Influence of Childhood on the Dynamic Balance in 2nd Cycle Students of Portuguese Elementary School

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Abstract:-Obesity is a chronic disease characterized by the breakdown of balancer synergies in the muscle and joints, which may lead to decreased stability and postural adaptations. Objective: The main objective was compare children with body mass index (BMI) above ideal with ideal and to understand the relationship between BMI and balance in 2nd cycle students. The sample of 20 students aged between 10 and 11 years. Methods: The collection methods used were the BMI and Star Excursion Balance Test (SEBT) to cross the results of these two variables and to understand their relationship Results: 55% of the children had a BMI above the ideal, being 30% were overweight and 25% were obese. Of the children above the ideal BMI, 81.8% are female (54.5% overweight and 27.3% obese). Subjecting the population to SEBT, it was observed that children with BMI above ideal and with a dysmetria the amplitudes obtained in SEBT by both lower limbs mainly reveal present balance alterations. Conclusions: Due to the anthropometric changes caused by obesity and changes in the center of gravity, this conduction modifies the motor pattern and stabilization, which negatively influences postural control and reduces the balance of obese individuals.

Keywords: - Body Mass Index (BMI), Childhood Obesity, Musculoskeletal, Physical Therapy

Introduction

According to WHO (2016), overweight and obesity are defined as the accumulation of abnormal or excessive fat that is harmful to health.

Obesity is considered a chronic disease and is interrelated with some pathologies that contribute to the development of diseases responsible for morbidity and mortality in the population, such as cardiovascular, musculoskeletal and neoplastic diseases (Carvalho, do Carmo, Breda, & Rito, 2011).

Obesity is a chronic disease that can be derived from multiple factors and is usually associated with genetic factors, changes in dietary patterns and decreased physical activity (Enes & Slater, 2010).

However, in addition to these factors, sedentary lifestyle is also one of the main factors related to weight gain, since in the last decades it has been verified that children became less active due to technological advances (Pimenta & Palma, 2001).

In Portugal, recent data confirm that 1/3 of Portuguese children from 6 to 8 years of age are overweight, with 14.6% being obese and consequently, overweight children are at an increased risk of becoming adult's obese individuals (Carvalho, do Carmo, Breda, & Rito, 2011).

Excess body mass in obese or overweight children may lead to a decrease in stability and the need to seek postural adjustment mechanisms. Thus, postural changes may occur due to the modification of the usual balance axis, resulting in lumbar lordosis increase, with protrusion of the abdomen and anterior slope of the pelvis (ante version) and with the passage of time, excessive shortening and stretching appear, which In combination with the anterior slope of the pelvis lead to internal rotation of the hips and to the appearance of valgus knees and flat feet (Aleixo, Guimarães, de Walsh, & Pereira, 2012).

Therefore, obese or overweight children find it difficult to participate in physical activities, either because of the shame of exposing their body appearance or by the difficulty of performing the exercises, which induces them to choose activities with low caloric expenditure, thus reducing the level of physical activity. This may exacerbate postural changes, dyspraxia and lack of balance in these children (Pazin, Frainer, & Moreira, 2006; Aleixo, Guimarães, de Walsh, & Pereira, 2012).

According to Caetano, Resende, & Cheik (2014), the integrity of the anatomical and functional elements (vestibular apparatus, vision, nerve centers, proprioceptive system and locomotor system) is responsible for the body balance, which can be compromised in obese people since obesity is responsible for Small joints.

For these conclusions, different evaluation methods were used, such as the "Star Excursion Balance Test" (SEBT) for the evaluation of the dynamic postural balance, since it has the advantage of being low cost and able to evaluate the neuromuscular control, the patient of form Dynamics, determine proprioceptive deficits, postural balance, the integrity of the body protection systems and the evolution of the patient in their rehabilitation (Hertel, Braham, Hale, & Olmsted-Kramer, 2006).

