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Artigo Original

ANTHROPOMETRIC INDICATORS AND MOTOR PERFORMANCE IN MANAUARAS PUPILS (AMAZONAS STATE – BRAZIL)

INDICADORES ANTROPOMÉTRICOS E DESEMPENHO MOTOR DE ESCOLARES MANAUARAS (AM – BRASIL)

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RESUMO

O objetivo deste estudo foi investigar os indicadores antropométricos e o desempenho motor em escolares. As variáveis selecionadas foram: índice de massa corporal, circunferência da cintura (CC), razão Cintura/estatura (RCEst) e Desempenho Motor (DM). Para a avaliação do DM utilizou-se o teste de coordenação motora corporal para crianças (KTK). Os dados foram analisados a partir da estatística descritiva e inferencial com $p \leq 0,05$. Ao comparar DM em relação ao status de peso se observou diferenças significantes entre o grupo acima do peso e os grupos eutrófico (p=0,000) e abaixo do peso (p=0,006). Ao comparar DM entre os grupos nas variáveis CC e RCEst observaram-se diferenças significantes entre os grupos Normal 97,07 ± 12,87 e 97,50 ± 13,25 respectivamente e com Risco a Saúde 92,26 ±10,5 e 92,00 ±9,58 (p = 0,001) (p = 0,000) respectivamente. É possível afirmar que alterações nos indicadores antropométricos afetam o DM motor de escolares.
Palavras-chave: Destreza motora. Estado nutricional. Obesidade.

ABSTRACT

This study aimed to investigate the anthropometric indicators and motor performance in young school. The variables selected were: body mass index (BMI), waist circumference (WC), ratio waist / height (RCEst) and Motor Performance (DM). For performance evaluation we used the Body Coordination Test for Children (Körperkoordinationstest für Kinder - KTK). Data were analyzed from the descriptive and inferential statistics with $p \leq 0,05$. Comparing DM relative to the weight status we observed significant differences between the overweight group and normal weight (p = 0.000) and underweight groups (p = 0.006). Comparing DM between groups in CC and RCEst variables were observed significant differences between normal groups (97.07 ± 12.87 and 97.50 ± 13.25 respectively) and health risk (92.26 ± 10.5 and 92.00 ± 9.58) (p = 0.001) (p = 0.000) respectivel . Thus, it can be to argued that changes in anthropometric indicators affect the DM of young school.
Keywords: Motor skills. Obesity. Nutritional status.

Introduction

The World Health Organization (WHO) has been emphasizing the need to conduct studies about growth levels among populations of underdeveloped and/or developing countries[1]. This concern results from lack of information on the matter from countries with these characteristics, which undoubtedly hinders the operation and monitoring of programs aimed at promoting these populations' health. The monitoring of physical growth and, consequently, nutritional status through anthropometric measures has been a good instrument in the acquisition of information on the health of young students, especially in third-world countries[2].

The food and nutrition matter in Brazil has been approached from different perspectives, which, in a complex and differentiated manner, show their structural-historical determinism before the economic and social development model[3]. There are three modalities of organic manifestations of nutritional status: manifestations produced by balance between food consumption and body needs, by insufficient consumption and by excessive consumption in relation to real needs. When there is proportionality between ingestion and

demand, there is normality; lack or deficit qualifies malnutrition; and excessive ingestion above real needs results in overweight or obesity, in qualitative or quantitative terms.

In Brazil, obesity as a public health problem is a recent event. Simultaneously to a decline in the occurrence of malnutrition among children and adults at a rapid rate, there was an increase in the prevalence of overweight and obesity in the Brazilian population[4]. Studies comparing 3 decades (1970s, 1980s and 1990s) showed reduction in malnutrition rates in 75% of children, 49% of the rural adult population and 52.7% of the urban adult population. In contrast, the obesity rate in adults triplicated in the Northeastern region and doubled in the Southwestern region[5].

Interest in the effects of excessive weight gain in childhood has been increasing due to the adipose cellularity in this period being determinant in an adult individual's body composition patterns. In addition, inadequate nutritional state can influence the quality of performance in activities that require body movements, in tasks of the daily routine of children such as running, jumping, throwing and others.

