Prevalence of Cardiovascular Risk Factor in Elementary School Students

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Abstract: Background: CVDs (cardiovascular diseases) are a major cause of death and expenditure on public health in the world. CVRFs (cardiovascular risk factors) have increased in the adult population and in children and adolescents. Objective: To obtain the prevalence of CVRFs in elementary school students. Methods: The cross-sectional and observational study was carried out with 379 schoolchildren aged 10 to 15 years old, in a Brazilian capital. The variables studied were BP (blood pressure), physical activity level (IPAQ-short version) and visceral fat, through the BMI (body mass index), WC (waist circumference) and the WHR (waist-hip ratio). In the statistical analysis a significance level of 5% (p < 0.05) was adopted. Results: The main alterations were related to physical inactivity (31.2%), overweight (29.1%) and high BP (24.5%), the correlation between BMI and WC showed good correlation (r = 0.787, p < 0.001). Conclusion: Physical inactivity was the most prevalent risk factor among school children, followed by overweight and high BP, in the FTS (full-time school) higher prevalence of these factors was observed. The BMI and WC showed a good correlation for the results that had the risk of diverting the probabilities of the altered BMI, evidencing that the BMI and WC measures became more effective in predicting CVD than just a single use of one of them.

Key words: Child, adolescent, CVDs, risk factors, hypertension.

1. Introduction

CVDs (Cardiovascular diseases) are a serious public health problem in Brazil and in the world, being the main cause of worldwide mortality, responsible for approximately 15 million deaths each year and representing the highest cost in health care according to the WHO (world health organization) [1].

The progressive increase in CVRFs (cardiovascular risk factors), such as AH (arterial hypertension), dyslipidemia, diabetes, obesity and physical inactivity determine the increase in cardiovascular morbidity and mortality by two, up to seven times, for both sexes [2]. The prevalence of these risk factors was increased in the adult population and these were found to have high prevalence of these factors in children and adolescents [3].

The inadequate dietary pattern associated with a sedentary lifestyle has contributed to the increase in the prevalence of obesity in recent decades, leading the WHO to declare obesity as a global epidemic [4]. In a review of 450 studies on obesity prevalence developed by Blössner, Borghiand and Onis [5] in 144 countries, it showed that there were 43 million overweight children in the world in 2010, 35 million in developing countries. In Brazil, approximately one third (33.5%) of children aged 5 to 9 years are overweight [6].

The adoption of the National High Blood Pressure Education Program definitions and standardization of BP (blood pressure) promoted uniformity in the classification of BP in the pediatric population. It is suggested that the percentage of children and adolescents diagnosed with AH has doubled in the past two decades. The current prevalence of AH in
pediatric age is around 3% to 5%, while that of prehypertension (PH) reaches 10% to 15%, and these values are mainly attributed to the great increase in childhood obesity [7].

Physical inactivity globally affected 81% of adolescents aged 11 to 17 years in 2010. Environmental factors linked to urbanization can discourage people from becoming more active [8]. Although a smaller number of adolescents may have chronic-degenerative disorders, studies show impairments in BP, plasma lipid-protein and body fat indicators at this age, as a result of lower levels of physical activity, and that induces important metabolic and functional limitations in adulthood [9].

A single risk factor can contribute to the development of CVD, but the coexistence of several factors in the same individual increases the chances of the appearance of these diseases. The high rates of CVD mortality are explained by the high incidence of associated risk factors and low levels of intervention on these factors [10]. With the increasing number of CVD in adulthood and the few studies related to the prevalence of CVRF in school age, the main of this study is to obtain the prevalence of CVRFs in elementary school students.

2. Materials and Methods

In this cross-sectional and observational study conducted in a Brazilian capital, children and adolescents from two state schools, a partial period and a full period, aged between 10 and 15 years, were evaluated. This study was approved by the research ethics committee of PUC Goiás under the number 3.189.115.

Schoolchildren of both sexes regularly enrolled in the second phase of elementary school (6th to 9th grade) of the chosen institutions were included in this study. Those whose parents did not sign the informed consent form or did not allow their child/guardian to participate, schoolchildren who did not sign the free and informed consent term, who refused to participate in the study, who had any chronic illness were excluded degenerative, congenital malformation, neurological pathologies, cardiopulmonary and/or permanent orthopedic diseases that used some medication to control BP.

