. For the evaluation of static balance, the observations were made with the volunteer standing still, with the hands always resting on the waist and the eyes closed. Next, the child should be able to remain in the following positions: standing with the feet together; standing with the heel of one foot placed in front of the toes of the other (tandem standing); standing on tiptoes; standing on only one foot and the contralateral lower limb flexed at approximately 90º. For the analysis of dynamic balance, the child continued in the same position (hands on the waist, eyes closed, and feet together), performing the followings tasks over a 3-m long line drawn on the floor: controlled walking with one feet in front of the other (heel to toe), jumping with feet together, and one-foot jumping.

The psychomotor profiles obtained during the balance tasks can be classified as apraxic (1), dyspraxic (2), eupraxic (3), and hyperpraxic (4)[17]. In the present study, the psychomotor profiles were grouped as apraxic/dyspraxic when the child had difficulties in performing the tasks, and as eupraxic/hyperpraxic when the tasks were performed in an adequate manner. It was considered that this grouping does not comprise the analysis since the first indicates that the child has difficulties in performing the tasks and the second that the child has no difficulty in performing the tasks. All children were evaluated only once.

Statistical analysis

For descriptive analysis, absolute numbers and simple and relative frequencies are reported. Inferential analysis used the chi-square test for comparison between groups, adopting a level of significance of 5%. Statistical analysis was performed using the Stata 9.2 program.

Results

Among the 239 schoolchildren studied, overweight was identified in 64 and all of them were selected for the phase of statistical analysis. To compose two groups with the same number of subjects, 64 children were selected from the 175 without overweight (eutrophic) by convenience sampling. These children were matched for age so that there was no difference between groups since balance-related variables can be influenced by overweight. Thus, 128 schoolchildren participated in the final phase of the study, including 64 overweight and 64 eutrophic children.

The mean age was 7.5 (±1.1) years among the 64 overweight children and 7.6 (±1.11) years among the 64 eutrophic children. Table 1 shows the distribution of frequency and associations between nutritional status and psychomotor profile in the schoolchildren.

Table 1. Distribution of frequency and associations between nutritional status and psychomotor profile in the schoolchildren studied.

	Eutrophic *n* (%)	Overweight *n* (%)	Total *n* (%)	p-value
Standing with feet together				0.380
APR/DYS	8 (12.5)	5 (7.81)	13 (10.16)	
EUP/HYP	56 (87.5)	59 (92.19)	115 (89.84)	
Static balance				
Tandem standing				0.451
APR/DYS	19 (29.68)	23 (35.94)	42 (32.82)	
EUP/HYP	45 (70.32)	41 (64.06)	86 (67.18)	
Standing on tiptoes				0.029*
APR/DYS	41 (64.06)	52 (81.25)	93 (72.66)	
EUP/HYP	23 (35.94)	12 (18.75)	35 (27.34)	
Standing on one leg				0.082
APR/DYS	51 (79.69)	58 (90.63)	109 (85.16)	
EUP/HYP	13 (20.31)	6 (9.37)	19 (14.84)	
Dynamic balance				
One-foot jumping				0.285
APR/DYS	6 (9.38)	10 (15.63)	16 (12.5)	
EUP/HYP	58 (90.62)	54 (84.37)	112 (87.5)	
Two-foot jumping				0.465
APR/DYS	3 (4.69)	5 (7.81)	8 (6.25)	
EUP/HYP	61 (95.31)	59 (92.19)	120 (93.75)	
Controlled walking				0.770
APR/DYS	6 (9.38)	7 (10.94)	13 (10.16)	
EUP/HYP	58 (90.62)	57 (89.06)	115 (89.84)	
Total	64 (100)	64 (100)	128 (100)	

Legend: APR/DYS = apraxic/dyspraxic; EUP/HYP = eupraxic/hyperpraxic. *p<0.05 (chi-square test).
Source: The authors.

Most children had no difficulties in the subtasks of standing with feet together, tandem standing, one-foot jumping, two-foot jumping, or controlled walking. Although a larger number of overweight children had difficulties in these activities (except for standing with feet together), no significant difference was observed between groups.

Both groups exhibited difficulties in the subtasks of standing on tiptoes and standing on one leg. A significant difference between groups (p=0.029) was observed in the subtask of standing on tiptoes, indicating greater difficulty among overweight schoolchildren.

Discussion

Studies have reported an association between higher BMI and low motor performance in children. In this respect, the level of motor coordination has been associated with BMI, demonstrating a predominance of low weight/eutrophy among schoolchildren with high and normal levels of motor coordination, while children with overweight/obesity were mainly classified in the category of low motor coordination[18].