The reach of one of the lower limbs is performed with unipodal support for 8 directions. It is used to identify functional deficits of the lower limbs and requires postural control and proprioception, muscle strength and range of motion of the joint (Hertel, Braham, Hale, & Olmsted-Kramer, 2006).

The test is performed with the participants standing at the interception of the tapes and is asked to reach with one of the lower limbs as far as possible along each of the vectors (tapes attached to the floor, each 120 cm long Common point in the center and arranged at 45 ° between each other, using a goniometer). The participant tests with body support on a single lower limb, while the opposing limb reaches maximum distance in 8 directions. The terminology of the eight directions to which the contralateral limb should reach relative to the lower limb in support is lateral (L), posterolateral (PL), posterior (P), posteromedial (PM), medial (M), anteromedial, Anterior (A), and anterolateral (AL) (Figure 1).

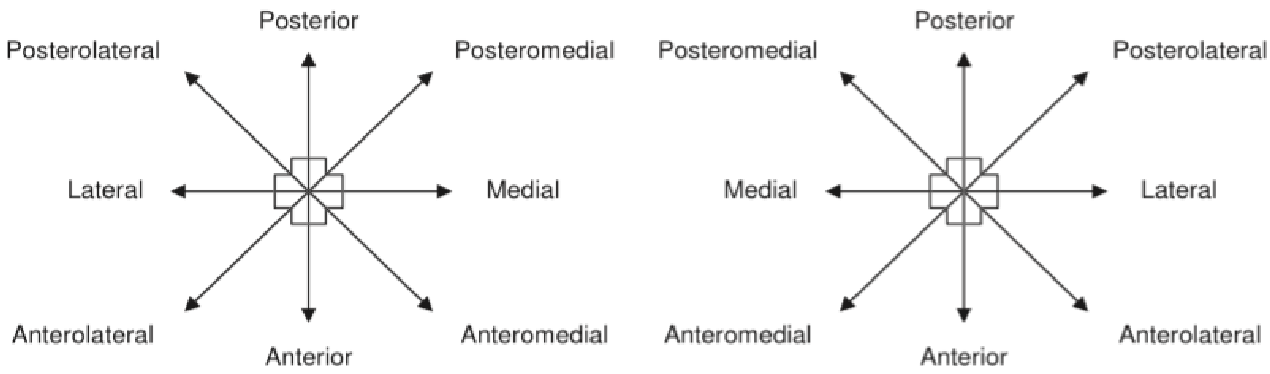

Figure 1- Star Excursion Balance Test (SEBT) corresponding to each lower limb

After collecting the amplitudes of each limb, to ensure that there is chronic instability that can lead to osteoarticular lesions (and more precisely the ankle), the individual must have a 4cm difference between the two lower limbs in the Amplitude of the same vectors (Olmsted, Carcia, Hertel, & Shultz, 2002).

In this way, with the intention of contributing with the literature of the area and, mainly, to be able to intervene later, the purpose of this study was understand the incidence of obesity in schoolchildren between 10 and 11 years old, as well as the possible relation with the balance.

Methods

Aim

This is an observational study aimed to understand the incidence of obesity in schoolchildren by 5th and 6th school grade students from both gender of the School Group Infante D. Henriques from Viseu, as well as the possible relation with the balance.

This 5th and 6th grade population was chosen according to two different school periods, the entrance and exiting level for the twice Basic Education Cycle, this dues to our intent of seeing if there was already possible to compare children with BMI above ideal with children with ideal BMI in order to understand the influence of BMI and dynamic postural balance.

Study Sample

Dating from July 2015, there were 836 students enrolled in the school, 314 of which attending the 2nd Basic Education Cycle, in the 5th and 6th grade [146 and 168, respectively].

This study population, as mentioned earlier, represent the beginning of the 2nd Basic Education Cycle [5th grade] and the end of the same Basic Education Cycle [6th grade], which were chosen in order to establish if there were already the incidence of obesity and if the possible relation with the balance, by analyzing and comparing dynamic postural balance in both school periods.

