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ORIGINAL RESEARCH

Analysis of different anthropometric indicators in the detection of high blood pressure in school adolescents: a cross-sectional study with 8295 adolescents

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Abstract
Background: High blood pressure (HBP) is strongly associated with obesity in different populations. However, it is unclear whether different anthropometric indicators of obesity can satisfactorily predict HBP in the school setting.
Objectives: This study evaluated the sensitivity and specificity of body mass index (BMI), waist circumference (WC), and waist to height ratio (WTHR) in the detection of HBP in adolescents.
Methods: The sample consisted of 8295 adolescents aged 10–17 years. Weight was measured using a digital scale, height with a stadiometer, and waist circumference using a tape measure. Blood pressure was measured by an automatic blood pressure measuring device. ROC curves were used for the analysis of sensitivity and specificity of the three anthropometric indices in identifying HBP. Binary Logistic Regression was used to assess the association of BMI, WC, and WTHR with HBP.
Results: Low values of sensitivity were observed for BMI (0.35), WC (0.37), and WTHR (0.31) and high values of specificity for BMI (0.86), WC (0.82), and WTHR (0.83) in the detection of HBP. An association was observed between adolescents classified with high BMI (OR = 3.57 [95% CI = 3.10–4.10]), WC (OR = 3.24 [95% CI = 2.83–3.72]), and WTHR (OR = 2.94 [95% CI = 2.54–3.40]) with HBP.

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Conclusions: BMI, WC and WTHR presented low sensitivity to identify adolescents with HBP. However, adolescents classified with high BMI, WC, and WTHR demonstrated a high association of presenting HBP.

Introduction

Anthropometric parameters have been widely used to identify subjects with high blood pressure (HBP). Body mass index (BMI) and waist circumference (WC) have been associated with high blood pressure in adolescents.[1–3] Recently, the waist to height ratio (WTHR) has been proposed as a simpler tool to diagnose obesity, since it does not require the use of specific tables for sex and age.

In fact, studies with children and adolescents have pointed out that elevated WTHR is associated with cardiovascular diseases.[4,5] However a study with 5207 children in Switzerland did not find good predictive power of WTHR to identify children with HBP.[6] Part of this controversy may be explained by the different populations studied, suggesting that the efficiency of anthropometric parameters to predict cardiovascular risk seems to be dependent on the characteristics of the sample. Another factor to consider is the different ages of the samples included in the studies. The study by Hara et al.[5] evaluated children and adolescents aged 9–13 years[4]; Genovesi et al.[4] evaluated young people from 5 to 11 years; while in the study of Chiolero et al.[6] the age range of the sample was 10–14 years.

Anthropometric measures related to high blood pressure could be an important alternative for the identification of this condition in environments such as schools, where blood pressure measurement can be hampered by having to be carried out on a large scale, added to the difficulty of measuring this population. Moreover, a better statistical procedure may assist in determining the best identification method.

As statistical procedures, including the quantification of sensitivity, specificity and areas under the curve of anthropometric indicators could provide further insights into the comparison of methods. In addition, anthropometric parameters may identify subjects at risk of hypertension. The aims of this study were to investigate the relationship between BMI, WC, and WTHR with HBP in adolescents and to determine the sensitivity and specificity of these indices to identify HBP in adolescents.

Methods

Sample

This study was performed using the databases from two school based studies involving adolescents (aged 10–17 years) in the states of Paraná (Southern Brazil) and Pernambuco (Northeastern Brazil). Detailed information regarding sampling had been previously described elsewhere.[7–9] The study sample was composed of 8295 adolescents. This study was previously approved by the Ethics in Research Committee of the Universidade Estadual de Londrina-UEL (CAAE: 0181.0.268.000-10; Londrina, Paraná state) and Universidade de Pernambuco-UPE (CAAE-0158.0.097.000-10; Recife, Pernambuco state) and was conducted in accordance with the Declaration of Helsinki. All adolescent participants in the study received approval from a parent or guardian.

Anthropometric measures

The adolescents wore light clothing during all measurements. Body mass was measured using a digital scale with a precision of 0.1 kg and a maximum capacity of 150 kg. Height was measured using a portable stadiometer with an accuracy to 0.1 cm. BMI was calculated by dividing body mass by the height squared (kg/m^2). WC was obtained using a tape measure to the nearest 0.1 cm (the average of two measures was used). The WTRH was obtained by dividing the waist circumference by the height. The cutoff points used for BMI, WC, and WTHR were those proposed by Cole et al.,[10] Taylor et al.,[11] and McCarthy et al.,[12] respectively.

Blood pressure

The day before the blood pressure assessment, the adolescents were advised in class to avoid certain types of behaviors that could affect the BP, such as drinking caffeinated drinks (including cola soft drinks), exercising, and smoking.

To assess blood pressure, an oscillometric equipment was used (Omron, model HEM 742). This equipment was previously validated for use in adolescents.[13] Prior to the blood pressure evaluation, the subjects remained seated at rest for 5 min, after which the first measure was taken. For the measurement of BP, two types of cuffs were considered and an appropriate cuff size was used for each adolescent, taking into account arm circumference (6 cm × 12 cm and 9 cm × 18 cm). These procedures were performed in accordance with American Heart Association recommendations.[14] Two minutes after the first assessment, the second blood pressure measurement was performed. The average of the two evaluations was used to determine the blood pressure value of the subject (in the study carried out in Londrina; Southern Brazil). In the study conducted in the Northeast, the methodology was the same, except that three

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