



RISK FACTORS ASSOCIATED WITH POSTURAL CHANGES IN SCHOOLCHILDREN AT A PUBLIC INSTITUTION IN RIO DE JANEIRO

FATORES DE RISCO ASSOCIADOS À ALTERAÇÕES POSTURAIS DE ESCOLARES EM UMA INSTITUIÇÃO PÚBLICA DO RIO DE JANEIRO

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ABSTRACT: The objective was to identify factors possibly associated with the prevalence of postural alterations in schoolchildren from a public institution in Rio de Janeiro. In this observational, cross-sectional study, the posture of 304 children and adolescents was assessed using the Moiré Shadow Technique, allowing classification into two categories: presence or absence of deviation in the dorsal region. A questionnaire was applied to obtain information on potential variables associated with the prevalence of postural deviations. Data were collected between November 2019 and February 2020 and analyzed using logistic regression models to identify relationships among variables, with the aid of the R statistical software. The results showed that sex, age, body mass index, and level of physical activity practice were significantly associated with the outcome variable. These associated variables reflect important health indicators and are essential to support the development of effective public policies aimed at health promotion in the school environment.

KEYWORDS: Adolescent. Child. Posture. Risk Factors. Students.

RESUMO: O objetivo foi identificar os fatores que, possivelmente, estão associados à prevalência de alterações posturais em escolares de uma instituição pública do Rio de Janeiro. Neste estudo observacional, de corte transversal, a postura de 304 crianças e adolescentes foi investigada por meio da Técnica de Moiré de Sombra, permitindo a classificação em duas categorias: presença ou ausência de desvio na região dorsal. Um questionário foi aplicado para obter informações acerca de possíveis variáveis associadas à prevalência dos desvios posturais. Os dados foram coletados no período de novembro de 2019 a fevereiro de 2020. Os dados foram modelados por regressão logística para identificar as relações entre as variáveis, utilizando o software estatístico R. Identificou-se que as variáveis sexo, idade, índice de massa corporal e o estado de prática de atividade física apresentam associação significativa com a variável desfecho. As variáveis associadas refletem importantes indicadores de saúde, fundamentais para subsidiar políticas públicas eficazes e voltadas à promoção de sua saúde no ambiente escolar.

PALAVRAS-CHAVE: Adolescentes. Crianças. Estudantes. Fator de Risco. Postura.

INTRODUCTION

Improper postural habits tend to begin during childhood and adolescence, and when established early, they can become habitual and difficult to correct¹. Postural deviations can be considered a public health problem, particularly those affecting the spine, as they tend to affect large population groups, predisposing individuals to the development of degenerative conditions of the musculoskeletal system, which can result in chronic pain².

Children and adolescents commonly exhibit, notably as a result of growth, misalignment of body segments that give rise to different types of postural deviations^{3,4}. This is concerning since it is precisely during this period of life that individuals in these populations experience the school physical environment daily, in which they often use ergonomically unsuitable furniture⁵. These factors, combined with the current trend of adopting sedentary lifestyles, favor the development of postural alterations^{3,6}.

Regarding the scenario described above, experts and researchers point to the importance of daily postural screenings in the student population to estimate the incidence of postural deviations, so as to enable preventive actions to be implemented both inside and outside the school context, since the school also has the function of educating for the adoption of healthy habits^{6,7}. Furthermore, evidence suggests that the magnitude of healthy practices, when encouraged from an early age, is directly associated with better levels of quality of life and health in adulthood^{3,4,5,6,7}.

Different scholars have investigated the prevalence of postural deviations in the school-age population and found rates of 5%⁸, between 20% and 40%^{9,10}, and even more than 60% prevalence of postural defects^{1,4,7,11}. As can be seen, these findings are discrepant in terms of the extent of prevalence; however, others indicate that there is, in fact, a relationship between the presence of postural deviations and possible exposure variables, such as the degree of physical adequacy of school furniture¹², the way students carry their school material^{13,14}, and the magnitude of body mass^{11,13}.