Our sample consisted of 20 participants [7 male and 13 female subjects, with ages between 10 and 11 year old [10.55± 0.513 years old].

Approved by the ethical comity of Piaget Institute, this study asked for informed consents for students' parents and guardians. All of our procedures followed the Helsinki Declaration, to what human related studies should comply.

The inclusion criteria are: i] to be aged between 10 and 11 years; ii] understand the aims of the study and agree to participate voluntarily. As exclusion criteria: i] Presence of pathology a known health condition of rheumatological, orthopedic, cardio-respiratory, oncological pathology and / or diagnosed coronary disease; ii] the provision of informed consent by students' parents and guardians

Procedures

This study have taken one month from participant selection process, personal identification questionnaire fill, in order to assess body weight, a Body mass index (BMI) was conducted (Viester, et al., 2013; Desouzart, Filgueiras, Matos, & Marques, 2016). BMI was calculated and the subjects were classified as follows: obesity, overweight, normal weight and thinness according to the proposed limits (WHO, 2011).

The Star Excursion Balance Test (SEBT), which is a measure of dynamic postural control, and has been chosen because it is a reliable test that evaluates dynamic stability in different planes because it is economical and validated (Bicici, Karatas, & Baltaci, 2012).

The test was performed in the school gymnasium, where adhesive was applied to the soil in order to perform a star in which its segments were about 120 cm long and arranged at 45° between them, arranged with the help of the goniometer.

The children were instructed that they should engage in the interception of the ribbons (being the center), so that later they would only have one foot placed in it so that with the other foot they tried to reach as far as possible the 8 segments in the following Order: Anterior, Posterior, Lateral; Medial, Anterolateral, Posterior-medial, Antero-medial, Posterior-Lateral.

To facilitate children's understanding, they were told that they should reach as far as possible the 8 vectors in the following order: North, South, East, West, Northeast, Southwest, Northwest, Southeast, and were also given the opportunity to experience the Before measurements are taken.

The children performed the test and the measurements of the amplitudes reached by both lower limbs were taken for comparison.

It is relevant to note that in the test any repetition was discarded if the child moved the supporting leg from the center of the figure, was unable to maintain balance in the supporting leg during the test and deviated from the segment being evaluated.

As for the measurements, these were removed with a tape measure after the child placed the test foot and always the interception of the vectors (center) to the distal end of the hallux.

In order to know whether there are actually changes in balance, the method of Olmsted, Carcia, Hertel & Shultz (2002), which defines that in order to conclude if there is an osteoarticular imbalance, is necessary to have a difference of 4 centimeters of amplitude in the same segment between both Member States.

SPSS, 23.0 version was used in order to treat all the statistical data. Descriptive statistics were performed, considering all the variables obtained. Due to the small number of the sample and to facilitate the analysis, the variables of BMI were grouped, and we considered four groups: obesity, overweight, normal weight and thinness. The statistically level of significance was establish in $p \leq 0.05$.

Results

The sample consisted of 20 individuals, aged 10 to 11 years old [10.55 ± 0.513], 7 males [35%] and 13 females [65%]. 60% have an abnormal BMI value, 25% have a BMI corresponding to obesity [≥30] and 40% have a normal BMI [Table 1].

Table 1. BMI analysis:

		N	%
BMI	Slimness [<18.5]	0	0
	Normal [18.5 a 24.9]	8	40
	Overweight [25 a 29.9]	7	35
	Obesity [≥30]	5	25
	Total	20	100,0

Comparing according to the gender, it is possible to observe that the totality of overweight students (N = 7; 35%) corresponds only to female children. In addition to being overweight in females, there are 3 female children with BMI corresponding to obesity (15%). This means that 50% of children have high BMI and are female.