Poeta et al.[19] found significant differences in overall motor development, overall motricity, body image and balance between groups of obese and eutrophic children, with lower values in obese children. Berleze et al.[20] emphasized that obese children had disadvantages in the quality of motor skill execution such as jumping, running, throwing, and balancing. Investigating associations between obesity and motor coordination ability in Taiwanese children, Zhu, Wu and Cairney[21] reported that an increase in BMI was associated with poor motor coordination, which was most evident in the evaluation of body balance. Contreira et al.[22] observed a significant inverse correlation between BMI and balance, indicating that the higher the BMI, the worse the performance in tasks that require balance. Aleixo et al.[8], evaluating two groups of schoolchildren aged 6 to 12 years classified as overweight and obese, found no significant difference in static balance between groups. However, there was a significant difference in dynamic balance, characterizing a hyperpraxic psychomotor profile in the overweight group, while the obese group was found to be eupraxic.

Consideration must also be given to the participation of children, eutrophic or overweight, in sports and other motor activities. In this respect, studies emphasize characteristics of a sedentary lifestyle that, together with morphological variables, limit motor performance and the maintenance and development of other motor skills[20,21]. Thus, the practice of physical activities may be one explanation for the results of the present study in which the children had no difficulties in performing most tasks and these tasks were not influenced by overweight. In this case, physical activity would exert a greater influence on balance than excess weight. In this line of thought, Gallahue and Ozmun[23] point out that physical exercise is essential to develop, maintain or recover changes in postural control and regular exercise brings together and automates some skills due to the stimulation of neuromuscular structures that are essential for postural control. However, the present study cannot prove this since it did not use instruments that could link this discussion to the evaluation of physical activities, considering modality[24], site of activity[25], gender differences[26], frequency, and classification (mild, moderate, heavy, competitive modalities) of the exercises. Thus, studies investigating physical activity using validated instruments should be encouraged.

On the other hand, most participants in the two groups exhibited difficulties in the static balance tasks of standing on tiptoes and standing on one leg. A significant difference was observed in the subtask of standing on tiptoes in which a larger number of children with overweight had difficulties in performing this task. Static balance tasks require sensory control (visual, somatosensory, and vestibular stimuli), concentration, and body perception. In this process, the center of gravity of the body must remain within the base of support, which is defined by the area of the base of the feet during static upright posture, and balance is easily influenced by manipulating this base of support[27].

In the present study, the static balance tasks were performed with the eyes closed. With this suppression of vision, the body uses different systems to maintain balance, including the greater influence of articular proprioceptors which are commonly altered in obese individuals[28]. Furthermore, when the center of mass of the body provides a greater surface beyond the base of support, the boundaries of stability are exceeded, generating a situation of instability. When this fact is perceived by the sensory system, information is sent to the motor system and organized postural responses are elicited to recover alignment of the center of mass and base of support[29]. This fact would explain, at least in part, the difficulty of the schoolchildren to maintain balance during standing on tiptoes, which was significantly greater for overweight children. Within this context, McGraw et al.[30] suggested that obesity has a negative influence on the performance of fundamental motor skills and increases balance problems, with a greater visual dependence to maintain postural stability when compared to eutrophic children.

The maintenance of postural balance determines good quality of life and is fundamental for daily life activities, rendering individuals independent. In this respect, considering the difficulties encountered in the static balance subtasks, situations of imbalance are responsible for falls and for the risk of injuries[28] and these difficulties can have possible repercussions on the involvement of obese schoolchildren in systematic sports activities, increasing even more the differences between them and non-obese children. We therefore suggest that it is necessary to further stimulate schoolchildren in this age range to participate in activities that will develop this balance. In this respect, Berleze, Haffner and Valentine[20] highlighted the importance of children attending spaces for physical activity where they can play. In addition, the authors demonstrated that the school and family environment, as well as the stimulation to which children are submitted, are fundamental to complement their full motor development.

A more detailed investigation of the variables related to lifestyle habits and physical activity, comparing schoolchildren performing more dynamic activities with sedentary children, will increase our knowledge in this field of study and will help determine the real relationship of these variables with overweight and balance deficits in this population. Since the assessment of motor skills during elementary education permits, in a first step, to determine the degree of development of children and, in a second step, to suggest interventions for correcting the deficits detected, data such as those reported here can be of great value.

Conclusions

The present study showed that most schoolchildren only had difficulties in the static balance subtasks of standing on tiptoes and standing on one leg. A significant correlation with overweight was observed, which negatively influenced the subtask of standing on tiptoes.

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Author address: Isabel Aparecida Porcatti de Walsh. Rua Capitão Domingos, 309, Nossa Senhora da Abadia, Uberaba - MG, CEP 38025-010. E-mail: ewalsh@terra.com.br