Given the proven importance of periodic examinations to detect postural health status in schoolchildren and considering the scarcity of such actions in the municipality of Rio de Janeiro, Oliveira et al.¹⁵ conducted a study to investigate postural deviations in children and adolescents enrolled in a school in that municipality and found a high prevalence rate. However, to precisely design and implement actions aimed at changing this situation, it is necessary to know the factors that determine it. In addition, data such as these can help in understanding the environmental and behavioral influences that contribute to the postural condition of children and adolescents in Rio de Janeiro, since these factors are peculiar to each locality¹⁶.

In this sense, the present study aimed to identify the factors associated with the prevalence of postural deviations in children and adolescents enrolled in a public school in the municipality of Rio de Janeiro.

METHODOLOGY

This was an observational, cross-sectional study, as the behavior of the variables in the sample of interest was presented descriptively and as a single event. Therefore, it is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines¹⁷.

The project was approved by the Research Ethics Committee of the Pedro Ernesto University Hospital of the State University of Rio de Janeiro (Opinion No. 3,705,958).

The investigation was conducted from November 2019 to February 2020 at a municipal public elementary school in the city of Rio de Janeiro, located in an area of severe social vulnerability in the

Jacarepaguá neighborhood. The reference population consisted of 900 students enrolled in the institution, all of whom were invited to participate in the study. Potential participants received an Informed Consent Form (ICF), which had to be read and signed by their guardians agreeing to the participation of their dependents. Students who returned with a signed ICF and were classified as healthy and typical were included in the study. These procedures resulted in a convenience sample of 304 children and adolescents.

A 95% confidence level was adopted, resulting in a 5% error margin. Data were collected in three stages, each performed by two previously trained examiners. The first stage involved administering a structured questionnaire to obtain information on exposure variables and behaviors possibly associated with the prevalence of identified postural disorders.

In the second stage, the total body mass (TBM) and height of each participant were measured. A G-TECH digital scale (Glass 8 model, China) was used to determine the TBM values of the participating children. The horizontality and stability of the scale were initially checked for each measurement. After being correctly positioned on the scale, the individual was asked to remain still while the measurement value was recorded.

For height measurement, a stadiometer adapted using a standard measuring tape, vertically fixed to a smooth wall, was used with a previously calibrated wooden square as a delimiting ruler.

During the measurement process, the participants were instructed to stand against the wall with their back positioned over the measuring tape, keeping their feet and heels together. After positioning, the participants were instructed to take a deep breath and hold their breath for a few seconds. At the end of the deep breath, the examiner marked the height by gently pressing a wooden square against the vertex of the subject's head.

The procedures for taking these measurements were carried out in accordance with the strategies indicated by the International Standards for Anthropometric Assessment Manual, published in 2006 by the International Society for the Advancement of Kinanthropometry (ISAK). In the third stage, data relating to the postural condition of the participants were collected using the Shadow Moiré Technique (SMT) presented by Takasaki¹⁸. In general, SMT is a surface topography study strategy that uses optical methods to provide three-dimensional images of the surface contours of a body or object. This method consists of an optical phenomenon used to examine the posture of the spine and other body structures based on the projection of fringes in these regions to identify possible changes in spatial configurations¹⁹. In the third stage, the data obtained from the SMT examination were processed using the procedures proposed by Oliveira et al¹⁵.

Regarding the first data collection phase, corresponding to the aim of this study, the examiner responsible for this station completed the responses of each volunteer individually in a private room. The structured questionnaire consisted of the volunteers' identification data and questions regarding the daily habits of the schoolchildren participating in the sample. These questions were designed to investigate which daily life behaviors, particularly those typical of the school setting, may be associated with the development of postural changes in the study population.

Therefore, in addition to the registration data, the structured questionnaire included the following questions: 1) Do you practice physical activity (PA) outside the school setting?, 2) Do you carry school supplies?, 3) If the student answered yes to the previous question, they were asked to indicate, from the available options, which method they used: backpack with straps, wheeled backpack, briefcase, and others; 4) For students who indicated using a backpack with straps, they were asked to indicate how it was carried: bilaterally (with support on both shoulder joints), unilaterally right or left (with support only on one shoulder joint), or crossed. After detailing how they carried their school supplies, each

participant was asked to answer whether: 5) There are complaints of pain in the spine; 6) If the answer was positive to the previous question, the student was asked to indicate the location of the pain from the listed options: cervical spine, thoracic spine, or lumbar spine. Specifically, for the last question, the evaluator pointed directly to the spot on their own body so that the volunteer could correctly indicate the region of the spine affected by pain. All participants received a numerical identification recorded on their respective forms to ensure anonymity in the research.