For the research of sedentary lifestyle, the self-administered questionnaire, IPAQ (International Physical Activity Questionnaire) was used, which was originally developed with the purpose of estimating the level of habitual practice of physical activity of populations from different countries. We choose to use the short form, as it is the version most frequently suggested for application in younger populations. The IPAQ is divided into four questions related to the time spent on physical activities, and the individual must consider the activities performed in the week prior to the application of the questionnaire. The categories considered according to the IPAQ are sedentary, insufficiently active (which has two subdivisions—insufficiently active A and insufficiently active B), active and very active [11].

For weight measurement, an anthropometric scale (Welmy®, São Paulo, Brazil), was used, with a precision of 2 kg and a maximum limit of 150 kg, which also measured height using a stadiometer with a height of 2 m and accuracy of 0.5 cm. The subjects were instructed to wear light clothing that did not interfere with height or weight, with bare feet, the individual was in an orthostatic posture, for the height measurement the student was in an anatomical position and the head was positioned according to the Frankfurt plan [12].

After measuring weight and height, the BMI (body mass index) divided into body mass by the square of height was calculated and the classification was made into four groups: thinness (percentile < 3), eutrophic (percentile ≥ 3 and < 85), overweight (percentile ≥ 85 and < 97) and obesity (percentile ≥ 97). The classification was carried out using percentiles and cutoff points analyzed according to the WHO tables stratified by sex and age [13].
As an additional estimate of the distribution of body fat, WC (waist circumference) and hip were used. An inelastic anthropometric tape (WisoT87-2, Santa Catarina, Brazil) was used for the measurement, with a size of 2 m and an accuracy of 0.1 cm. The measurement was performed at the point between the tenth rib and the iliac crest, an inspiration so that measurement could be performed, the hip measurement, was obtained in the region of greatest gluteal protuberance, both being used for calculation WHR (waist-hip ratio) [14]. The WC value equal to or higher than the 75th percentile was considered as a changed value, adjusted according to age and sex [15].

BP was performed twice (1 minute interval) using the cuff of adequate size for the children’s arm circumference, after a 5-minute rest period, and a second measurement was performed when the systolic blood pressure (SBP) or diastolic values altered more than 10 mmHg, an average among the closest pressures was considered. An oscillometric method with a professional BP monitor (Omron HBP-1100, Bannockburn, IL, EUA) was used. As children and adolescents, they were hypertensive when SBD and/or DBP were higher than the 95th percentile (p), according to age, sex and height percentile. Defined as prehypertensive (SBD/DBP ≥ 90th p < 95th p and ≥ 120/80 mmHg and < 95th p in adolescents), stage 1 AH (SBD/DBP between 95th p plus 5 mmHg above 99th p) and stage 2 AH (values > stage 1) [7].

The data were analyzed with the aid of the Statistical Package of Social Sciences (SPSS, 23.0). The prior decision to perform non-parametric tests was made after the Shapiro-Wilk normality test. The characterization of the demographic and anthropometric profile in schools was done through absolute frequency (n), relative frequency (%) for categorical and average variables, standard deviation for continuous variables. The comparison of the profile of school students was performed using Chi-square and Mann-Whitney tests. Spearman’s correlation was applied in order to verify the relationship between exploratory variables in schools. In all statistical analyses, a significance level of 5% (p < 0.05) was adopted.

3. Results

Of the 430 students invited to participate in the study, 21 (4.9%) refused to participate or the parents did not sign the informed consent form, 20 (4.7%) incorrectly answered any question in the questionnaire or some anthropometric data were missing and 10 (2.3%) had some disease mentioned in the exclusion criteria. The final sample consisted of 379 children and adolescents, with a predominance of males (50.9%), brown skin (51.7%) and mean age of 12.64 ± 1.61 years (Table 1).

The characterization and comparison of the anthropometric and clinical profile are shown in Table 2. The overall mean BMI was 20.13 ± 3.82 (p = 0.43). The comparison of BMI, WC and WHR data did not show any significant difference between the two schools. The BMI classification showed that the prevalence of overweight and obesity in the total sample was 29.1%, slightly higher in the PTS (part-time school) and among boys (32.7%). WC was altered in 15.8% of the total samples with a higher prevalence in males (21.2%), while WHR showed that 11.6% of the samples had a higher cardiovascular risk, being moderately higher in males (14%).