Recent researches have observed poor performance regarding gross motor skills among overweight and obese children, especially those which involve locomotion, balance and motor coordination[6-13]. Lopes et al.[6]; Stodden; Rodrigues[10] have found low to moderate negative correlation between motor coordination and weight status among children of both sexes and different ages, finding lower levels of motor coordination in overweight and obese children of both sexes, in comparison to normal-weight ones. Araújo et al.[7] and Melo Lopes[8] have also identified losses in the motor performance of obese and overweight children. A study by Da Silva, Araújo and Aburachid[11] showed similar results. D'Hondt et al.[9] have identified levels of gross motor coordination and levels of physical activity in normal-weight and obese/overweight children, finding relations between the children's weight status and motor development, with normal-weight ones presenting better progress compared to their peers.

However, other studies conducted with children have not detected significant associations between nutritional profile indicators and adequate performance for said age as to motor skills[14-16]. Catenassi et al.[14] have investigated the relation between a nutritional status indicator and performance in gross motor skills of 27 children aged between four and six years old and have not identified significant correlations. Olesen et al.[16] assessed 627 children aged 5 and 6 years old and their results were similar. The same happened in a study by Soares et al.[17], which assessed 108 children aged between 10 and 12 years old. All mentioned studies used the KTK test to measure motor development.

From this perspective, De Oliveria Luz et al.[18], conducting a meta-analysis study, have also found divergences when comparing results of several researches. The authors state that there is a positive relation trend between higher BMI values and lower KTK performance results among children and adolescents. However, to confirm this trend further studies are recommended in order to allow for an isolated interpretation of the existing relationship between BMI and the KTK for both sexes and different age groups. This, in fact, shows that impacts of an inadequate nutritional profile on a child's motor performance, especially school-aged ones, need to be further discussed[15].

This discussion on implications is imperative so we can deepen knowledge about the theme and ensure that factors associated with the environment do not interfere with a child's motor development, because typical motor development is not only regarded as a key factor in the general development of children but is also the pillar for an active and healthy lifestyle. This is confirmed when recently it has been shown that adequate levels of motor skill and coordination can be considered as predicting factors as to the engagement of children in

physical activities. Thus, the present study aimed to investigate different anthropometric indicators concerning the motor development of young students.

Methods

Participants

To meet the objectives in empirical terms, the research context involved three schools, being two public schools and one private school selected according to the participation availability, located in the city of Manaus, Amazonas, Brazil. This study had the participation of 350 young students, being 184 girls and 166 boys, aged on average 8.94 years old ± 0.785, with body mass of 32.89 Kg ± 9.2 and height of 1.35 m ± 0.078, all regularly enrolled. The study participants were intentionally selected, as opposed to a random selection, that is, the participants were young students who showed interest and returned the informed consent form signed by their parents and/or legal guardians.

Inclusion criteria were: having an informed consent form signed by parents or legal guardians and being duly enrolled and attending classes at the respective schools. The study was approved by the Ethics Committee on Research Involving Humans of the Federal University of Amazonas, under No 114.687.

Determination of Anthropometric Indicators

The children were weighed and measured according to procedures standardized by Alvarez; Pavan; Petroski[19], for which they wore light clothes and did not wear shoes. For body mass assessment, a LAICA digital balance was used, which had a platform and weighed in kilos and at 200g intervals, with minimum and maximum record of 12Kg and 136Kg, respectively, and whose maximum tolerance corresponded to approximately 1% of the weight applied. Height was measured with a measuring tape with a 0.1 cm scale set on a wall without skirting; the students stood in an orthostatic position, having their heights equally distributed. Waist circumference (WC) was measured with a glass-fiber anthropometric tape (Sanny®, Brazil) at the midpoint between the last rib and the iliac crest.

By means of anthropometric data collected it was possible to determine: weight status through BMI [BMI = body mass (kg) / height2 (m)], in which the criteria used for BMI classification were the reference values proposed by Cole et al.[20] to classify overweight and eutrophy strata, and the values proposed by Cole[21] to classify underweight strata. This type of procedure has already been used in other studies[10]. To classify the students from waist circumference measures, the reference values proposed by Taylor et al.[22] were used. Waist-height ratio (WHR) was determined dividing waist circumference (cm) by height (cm), and the students were classified according to the reference values proposed by Beck; Lopes; Pitanga[23].