In accordance with Oliveira et al.¹⁵, the findings regarding the postural condition of the examined individuals were distributed into four types: a) presence of a difference in fringes in the dorsal region; b) absence of a difference in fringes in the dorsal region; c) presence of a difference in fringes in the scapular girdle region; and d) absence of a difference in fringes in the scapular region. The difference in the number of fringes between the right and left sides in the dorsal region of the vertebral column suggests the presence of a scoliotic posture in that region²⁰. The difference in the number of fringes on one side and the other, identified in the scapular girdle region, suggests the presence of postural deviation related to an alteration in the position of the scapulae or shoulder joints²¹.

The number of cases in these categories, as well as the responses indicated in the structured questionnaire for identifying associated factors, were recorded and descriptively analyzed by calculating the absolute and relative frequencies for each item. Sample characterization data, such as mass, height, and body mass index, were analyzed using descriptive statistics in Microsoft Excel software (version 1808-2019), stratified by sex and age.

After the data collection stages were completed, the data were subjected to statistical treatment to identify possible relationships between the outcome variables (presence of deviation in the back and shoulder girdle) and the exposure variables (total body mass (TBM), height, body mass index (BMI), age, and postural habits of the sample participants, obtained from the structured questionnaire: physical activity status, school supplies, method used for carrying school supplies, way of carrying the backpack with straps, spinal pain, and location of pain).

Considering the binary nature of the variables of the presence of deviation in the back and shoulder girdle, the respective data were modeled using logistic regression (General Linear Models (GLM) – Link Function: Logit) to identify whether the collected variables could help explain the findings of the examinations performed²². The interaction between the variables BMI, physical activity (PA), and age (three-way interaction) was included in the test model.

The stepwise method was used to identify the most parsimonious model (ideal model), that is, with the fewest number of variables²² that could be related to the outcome variables without losing the predictive power of the model. To confirm the results of the stepwise method, the initial and ideal models were compared (Anova.GLM - analysis of deviance - adjusted by chi-square). Statistical analysis was performed using R software (1.41106), and the significance level was set at $\alpha = 0.05$.

RESULTS

The sample consisted of 304 subjects, 168 females and 136 males, with a mean age of 11.5 ± 2.6 years, total body mass of 44.9 ± 15.3 kg, and height of 150.3 ± 14.6 cm.

The data from the measurements of the anthropometric variables of height, TBM, and BMI were stratified by sex and age (Table 1).

Table 1. Anthropometric data stratified by age and sex (mean values and standard deviations).

Age (years)	Sex	N	Height (cm)	TBM (kg)	BMI (kg/m ²)
6	♂	7	121.7 ± 3.6	22.1 ± 2.3	15.2 ± 1.2
	♀	2	119.3 ± 5.3	22.9 ± 4.8	15.9 ± 1.9
7	♂	17	128.9 ± 4.6	25.6 ± 4.9	15.9 ± 1.8
	♀	10	124.2 ± 3.5	24.8 ± 4.7	16.1 ± 2.5
8	♂	2	131.9 ± 4.8	24.3 ± 1.8	14.0 ± 0.0
	♀	14	132.6 ± 4.0	28.9 ± 5.4	16.3 ± 2.4
9	♂	10	135.4 ± 4.3	30.3 ± 3.3	16.6 ± 1.0
	♀	5	132.8 ± 12.7	27.3 ± 6.6	16.6 ± 0.7
10	♂	14	143.1 ± 4.9	33.8 ± 5.3	15.7 ± 2.3
	♀	20	141.1 ± 6.6	35.0 ± 6.1	17.3 ± 2.0
11	♂	21	150.7 ± 5.0	44.2 ± 10.2	19.6 ± 3.8
	♀	18	149.6 ± 5.0	42.8 ± 5.6	19.1 ± 1.8
12	♂	22	151.7 ± 5.1	43.4 ± 7.3	18.5 ± 2.4
	♀	31	155.0 ± 4.8	45.1 ± 8.4	18.3 ± 2.9
13	♂	14	162.1 ± 6.1	56.4 ± 10.8	20.4 ± 3.2
	♀	24	157.4 ± 3.8	48.1 ± 7.4	19.3 ± 2.6
14	♂	16	168.0 ± 5.6	57.1 ± 8.5	19.8 ± 2.6
	♀	19	163.6 ± 4.8	53.0 ± 9.4	22.0 ± 3.4
15	♂	8	173.3 ± 6.4	65.6 ± 6.6	21.5 ± 1.5
	♀	18	163.8 ± 5.4	53.0 ± 9.7	19.9 ± 3.3
16	♂	4	172.8 ± 4.9	70.5 ± 4.4	22.5 ± 1.9
	♀	5	161.6 ± 5.2	50.0 ± 5.6	18.6 ± 3.3
17	♂	1	179.4 ± 0.0	60.7 ± 0.0	18.9 ± 0.0
	♀	2	163.4 ± 2.8	57.3 ± 8.8	21.6 ± 4.0