The data on the level of physical activity show that 31.2% of the total samples do not reach the ideal level of physical activity according to IPAQ, with 17.2% of the total population being irregularly active and 14% sedentary, consequently not reaching the level of activity recommended by the WHO, these changes were more prevalent in the FTS (full-time school) (31.7%) and in women with (38.2%).

BMI correlated with WC and WHR had a strong correlation with PTS (r = 0.860, p ≤ 0.001) for WC and (r = 0.839, p ≤ 0.001) for WHR, the same happens in the FTS (r = 0.715, p ≤ 0.001) for BMI and WC correlation (r = 0.675, p ≤ 0.001) for WHR. This
Table 1  Characterization and comparison of the demographic profile between schools.

|          | PTS        | FTS        | Total      | Average ± Standard deviation |
|----------|------------|------------|------------|-----------------------------|
| Age**    | 12.39 ± 1.91 | 12.87 ± 1.24 | 12.64 ± 1.61 |                             |
| Grade*   | 40 (22.2)  | 57 (28.6)  | 97 (25.6)  |                             |
| 6º       | 63 (35.0)  | 65 (32.7)  | 128 (33.8) |                             |
| 7º       | 39 (21.7)  | 36 (18.1)  | 75 (19.8)  |                             |
| 8º       | 38 (21.1)  | 41 (20.6)  | 79 (20.8)  |                             |
| Period*  | 0 (0.0)    | 199 (100.0)| 199 (52.5) |                             |
| Full-time| 108 (60.0) | 0 (0.0)    | 108 (28.5) |                             |
| Morning  | 72 (40.0)  | 0 (0.0)    | 72 (19.0)  |                             |
| Gender*  | 87 (48.3)  | 99 (49.7)  | 186 (49.1) |                             |
| Female   | 93 (51.7)  | 100 (50.3) | 193 (50.9) |                             |
| Skin color* | 16 (8.9)  | 22 (11.1)  | 38 (10.0)  |                             |
| Yellow   | 28 (15.6)  | 41 (20.6)  | 69 (18.2)  |                             |
| White    | 9 (5.0)    | 3 (1.5)    | 12 (3.2)   |                             |
| Other    | 94 (52.2)  | 102 (51.3) | 196 (51.7) |                             |
| Brown    | 33 (18.3)  | 31 (15.6)  | 64 (16.9)  |                             |
| BMI      | 1.54 ± 0.11 | 1.58 ± 0.09 | 1.56 ± 0.10 | 0.001**                     |
| Weight   | 48.05 ± 13.33 | 50.52 ± 12.41 | 49.35 ± 12.90 | 0.02**                      |
| BMI      | 20.02 ± 3.71 | 20.23 ± 3.93 | 20.13 ± 3.82 | 0.43**                      |
| WC       | 68.42 ± 9.66 | 68.92 ± 10.02 | 68.68 ± 9.84 | 0.57**                      |
| WHR      | 84.95 ± 10.57 | 85.48 ± 10.15 | 85.23 ± 10.34 | 0.59**                      |
| SBP      | 111.79 ± 11.11 | 115.51 ± 10.90 | 113.74 ± 11.14 | 0.001**                     |
| DBP      | 61.75 ± 7.47 | 64.90 ± 6.80  | 63.40 ± 7.29  | < 0.001**                   |
| HR       | 82.57 ± 12.13 | 80.17 ± 10.77 | 81.39 ± 11.52 | 0.06**                      |

*Pearson’s Chi-square; **Mann-Whitney; n = absolute frequency; % = relative frequency.