Motor Performance Determination

Motor performance was determined through the *Körperkoordination Test für Kinder* test (KTK) proposed by Kiphard; Schilling[24]. The KTK test is composed of four tasks: balance; hops; lateral jump and lateral transposition. Each task represents a gross score which is summed and turned into Motor Quotient (MQ) values according to normative tables present in the manual. The MQ of each task is summed, generating a final MQ for each individual, and from this MQ there is a classification according to five levels: very good (131-145), good (116-130), normal (86-115), regular (71-85) and low (56-70). The KTK was validated in Brazil and presents individual reliability of 0.65 and 0.87, and total reliability of 0.9, showing

credibility for its application[25]. This instrument is widely used in both national[13,26,27] and international[9,12,28] researches to identify motor coordination levels.

Data collection

Data were collected at the selected schools in the morning and afternoon, according to the availability of access to students established by the school's principal and teachers. First, anthropometric measures were performed (body mass, height and waist circumference) and the children had their sex and aged recorded. Afterwards, motor assessment was carried out in a duly prepared space (classroom without chairs or desks), according to the requirement of each task. Each participant was assessed separately and the tasks were performed as follows: first the child performed the balance task, then hops, lateral jump and finally lateral transposition. The KTK assessment lasted about twenty (20) minutes. The task application complied strictly to the norms (protocol) set by the instrument's creators. The students were assessed during school hours, except for Physical Education classes.

Statistical Analysis

Data were expressed with frequency, percentage, mean and standard deviation (± SD), and normality was checked through the Kolmogorov-Smirnov test. Motor performance comparisons were done from the final motor quotient. Student's T test was adopted to compare motor performance mean values between sexes and individuals classified as Normal and with Health Risk as to Waist Circumference and Waist/Height Ratio. Analysis of variance (Anova One Way) was used to compare motor performance mean values between individuals in different weight status categories (Underweight, Eutrophic and Overweight), and Tukey's post hoc test was used to find differences. Results were analyzed with the aid of the Statistical Package for Social Sciences (SPSS), version 20. Statistical significance was set when $p \leq 0.05$

Results

According to Table 1, it is possible to see that, regardless of weight status, most students showed normal motor performance. However, there was a raise in regular and low motor performance scores according to changes in the normality values of the anthropometric indexes. It is possible to observe that individuals with non-normal anthropometric indicators show inferior motor performance compared to their peers. The BMI variable shows that individuals classified as overweight presented the lowest motor performance indexes, that is, higher frequencies in regular and low classifications. Also, observing motor performance according to the Normal and Health Risk classifications, for both WC and WHR variables, the latter also presented higher frequencies in Regular and Low classifications (Table 1).

Table 1. Motor Performance in frequency and percentage according to classifications of anthropometric indicators.

BMI	**Classification**	**Frequency**	**Percentage (%)**
Underweight	Good	1	2.7
	Normal	34	91.9
	Regular	2	5.4
	Low	0	0
	Total	37	100
Eutrophic	Good	8	3.5
	Normal	190	83.3
	Regular	27	11.8
	Low	3	1.3
	Total	228	100
Overweight	Good	0	0
	Normal	64	75.3
	Regular	17	20
	Low	4	4.7
	Total	85	100
Waist Circumference	Classification	Frequency	Percentage (%)
Normal	Good	9	4
	Normal	193	86.5
	Regular	18	8.1
	Low	3	1.3
	Total	223	100
Health Risk	Good	0	0
	Normal	95	74.8
	Regular	28	22
	Low	4	3.1
	Total	197	100
Waist-Height Ratio	Classification	Frequency	Percentage (%)
Normal	Good	8	3.4
	Normal	206	87.3
	Regular	19	8.1
	Low	3	1.3
	Total	236	100
Health Risk	Good	1	0.9
	Normal	82	71.9
	Regular	27	23.7
	Low	4	3.5
	Total	114	100

Source: The authors

Comparing motor performance between the different weight status categories, it was possible to observe statistically significant differences between the overweight group and the eutrophic and underweight groups (Table 2), with individuals classified as overweight presenting motor performance mean values inferior to those of the other groups. It is also observed (Table 2) that underweight individuals did not differ from eutrophic ones, which allows inferring that body mass deficit did not influence the motor performance of the studied group.