♂ boys, ♀ girls, n number of participants, cm centimeter, kg/m² kilogram per square meter.

Data regarding the presence of deviation in the dorsal region and shoulder girdle were stratified by sex and age and are listed in Table 2.

Table 2. Data on deviations of the dorsal region and shoulder girdle stratified by age and sex.

Age (years)	Sex	N	Fringe Difference in the dorsal region (%)		Fringe Difference in the shoulder girdle region (%)	
			YES	NO	YES	NO
6	♂	7	86	14	86	14
	♀	2	00	100	100	00
7	♂	17	71	29	94	06
	♀	10	60	40	80	20
8	♂	2	50	50	100	00
	♀	14	86	14	64	36
9	♂	10	50	50	50	50
	♀	5	60	40	80	20
10	♂	14	93	07	71	29
	♀	20	60	40	70	30
11	♂	21	76	24	62	38
	♀	18	83	17	83	17
12	♂	22	77	23	82	18
	♀	31	77	23	77	23
13	♂	14	93	07	64	36
	♀	24	79	21	71	29

Age (years)	Sex	N	Fringe Difference in the dorsal region (%)		Fringe Difference in the shoulder girdle region (%)	
			YES	NO	YES	NO
14	♂	16	75	25	63	37
	♀	19	79	21	74	26
15	♂	8	75	25	75	25
	♀	18	67	33	72	28
16	♂	4	25	75	100	00
	♀	5	60	40	60	40
17	♂	1	100	00	100	00
	♀	2	50	50	100	00
Total		304				

♂ boys, ♀ girls, n number of participants.

Table 3 presents the information obtained from the structured questionnaire regarding the participants' daily and postural habits.

Table 3. Descriptive data from the structured questionnaire of the sample.

Questionnaire Categories		
Physical Activity Practice	Yes	35%
	No	65%
Carrying School Supplies	Yes	99%
	No	1%
Back Pain	Yes	54%
	No	46%
Method for Carrying School Supplies	Backpack	89%
	Wheeled backpack	3%
	Briefcase	0%
	Others	8%
Way of Carrying the Backpack	Bilaterally	70%
	Right side	18%
	Left side	9%
	Crossed	3%
Region of Back Pain	Thoracic	54%
	Lumbar	28%
	Cervical	18%

% percentage of classifications into the subcategories.

The ideal model indicated by the stepwise method showed a good fit (Residual deviance [322.03], degrees of freedom [295], $p = 0.134$). Deviance analysis confirmed this model as the most parsimonious for identifying the variable "back deviation" ($p = 0.9$). The ideal model identified the following exposure variables that were associated with the presence of back deviation (Table 4).

Sex, Age, BMI, and PA, as well as the interaction between them: Age.BMI, BMI.PA, Age.PA, Age.BMI.PA showed good predictive power for the outcome variable, that is, the presence of deviation in the back. The prediction boundary of the response variable was 0.7 between the negative and positive results of the deviations in the back. This value was defined considering the eightieth value of the sample arranged in ascending order, as only 79 subjects did not present deviation.