Table 2  Characterization and comparison of anthropometric profile and vital signs between schools.

|          | PTS        | FTS        | Total      | Average ± Standard deviation |
|----------|------------|------------|------------|-----------------------------|
| Height   | 1.54 ± 0.11 | 1.58 ± 0.09 | 1.56 ± 0.10 | 0.001**                     |
| Weight   | 48.05 ± 13.33 | 50.52 ± 12.41 | 49.35 ± 12.90 | 0.02**                      |
| BMI      | 20.02 ± 3.71 | 20.23 ± 3.93 | 20.13 ± 3.82 | 0.43**                      |
| WC       | 68.42 ± 9.66 | 68.92 ± 10.02 | 68.68 ± 9.84 | 0.57**                      |
| WHR      | 84.95 ± 10.57 | 85.48 ± 10.15 | 85.23 ± 10.34 | 0.59**                      |
| SBP      | 111.79 ± 11.11 | 115.51 ± 10.90 | 113.74 ± 11.14 | 0.001**                     |
| DBP      | 61.75 ± 7.47 | 64.90 ± 6.80  | 63.40 ± 7.29  | < 0.001**                   |
| HR       | 82.57 ± 12.13 | 80.17 ± 10.77 | 81.39 ± 11.52 | 0.06**                      |

IPAQ

|          | PTS        | FTS        | Total      | p       |
|----------|------------|------------|------------|---------|
| Sedentary| 32 (17.8)  | 21 (10.6)  | 53 (14.0)  |         |
| Insufficiently active | 23 (12.8)  | 42 (21.1)  | 65 (17.2)  | 0.04*   |
| Active   | 85 (47.2)  | 89 (44.7)  | 174 (45.9) |         |
| Very active | 40 (22.2)  | 47 (23.6)  | 87 (23.0)  |         |

BMI

|          | PTS        | FTS        | Total      | p       |
|----------|------------|------------|------------|---------|
| Thinness | 1 (0.6)    | 8 (4.0)    | 9 (2.4)    |         |
| Eutrophic| 123 (68.3) | 137 (68.8) | 260 (68.6) | 0.14*   |
| Overweight| 31 (17.2)  | 31 (15.6)  | 62 (16.4)  |         |
| Obesity  | 25 (13.9)  | 23 (11.6)  | 48 (12.7)  |         |
correlation remained high when adding the two schools \((r = 0.787, p < 0.001)\) for WC and \((r = 0.755, p < 0.001)\) (Fig. 1).

The mean SBP was 111.79 ± 11.11 mmHg in the PTS whereas in the FTS it was 115.51 ± 10.90 mmHg \((p = 0.001)\). The mean DBP values were 61.75 ± 7.47 mmHg in the PTS and 64.90 ± 6.80 mmHg in the FTS \((p \leq 0.001)\). When the SBP and DBP values were classified according to the age, sex and height curve, it was observed that 24.5% of the total samples had some type of BP change, with grade 1 hypertension being most frequent (15%). The correlation with WC \((r = 0.320, p < 0.001)\), DBP behaves in the same way \((r = 0.273, p < 0.001)\) (Fig. 2).

**Fig. 1**  Scatter plot showing the correlation between waist circumference and BMI.
4. Discussion

The aim of this study was to estimate the prevalence of CVRFs in elementary school students from two schools in a Brazilian capital. In the present study, 24.5% of children and adolescents presented altered BP, these findings corroborate with the study by de Bloch and collaborators [16] and are higher than the percentage found by Pazin and collaborators [17], who evaluated 3,417 children with normal BMI, finding altered BP in 10.7% of these children. However, methodological differences such as the number of measurements taken, and the different criteria are the main causes of the great variability in the prevalence of high BP between investigations [18].

High BP is considered one of the main CVRFs, both for adults and children and adolescents. Although secondary forms of hypertension are more common in children than in adults, most cases of mild to moderate hypertension in children have no identifiable cause. The early identification of this CVRF in the life can contribute to a decrease in the incidence of CVDs in the future, thus reducing the social, financial and well-being impacts of the population [19-21].

One of the main risk factors for hypertension is general obesity; there are many studies that correlate the elevation of BP with the increase in body mass, Friedemann et al. [20] in a systematic review with meta-analysis observed that obese children had BP levels approximately 40% higher than children with normal weight, these data were also presented by the study of cardiovascular risks in adolescents (ERICA) which evaluated 73,399 students from all regions of Brazil [16].

Childhood obesity is associated with a greater chance of obesity, premature death and disability in adulthood. But in addition to increasing future risks, obese children experience breathing difficulties, increased risk of fractures, hypertension, early markers of CVD insulin resistance and psychological effects. According to the WHO, the prevalence of overweight and obesity among children and adolescents aged 5 to 19 years increased dramatically from just 4% in 1975 to just over 18% in 2016 [22].
The prevalence of overweight and obesity in the present study was 29.1%, higher than that found by studies of Monego and Jardim [23] that studied a population of 3,169 children and adolescents, and ERICA [16], a multicenter study that found 16% and 25% overweight, respectively, however, our results are lower than that of Fraporti et al. [24] (41.8%).