Table 2. Comparison of motor quotient mean values between the different body mass levels.

Variable	Classification (mean ± SD)		*p*
Weight Status	Underweight (97.84 ± 8.85)	Eutrophic	.914
		Overweight	.006*
	Eutrophic (96.98 ± 11.94)	Underweight	.914
		Overweight	.000*
	Overweight (90.53 ± 13.38)	Underweight	.006*
		Eutrophic	.000*

* Statistically significant differences with p ≤0.05
Source: The authors

Comparing motor performance mean values between groups in WC and WHR variables, significant differences were observed between individuals classified as Normal and Health Risk (Table 3). It was also possible to observe that in both variables individuals classified in the health risk category presented motor performance mean values inferior to those of the normal group (Table 3).

Table 3. Comparison of motor quotient mean values between WC and WHR.

Variables	Motor Performance Mean (standard deviation)		*p*
	Normal	Health Risk	
Waist Circumference	97.07 (12.87)	92.26 (10.56)	0.001
Waist/Height Ratio	97.50 (13.25)	92.00 (9.58)	0.000

* Statistically significant differences with p≤0.05
Source: The authors

Moreover, in this study, observing motor performance between sexes (Table 4) in different weight statuses, it was possible to find that Eutrophic and Overweight boys showed a performance statistically superior to that of girls (Table 4).

Table 4. Comparison of motor quotient mean values between boys and girls in different weight statuses.

Variables		Motor Performance (Sum Motor Quotient) Mean (standard deviation)		*p*
		Boys	Girls	
Weight Status	Underweight	326.9 (36.2)	307.6 (30.2)	0.086
	Eutrophic	327.2 (38.5)	308.0 (67.8)	0.010*
	Overweight	305.4 (34.9)	282.8 (40.8)	0.009*

* Statistically significant differences with p≤0.05
Source: The authors

Discussion

This study aimed to investigate anthropometric indicators and motor performance among young students. It was possible to observe that most of them showed motor performance classified as Normal. These findings are in line with those of a study by Da Silva; Araújo; Aburachid[11], in which the authors verified relationship between nutritional status and motor coordination of children and adolescents of both sexes and found predominance of individuals classified as "normal" as to coordination.

Marramarco et al.[24], in turn, when analyzing the motor development of 287 children, found that, in general, the children investigated in their study showed poor motor performance (41.5%) and very poor motor performance (31.7%). Corroborating with Marramarco et al.[24], some authors warn that Brazilian children have been presenting motor deficit regardless of sex, nutritional status, socioeconomic level or region where they live[7,11].

However, in this study, conducted in Northern Brazil, this motor deficit trend was not confirmed. It is believed that this adequate level of coordination is associated with daily activities in which those children are involved and also with their ethnic and biological characteristics, which may have favored motor performance concerning the requirements of the performed tasks. Nevertheless, this is only a possibility, as these factors have not been controlled.

The motor performance comparison considering weight status highlights that students classified as Overweight (BMI) and Health Risk (WC and WHR) showed a motor performance statistically inferior to that of their peers (Tables 2 and 3). These findings allow stating that negative changes in these indicators showed, in this study, an increase in cases of students with regular and low motor performance in all indicators (Table 1). This fact corroborates with findings of Luz et al.[18] and Luz et al.[13], because the authors found, in their respective studies, a positive relation trend between higher BMC values and lower motor coordination results, and a low to moderate inverse correlation between motor coordination and height, body mass, waist perimeter and fat mass in children and adolescents.