From the Classification Matrix (Table 5), the ideal model presented an accuracy of 68%, sensitivity of 72%, and specificity of 56% for the outcome variable deviation in the back. These results suggest that the model is a good fit for classifying deviations in the dorsal region.

Table 4. Exposure variables with their respective coefficients.

Variable	Coefficient
Intercept	-14.773
Sex	-0.531
BMI	0.944
PA	13.779
Age	1.199
BMI × PA	-0.763
BMI × Age	-0.068
PA × Age	-1.201
BMI × PA × Age	0.061

BMI Body Mass Index, PA Physical Activity.

Table 5. Classification Matrix Values for Deviations in the Shoulder Girdle and Back.

Classification Matrix						
Observed	Deviation	Estimate (Shoulder)		Deviation	Estimate (Back)	
		Without deviation	Correct classifications (%)		Without deviation	Correct classifications (%)
Deviation	177	48	79	162	63	72
Without deviation	46	33	42	35	44	56
Total	210	94	69	206	98	68

% percentage of correct classifications.

For shoulder girdle deviation, the analysis of variance also confirmed the suggestion of a more parsimonious model indicated by the stepwise method ($p = 0.9195$). As can be seen, the model for this outcome variable was not well-fitted by the GLM; therefore, it was not presented. This finding was based on the Classification Matrix of the variable, in which a specificity of only 42% was observed, while the sensitivity and accuracy were 79% and 69%, respectively (Table 5). In this case, these data indicate that the model for the shoulder girdle region is biased, given that almost all the subjects were identified with the presence of deviation.

The odds ratios of the exposure variables and their respective confidence intervals are presented in Table 6.

Table 6. Odds ratios and confidence intervals of exposure variables.

Variable	Odds ratio	Confidence interval (95%)
Female Sex	0.59	0.32 – 1.04
BMI	2.57	1.49 – 4.73
Age	3.31	1.61 – 7.17
Physical Activity	0.40	0.22 – 0.71
BMI*Physical Activity	0.46	0.18 – 1.16
Age*Physical Activity	0.30	0.08 – 1.14
BMI*Age	0.93	0.89 – 0.97
BMI*Age*Physical Activity	1.06	0.98 – 1.14

BMI Body Mass Index.

Based on the proposed model and the analysis of the odds ratios presented in Table 6, it can be seen that the fact that the individual does not practice physical activity, is male, and has advancing age and increasing BMI results in an increase in the coefficient, indicating the presence of a possible deviation in the back region. On the other hand, being female and engaging in physical activity tended to reduce

the probability of such deviations. The interaction of physical activity with BMI and age also seems to influence the reduction in the probability of back deviation.

DISCUSSION

The present study aimed to identify factors associated with the prevalence of postural changes in schoolchildren in the city of Rio de Janeiro.

The results suggest that, for the population investigated, the behavior of the variables Sex, Age, BMI, and Physical Activity, as well as the interaction between them, shows a significant association with the outcome variable “presence of deviation in the back,” indicating the possibility of a predictive potential. In fact, the statistical model with an accuracy of 68%, sensitivity of 72%, and specificity of 56% indicates that male individuals who do not practice Physical Activity, with increasing age and BMI, are more prone to deviations in the back region.

Our findings are in agreement with those of other researchers, notably those relating to the association between physical activity status and BMI values. Wyszynka et al.²³ identified that schoolchildren who do not engage in regular physical activity and have high body fat indices are more likely to present postural deviations in the spine and shoulder girdle. Similar findings were reported by Matusik, Durmala and Matusik²⁴, who found a significant positive correlation between BMI and scoliosis severity in adolescents.

Similarly, Rusek et al.²⁵ examined in detail the body composition and postural status of 464 Polish schoolchildren aged 6–16 years and found significant associations between the magnitude of body fat percentage and the prevalence of postural alterations. Golalizadeh et al.²⁶ verified a similar trend by identifying an increased risk for lumbar hyperlordosis in adolescents with higher values of fat mass and BMI. The same was obtained by Jorgic et al.¹¹, who demonstrated that body composition was significantly associated with the postural alignment of schoolchildren examined, notably in deviations from the sagittal plane.