On the other hand, only two male students have high BMI, thus, 10% of the children selected for the study are male and have a BMI categorized as obesity.

After assessing the anthropometric data of the children, the SEBT was continued in both lower limbs where the amplitudes were measured with a tape measure. After the SEBT was performed, the difference between the amplitudes reached by both lower limbs was calculated in order to understand where there would be more equilibrium decreases (Table 2).

According to the literature, all amplitudes with less discrepancy were indicated with number <5 in Table 2, and it needs to be less than 4cm in order to determine that there are no equilibrium changes, the rest represent all the amplitudes that lead us to that there is a change in the balance.

Table 2 – Table with the difference between the amplitudes obtained in the segments by both lower limbs in cm and percentile corresponding to each child:

Subject			**Difference obtained between both lower limbs**					
	Ant.	**Post.**	**Med.**	**Lat.**	**Ant.M.**	**Post.M.**	**Ant.L.**	**Post.L.**
1	18	1	10	67	53	43	12	1
2	14	14	7	3	39	21	9	33
3	25	45	10	8	5	46	39	10
4	6	24	20	48	6	35	59	27
5	10	16	6	42	14	2	7	5
6	17	20	15	15	16	7	17	36
7	15	8	3	3	1	8	2	5
8	5	25	2	14	2	33	7	12
9	3	1	7	0	11	16	7	3
10	2	12	19	12	9	25	6	20
11	2	13	11	13	8	36	0	6
12	0	5	7	3	3	18	11	7
13	0	10	6	5	16	2	3	30
14	9	14	27	6	15	8	13	8
15	17	10	0	5	12	19	2	8
16	3	8	5	10	7	16	2	19
17	17	5	8	1	14	3	5	0
18	5	2	2	3	17	1	2	24
19	23	29	15	2	5	35	2	32
20	1	7	6	0	10	26	1	1

In Table 3, for easy viewing of the number of children presenting changes in each of the segments, children are represented according to their BMI (where "O" represents children with obesity, "OV" represents children with overweight and "N" children with normal/ideal BMI) and according to the calculated difference between the amplitudes obtained by the two lower limbs.

Table 3- Table with the number of children who obtained amplitude differences greater than or equal to 4cm in all segments of the SEBT according to their BMI:

	Number of children and respective amplitude differences obtained in the segments by both members											
	Equal or Greater than 4cm						Insignificant range					
	O		**OV**		**N**		**O**		**OV**		**N**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Ant.	1	5%	4	20%	8	40%	4	20%	3	15%	0	0%
Post.	4	20%	6	30%	7	35%	1	5%	1	5%	1	5%
Med.	4	20%	7	35%	7	35%	1	5%	0	0%	1	5%
Lat.	3	15%	6	30%	5	25%	2	10%	1	5%	3	15%
Ant. M.	4	20%	6	30%	7	25%	1	5%	1	5%	1	5%
Post. M.	5	25%	5	25%	5	25%	0	0%	2	10%	3	15%
Ant. L.	3	15%	4	20%	5	25%	2	10%	3	15%	3	15%
Post. L.	3	15%	5	25%	8	40%	2	10%	2	10%	0	0%

Thus, it is possible to verify that children with a BMI above the ideal and with a dismetry of the amplitudes obtained in the SEBT by both lower limbs equal to or greater than 4cm represent 25% (N = 5) in the anterior segment, 45% (N = 9) in the posterior segment, 55% (N = 11) in the medial segment, 50% (N = 10) in the lateral segment, 50% (N = 10) in the anterior-medial segment, 35% Posterior-lateral, 30% (N = 6) in the Antero-lateral segment and 40% (N = 8) in the posterior-medial segment.

Regarding children with a BMI above the ideal and with a dismetry of the amplitudes obtained in SEBT by both lower limbs of less than 4cm, they represent 35% (N = 7) in the anterior segment, 10% (N = 2) in the posterior segment, (N = 1) in the medial segment, 15% (N = 3) in the lateral segment, 10% (N = 2) in the antero-medial segment, 20% (N = 5) in the Antero-lateral segment and 10% (N = 2) in the posterior-medial segment.