The results of this study also agree with those of a study by D'Hondt et al.[30], in which the authors assessed 117 children aged between 5 and 12 years old in order to find differences in the gross motor coordination of normal-weight, obese and overweight individuals. It was observed that overweight children and especially obese ones had the worst results in the KTK test ($p<0.001$). The authors highlighted that less than 20% of normal-weight children were classified as having motor problems; however, this proportion raised to 43.3% and 70.8% among overweight and obese children, respectively. In a longitudinal study, D'Hondt et al.[9] investigated gross motor coordination levels and physical activity levels among normal-weight children (n=50) and obese/overweight children. Evolution in motor coordination levels was strongly related to the children's weight status, because normal-weight ones showed better progress compared to their peers, and the latter presented a significantly poor performance.

Lopes et al.[6], in a cross-sectional study, analyzed the association between MC and BMI in 7,175 children aged between 6 and 14 years old; KTK test was used for motor coordination assessment. Low to moderate negative correlation was observed between BMI and motor coordination for all ages; overweight and obese children presented lower motor coordination level than those with normal weight. Valdivia et al.[31] have also found in their studies significant association between adiposity levels and lower motor performance levels in children with high adiposity levels.

A study by Melo, Lopes[8] analyzed the association between the body mass index (BMI) and motor coordination (MC) of 794 children (6-9 years old) of both sexes, with the KTK battery of tests. BMI was calculated from weight and height measures [Weight(kg)/Height

(cm2)]. There were significant differences regardless of sex as to MC between the three BMI groups (normal weight, overweight, obese). Normal-weight children of both sexes achieved better results than overweight ones, and the latter obtained better results than obese ones. MC is moderately and negatively associated with BMI. Overweight and obese children of both sexes presented lower MC levels than normal-weight ones.

These changes in motor performance due to changes in anthropometric indicators can be explained, because prolonged lack or excess of food can bring serious impacts on the growth and development of children and adolescents. This shows that physical growth is directly related to motor development and nutritional status, and an adequate diet is an essential condition for these two variables. Severe and prolonged poor nutrition is frequently associated with delayed development, apathy and concentration issues[32-34].

However, another important factor to highlight, which can explain the discrepancy between the results found and those of other studies that have been conducted, as shown by Luz et al.[18], is how increase in body mass and physical demands of a task may have influenced the motor performance of individuals in this study. Vandorpe et al.[35] highlight that "Jumping on one foot" and "Jumping laterally", present in the KTK, require a great collaboration of physical abilities such as strength, resistance and agility, differently from those of other tasks. It is thus understood that restrictions proper of each task in the KTK may influence the organization of the movement, for involving demands on different levels for the structuration of body movements towards the action execution.

In this way, this fact leads to the belief that students with changes in anthropometric indicators may present inferior motor performance not due to delayed motor development but rather to the requirements of the task of a battery. This is confirmed in this study when underweight students did not differ from eutrophic ones, allowing to infer that body mass deficit did not influence the motor performance of the studied group, and the great responsible for the changes was the increase in body mass (Table 2).

This study could also find that Eutrophic and Overweight boys showed a performance statistically superior to that of girls (Table 4). These results corroborate with the study by Pelozin et al.[26], which assessed 145 children, showing that boys presented a performance superior to that of girls as well. Additionally, Carminato[27], in a study with 931 young students from Paraná aged between 7 and 10 years old, showed that boys had higher coordination levels than girls. Also, Lopez et al.[6] and Luz et al.[13] observed the same superiority of boys over girls.

It is believed that boys present better motor performance due to their greater engagement in motor-physical activities in general[31,17] that involve strength, resistance and power, whereas girls participate in activities with lighter movements, less aggressiveness and in smaller spaces[36]. Moreover, these differences can be explained by the cultural context, in which a greater diversity of motor opportunities within the family and school environments is offered to boys.

Conclusions

Based on the results obtained in the present study with Manaus' urban children it is possible to conclude that changes in anthropometric indicators have a negative influence on the students' motor performance. This shows that these indicators can serve as a prognosis means for the intervention of actions that can help promote the health and wellbeing of these children, in addition to assisting in the identification of future motor problems.

Moreover, there should be attention to further studies as to the type of motor assessment instrument used, because many of the differences found or not can be explained by the specific nature of each motor task that composes the assessment instrument.

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