In Brazil, the situation appears to be no different. Batista et al.²⁷ found a positive association between high BMI values and lack of physical activity with the presence of postural disorders in children and adolescents from a public school in a municipality in São Paulo. Likewise, Bertonecello et al.⁴ produced data suggesting that the high prevalence of postural disorders in the spine in adolescents is related to the fact that the participants do not practice physical activity.

As can be seen, the findings in the scientific literature support the assumption that the magnitude of BMI values, along with the status of physical activity, is associated with the prevalence of postural deviations in children and adolescents. This situation tends to be even more concerning if we consider that physical inactivity or lack of sports activities among children and adolescents is accompanied by the routine use of electronic devices^{13,27}. The combination of these factors tends to result in the worsening of a condition characterized by low physical fitness, which, consequently, constitutes a cause of the increase, for example, in the number of overweight or obese individuals, this being one of the main characteristics of a sedentary population^{11,13,23,27}.

The phases of childhood and adolescence correspond to those in which individuals attend the school environment, where they remain seated for long periods, usually adopting improper posture^{5,26}. This includes the tendency towards a sedentary lifestyle adopted during the school years, which can also favor the emergence of postural changes in the spine^{4,11,28}. Based on the findings of our study, added to what is reported in the scientific literature, it seems that sedentary behavior constitutes an additional

factor, not only in terms of the causal framework that results in an increased risk of overweight and obesity, but also in increasing the probability of developing postural deviations in schoolchildren^{4,11,28}, which, to some extent, compromises the health and quality of life of these individuals.

Considering the ideal prediction model suggested here, it is proposed that the probability of suspected back deviation should also consider the interaction between exposure variables, instead of just a separate analysis of each variable. This is relevant because, as chronological age advances, there is also a proportional increase in BMI, respecting the interindividual differences imposed by the particular morphological characteristics related to growth and maturation^{11,29}. Furthermore, BMI values are directly affected by the fact that the individual does not practice physical activity, which seems to increase the probability of back deviation, according to the proposed model.

Although the study reported here did not investigate cause-and-effect relationships, the identification of interactions between the examined variables is a suggestive indicator that the implementation, in the school context, of strategies aimed at controlling BMI, reducing sedentary behavior, and promoting adherence to regular physical activity will prevent the onset and progression of postural changes in the investigated population. The relevance of this proposition is reinforced by the finding that there is low participation of schoolchildren in physical activity programs, and even when it exists, it is known that the minimum requirements recommended for effective physical exercise are rarely met^{30,31,32,33}.

In addition to these factors, the role of day-to-day habits such as excessive screen time, usually linked to the use of electronic devices and increased sedentary behavior, stands out^{31,32,33}. Since such behavior may be associated with a lack of physical activity and an increase in BMI, variables identified in this study, the time spent using these devices could increase the likelihood of postural deviations. However, this information was not controlled for in this investigation; therefore, its inclusion in future studies is recommended to allow for more information on school health.

Several characteristics make schools an ideal environment for implementing strategies such as the one mentioned above, notably the compulsory daily attendance of students, which facilitates their adherence to an ideal frequency of exercise, the fact that there is a space in the curriculum reserved for the practice of physical activities, and the existence, within the teaching staff, of a specialist trained to design, implement, and conduct educational interventions aimed at these purposes. In fact, the Physical Education teacher receives training to act as a health agent in the school setting and is therefore able to take a leading role in the implementation of the strategies mentioned above³⁴.

Regarding the age factor, the proposed model showed that with increasing values of this variable, there was an increase in the estimated coefficient for classifying the presence of possible deviations in the dorsal region. This behavior can be explained by factors inherent in the profile of the examined sample. For example, a significant portion consists of individuals in the 10–14-year age range (Tables 1 and 2). Furthermore, the fact that they are children and adolescents enrolled in the school system and with an average age of 11.5 years characterizes a population that, according to data from the literature, is composed of individuals who tend to develop postural alterations^{7,11,16,34,35}.