A change in the WC was presented in 15.8% of the general population, being greater in the male gender, which had 21.2% of alteration, with no significant difference between the two types of school. A change in the WHR occurred in 11.6% of the total sample, being more prevalent in the FTS with 13.6% and no male gender presented 14%. The data on WC and SBP when correlated show good correlation corroborating the results by Pazin et al. [17] that demonstrate that children and adolescents with altered WC tend to have higher BP levels, with visceral adiposity assessed by the WC measure and a good predictor of hypertension in childhood and adolescence [25]. The pattern of body fat distribution is a predictor of CVD, regardless of the degree of obesity determined by BMI [26]. Using a combination of BMI and WC measurements with CVD prediction it becomes more effective than just using one of them [27].

The greater amount of visceral fat can favor an increase in sympathetic activity through the associated insulin resistance, in addition to potentiating the activity of the renin-angiotensin-aldosterone system since visceral adipocytes secrete more angiotensinogen, when compared to the fat deposited in subcutaneous region [28]. One of the strong correlations that this study found was WC and BMI ($r = 0.777$). This result corroborates those of Santos et al. [29], who in a longitudinal study evaluated a population of 557 adolescents and found a strong correlation ($r = 0.85$).

The control of CVRF since childhood and adolescence has been advocated worldwide, since studies strongly suggest that the presence of risk factors since childhood will influence cardiovascular health in adulthood [30]. The low level of physical activity in adolescence may be associated with a higher risk of CVD in the future, while participation in physical activities in this phase is related to a lower future risk of CVD, cancer and overall mortality [31].

The prevalence of sedentary lifestyle found this study reached 14% of the general population, with girls being more sedentary 17.2% against 10.9% of boys. Craggs and collaborators [32] in a systematic review of 46 studies, observed that girls tend to perform less physical activity than boys due largely to physical maturation. Cureau and collaborators [33] evaluating 74,589 Brazilian adolescents, showed a prevalence of 54.3% of physical inactivity at leisure, this number was higher among girls with 70.7% inactivity, socioeconomic status was associated with increased inactivity among girls.

Although several studies recommend at least 300 min/week of moderate to vigorous physical activity for health promotion among adolescents, some evidence shows that smaller volumes can already generate benefits in this population; this is due to the multicausal origin of each morbidity. A randomized clinical trial with overweight and inactive youth showed that 20 minutes of aerobic physical activity for five days a week, for 13 weeks, already reduces the risk of developing diabetes, the percentage of general fat and visceral fat [34]. Actions that aim to stimulate physical activity in childhood and adolescence, can promote immediate impacts and the school becomes an ideal space for the creation of this type of intervention, due to the large concentration of children and adolescents, security, physical space, professional trained to stimulate and supervise such activities [35].

One of the limitations found by this study was the application of the IPAQ, since most students underestimate the time they spend sitting and overestimate the time spent on moderate and vigorous activities, in order to reduce this bias, it was decided to apply the questionnaire to students. Another limitation encountered was regarding the participation
of students in recent years, since because periods of school tend to increase the burden of teaching and tests for these students ad many could not leave the rooms, so the related data of schoolchildren in recent years may have suffered significant losses.

5. Conclusions

The main risk factors found by this study were in relation to physical inactivity, overweight and high BP, the FTS was more affected by the change in these variables, where we observed higher rates, mainly of changes in BP. Some variables, when correlated obtained a good relationship, the BMI correlated with WC demonstrated that children and adolescents with circumference tend to have an altered BMI, showing that the combination of the BMI and WC becomes more effective in predicting CVD that only the isolated use of one of them. Public policies aimed at primary health care should be developed with a greater focus on the school population in order to prevent the advance of these risk factors, preventing children and adolescents with changes in these factors from becoming adults with CVD’s.

Author Contribution

Conception and design of the research, data collection, analysis and interpretation of data, writing of the manuscript and critical review of the manuscript for important intellectual content: Brito, E., Nascimento L. L.

Conflicts of Interests

We declare that there is no relevant conflict of interest.

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