Discussion

Due to the anthropometric changes caused by obesity and changes in the center of gravity, this leads to changes in motor pattern and stabilization, negatively influencing postural control and reducing the balance of obese individuals (Nantel, Brochu, & Prince, 2006).

According to Corbeil et al. (2001) postural balance is an essential prerequisite to daily life as it is the basis of all movements and is usually defined as the state in which all forces acting on the body are balanced so that it Remain in the desired position and orientation. While maintaining a stable posture is often considered a simple task, the fact that being able to fall is inevitable and occurs in our lifetime. This may be due to obesity because it has an influence on body balance due to an increase in body mass, which causes greater instabilities,

because adiposity moves the body's center of gravity forward, and thus, affects postural stability in response to disturbances that Occur through the relationship between the position of the center of gravity, the response of the ankle torque to this movement, and the response of the body and muscles involved to act in a motor way in the task of bringing the center of gravity into the support base.

Thus, it can be deduced that obesity is associated with a greater occurrence of changes in motor pattern and stabilization, which negatively influences postural control and reduces the balance of obese individuals.

These affirmations are reinforced by the results obtained by the SEBT, since in Table 2 it was possible to observe that most of the children presented an asymmetry equal or superior to 4cm in the amplitudes obtained by both lower limbs when reaching as far as possible each of the segments, refers to children with a BMI above the ideal, which shows that these children, in comparison with the others, present a greater number of changes in balance.

According to Siqueira & Silva (2011) in the obese subject, the maintenance of balance is conditioned during static posture, walking and locomotion due to excess weight, body mass distribution and differentiated anthropometric relationships between the anatomical structures of the trunk and the Member States. This justifies the results obtained in the SEBT, since it was possible to observe that children with a BMI above ideal that present a difference of amplitudes obtained by both lower limbs in all segments of the test prevail in relation to the rest except in the previous segment.

According to Barbacena (2011), it is known that a child with a prolonged history of obesity potentiates and anticipates the aggravation of joint problems. With this, body balance is the main functionality of the body to be affected. Since it is of fundamental importance in the life of human beings to be present in the activities of daily life, in children it has a peculiar importance, since it is the primary motor skill for the other fundamental abilities. Thus, a good development of balance will allow the acquisition of a larger and more qualified motor repertoire in childhood.

Thus, it is relevant to detect changes in balance as early as possible in order to prevent any osteoarticular limitation or injury. Corbeil et al. (2001) found it necessary to perceive the existence of the relationship between weight and balance changes. Thus, they were interested in studying the biomechanical changes imposed by obesity at the moment of postural destabilization. For this, they performed an imbalance simulation with a humanoid model and estimated that there was an increase of forces applied at the ankle level for postural stabilization. These results led the authors to conclude that the weight variation leads to the readaptation of postural parameters which, according to them, confirms that due to the anteriorization of the center of gravity of the body and anterior projection of the body, there is a facility of imbalance.

Conclusion

Several aspects related to the weight and postural postures and habits of the children are determinant for the musculoskeletal development, especially in the period of osteoarticular growth, when the equilibrium search for the new proportions of the body occurs (Penha, João, Casarotto, Amino, & Penteado, 2005; Caetano, Resende, & Cheik, 2014).

This descriptive study aimed to identify balance changes present in 2nd cycle students, be they physiological or compensatory. According to the results obtained, it was possible to observe that as the literature states, there is a relationship between balance and obesity. In view of the complexity of the subject, this research had some limitations (e.g. reduced sample size) but could open the way to new discoveries and more in-depth studies in the field of Physiotherapy.

The results of the study may be useful for future research and help in the development of intervention programs related to obesity and school health exercise programs as a way to prevent or treat early balance changes.