From what we know, the development of postural deviations in this age group may be related to anatomical and physiological changes that generally manifest during this period of life, which is characterized by the growth spurt^{29,34,35}. Therefore, postural changes are expected to manifest in schoolchildren during this period, especially those affecting the spine^{11,35}.

In the natural growth spurt process, a high rate of growth of body segments and height is observed, which characterizes the modification of body dimensions. This phenomenon tends to result in changes in the body posture. This event causes the body structures to adapt to the demands imposed

by gravity, reducing the degree of body stability and possibly resulting in an increase in the magnitude of mechanical load on the spine^{3,4,5}. This process normally occurs during the period covered in this study; however, in the presence of deviations, it can be detrimental to the body structure and sometimes to organic functions¹¹.

In addition to maturational indicators of rapid and asymmetrical growth of body structures, other factors possibly associated with postural deficiencies, such as the use of unsuitable school furniture^{5,6}, were not investigated in the present study. Therefore, future research on the association between unsuitable furniture and the high prevalence of postural alterations is recommended, as it could greatly contribute to interventions aimed at promoting the health of children and adolescents.

Furthermore, it is believed that investigating such information is pertinent, considering that, during the school years, children and adolescents fulfill a high workload of pedagogical activities and remain seated for an excessive amount of time. It should also be considered that, in some institutions, the school furniture is unsuitable for its users, which favors the maintenance of incorrect posture and the development of postural changes in the aforementioned population^{5,6,16,25}.

Therefore, researchers emphasize that investigations on this topic should be further explored by the scientific community, considering that school furniture, as part of the school's physical space, plays an essential role in students' health^{5,6,36}.

The present study has some limitations that should be considered when interpreting the results. The lack of control for potential confounding factors could influence the association between the investigated exposure variables and the postural outcome variables. Factors such as socioeconomic level, eating habits, clinical history, and school furniture conditions were not included in the statistical models. Therefore, future studies should be designed to control for such variables to increase the robustness and validity of the explanatory models.

Furthermore, the absence of formal strategies for controlling potential biases is a limitation of the present study. This should be considered when interpreting the results, particularly about the possibility of uncontrolled confounding factors influencing the results obtained. Therefore, future studies should adopt strategies to detect and mitigate potential sources of bias.

Notably, despite having developed an ideal statistical model, the present study did not aim to develop a prediction equation. We investigated the variables associated with the outcome variables. Therefore, future studies should test the cross-validation of the prediction equation. It is also recommended to investigate more adjusted models with better specificity for suspected deviations in the shoulder girdle region, considering the findings of this study.

In addition to these arguments, it should be noted that this cross-sectional, associative study does not allow for the establishment of causal relationships between the investigated variables. Furthermore, the study only included children and adolescents from one school in the municipality of Rio de Janeiro, which requires caution in extrapolating the data to the population of other locations. Therefore, it is recommended that studies be conducted with a larger sample and from different educational institutions in the aforementioned municipality, including longitudinal designs to monitor the prevalence and daily habits of children and adolescents.

In addition to issues related to the interpretation of the findings of this study, a notable limitation is the lack of an Informed Assent Form for the participants in the sample.

CONCLUSION

This study found that sex, age, BMI, and physical activity, as well as the interactions between them, are risk factors that are possibly associated with postural changes in children and adolescents from a public school in Rio de Janeiro. In fulfilling this task, information was produced about the behavior of postural deviations in a portion of schoolchildren in the municipality of Rio de Janeiro, which can assist in the development of actions for the prevention and treatment of body posture in educational institutions.

Therefore, monitoring the physical activity status and BMI of children and adolescents contributes to the production of information that can be used in planning health actions to be implemented in the school environment, aimed at preventive measures to mitigate the negative effects of physical inactivity, particularly those related to the onset and worsening of postural changes in the future. Thus, studies that assess health indicators in this population are essential for establishing effective public policies to promote their health.

Furthermore, it is noteworthy that the school setting has a Physical Education Teacher on its professional staff, who is qualified to implement health initiatives and include periodic and longitudinal examinations in their work plan, in order to obtain information about aspects related to public health, such as the variation in incidence and prevalence, the rate of progression of the postural condition found, and the effectiveness of preventive strategies and/or therapeutic actions.

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