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Reference

1. Aleixo, A., Guimarães, E., de Walsh, I., & Pereira, K. (2012). Influence of overweight and obesity on posture, overall praxis and balance in schoolchildren. Journal of Human Growth and Development, 22(2), 239-245.
2. Barbacena, M. (2011). Postural balance in children with obesity and overweight from 7 to 14 years old. Brasília: UNB.
3. Bicici, S., Karatas, N., & Baltaci, G. (2012). Effect of Athletic Taping and Kinesiotaping on Measurements of Functional Performance in Basketball Players with Chronic Inversion Ankle Sprains. The International Journal of Sports Physical Therapy, 7(2), 154-166.
4. Caetano, C., Resende, W., & Cheik, N. (2014). Effects of obesity on the postural balance of adolescents. Acta Brasileira do movimento, 4(2), 17-28.
5. Carvalho, M., do Carmo, I., Breda, J., & Rito, A. (2011). Comparative analysis of methods of approaching childhood obesity. Portuguese Journal of Public Health, 29(2), 148-156.
6. Corbeil, P., Simoneau, M., Rancourt, D., Tremblay, A., & Teasdale, N. (2001). Increased risk for falling associated with obesity: mathematical modeling of postural control. IEEE Transactions on Neural Systems and Rehabilitation Engineering, 9(2), 126-136.
7. Desouzart, G., Filgueiras, E., Matos, R., & Marques, A. (2016). Relationship between BMI, regular physical activity and musculoskeletal back pain indication in college students. In Occupational Safety and Hygiene IV (pp. 545-48). CRC Press.
8. Enes, C., & Slater, B. (2010). Obesity in adolescence and its main determinants. Rev Bras Epidemiol , 13, 163-171.
9. Hertel, J., Braham, R., Hale, S., & Olmsted-Kramer, L. (2006). Simplifying the Star

Excursion Balance Test: analyses of subjects with and without chronic ankle instability. Journal of Orthopaedic & Sports Physical Therapy, 36(3), 131-137.

10. Nantel, J., Brochu, M., & Prince, F. (2006). Locomotor Strategies in Obese and Non-obese Children. Obesity, 14(10), 1789-1794.
11. Olmsted, L., Carcia, C., Hertel, J., & Shultz, S. (2002). Efficacy of the star excursion balance tests in detecting reach deficits in subjects with chronic ankle instability. J Athl Train, 37(4), 501-506.
12. Pazin, J., Frainer, D., & Moreira, D. (2006, Oct). Obese children have a delay in motor development,. Rev Digital, 11(101). Retrieved from http://www.efdeportes.com/efd101/criancas.htm
13. Penha, P., João, S., Casarotto, R., Amino, C., & Penteado, D. (2005). Postural assessment of girls between 7 and 10 years of age. Clinics(60), 9-16.
14. Pimenta, A., & Palma, A. (2001). Epidemiological profile of obesity in children: relation between television, physical activity and obesity. Rev Bras Ciência Movimento, 9, 19-24.
15. Siqueira, G., & Silva, G. (2011). Postural alterations on the spinal column and lumbar instability in obese individual: a literature review. Fisioterapia em movimento, 24, 557-566.
16. Viester, L., Verhagen, E., Hengel, K., Koppes, L., van der Beek, A., & Bongers, P. (2013). The Relation Between Body Mass Index and Musculoskeletal Symptoms in the Working Population. BMC Musculoskeletal Disorders, 14(238), 1-13.
17. WHO, W. H. (2011). Global Recommendations on Physical Activity for Health: World Health Organization. WHO. Retrieved from http://www.who.int/dietphysicalactivity/physical-activity-recommendations- 5-17years.pdf?ua=1
18. World Health Organization, W. (2016, June). Obesity and overweight. Retrieved June 15, 2016, from http://www.who.int/mediacentre/factsheets/fs311/en/