DOI: https//doi.org/10.13037/ras.vol19n68.7495

Original Article

Recebido em: 23/11/2020 | Aceito em: 05/03/2021

Waist circumference as a predictor of cardiovascular risk factors in adolescents: Erica Study in the municipality of Porto Velho (RO)

Circunferência da cintura como preditor de risco cardiovascular em adolescentes: Estudo Erica no Município de Porto Velho (RO)

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Resumo

Introdução: As doenças cardiovasculares representam a principal causa de morbimortalidade no Brasil. **Objetivo:** Analisar o Risco Cardiovascular (RCV) pela circunferência da cintura (CC) e seus fatores associados em adolescentes do município de Porto Velho, RO. **Materiais e Métodos:** A amostra foi composta por 74.589 participantes do Estudo de Risco Cardiovascular em Adolescentes, envolvendo municípios acima de 100 mil habitantes. Neste estudo foi incluído apenas amostragem de Porto Velho, totalizando 706. A variável de desfecho foi CC e as variáveis independentes foram: demográficos, comportamentais, antropométricas, clínica e bioquímicas. Realizamos uma análise multivariada de Poisson. **Resultados:** A proporção de RCV pela circunferência da cintura foi de 10,6% para ambos os sexos, com predomínio para as meninas de 12,8%. No modelo final se mantiveram associadas o sexo feminino, idade entre 15 a 17 anos, excesso de peso, HDL alterado, LDL alterado, triglicerídeos alterado, pressão arterial sistêmica alterada e o HOMA-IR ≥ 4º quartil ($p<0,05$), respectivamente. **Conclusão:** A medida da cintura mostrou ser uma boa preditora para avaliação do RCV em adolescentes, assim, faz-se a necessidade de implementar a medida da CC como meio de prevenção e controle de RCV em crianças e adolescentes, em escolas e unidades básicas de saúde.

Palavras-chave: adolescentes; circunferência da cintura; escolares.

Abstract

Introduction: Cardiovascular diseases represent the main cause of morbidity and mortality in Brazil. **Objective**: To analyze the cardiovascular risk (CVR) by waist circumference (WC) and its associated factors in adolescents from the city of Porto Velho, RO. **Materials and Methods**: The sample consisted of 74,589 participants in the Cardiovascular Risk Study in adolescents, involving municipalities above 100 thousand inhabitants. In this study, only Porto Velho sampling was included, totaling 706. The outcome variable was WC and the independent variables were: demographic, behavioral, clinic, anthropometric and biochemical. We performed a multivariate Poisson analysis. **Results:** The proportion of CVR waist circumference was 10.6% for both sexes, with a predominance for girls of 12.8%. In the final model, females remained associated, age between 15 to 17 years, overweight, altered HDL, altered LDL, altered triglycerides, altered systemic blood pressure and the HOMA-IR ≥ 4th quartile ($p<0.05$), respectively. **Conclusion**: Waist measurement proved to be a good predictor for CVR evaluation in adolescents, thus, it is necessary to implement the WC measurement as a means of prevention and control of CVR in children and teenagers, in schools and basic health units.

Keywords: adolescents; waist circumference; students.

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DOI: https//doi.org/10.13037/ras.vol19n68.7495

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Introduction

Cardiovascular diseases represent the main cause of morbidity and mortality in Brazil and worldwide [(1)]. This epidemiological scenario is concerned because it implies a decrease in the quality of life of the populations, in addition to causing high and increasing costs for the government, society, family, and individuals [(2)]. The relationship between the development of cardiovascular diseases related to the metabolic syndrome, particularly the central distribution of fat, is well established [(3,4)].

For a long time, these cardiovascular risk factors were considered important only in populations with advanced age. However, lately, studies have shown that this is also a reality among younger people [(5,3)].

The use of anthropometric indicators has grown as a simple and effective way to assess cardiovascular risk. The main indicator used for detecting general obesity is the body mass index (BMI) and for abdominal obesity, waist circumference (WC), waist-to-hip ratio (WHR) and waist-to-height ratio (WHtR) [(5)].

According to the study by Yan et al. [(6)], the anthropometric indicators BMI, WC, WHR, WHtR and taper index have a good predictive capacity for high coronary risk. Oliveira and Guedes [(5)] found a high correlation between BMI, WC and WHR, and cardiovascular risk factors, especially dyslipidemia.

Adolescents represent a public whose sedentary lifestyle has been increasing in recent decades, influenced by the compulsion of abusive use of the internet in the search for electronic games and social networks, the consequences are the emergence of diseases related to the metabolic syndrome that contribute to increased cardiovascular risk [(7)].

Several investigations on CVR factors associated with adolescents have been published in several Brazilian locations; however, such factors identified in one place may be irrelevant in another region. Thus, it is necessary to know the dynamics of these factors in regional contexts for the effective implementation of prevention and control actions. Therefore, the scarce information related to the theme justifies the relevance of the study in the northern region of Brazil.

Hence, the study aimed to analyze cardiovascular risk by measuring waist and possible associated factors in adolescents in Porto Velho, RO.

Materials and methods

Sample and type of study

This was a cross-sectional, school-based study conducted at a center, using raw data from the Study of Cardiovascular Risks in Adolescents (ERICA 2013/2014). The ERICA study design was previously published by Bloch KV., Et al. (11). Briefly, students from 12 to 17 years old were enrolled in public and private schools, located in one of the 273 Brazilian municipalities. This study was approved by the Ethics and Research Committee (CEP) of the Federal University of Rondônia (CAAE nº 05185212.2.2009.5300, opinion nº 545.442) and Institute of Studies in Collective Health of the University of Rio de Janeiro (process 45/2008). The analysis was adjusted to consider the sample design, using statistical routines for complex sampling that consider the sources of variability and the calibration with population estimates (8). For this study, only the sample of schoolchildren of both sexes, aged 12 to 17 years old, public schools n = 614, private schools n = 92, was included, totaling 706 adolescents who were part of the large Brazilian study by the ERICA bank.

Research design

The outcome variable was measured by waist circumference (WC), which was categorized in the presence or absence of CVR. The dependent variables selection to check possible associations was categorized into sociodemographic; gender (male and female), type of school (public and private), region (urban and rural), skin color (white, brown and others: yellow, indigenous, and black), age (12 to 14 and 15 to 17 years old), and behavioral; physical activity (active and inactive), alcohol consumption (yes, no), computer use (<2 and ≥2 hours). For determining the physical activity level, the product between time and frequency in each activity was calculated, and the sum of the times obtained was computed. Adolescents who did not accumulate at least 300 min/week of physical activity were considered inactive [9].

Inclusion and Exclusion Criteria

For this study, only 12 to 17 years old school children of both genders were included. The exclusion criterion is those who did not participate in all stages of the evaluation process.

Procedures

Sociodemographic and behavioral variables were obtained through a self-administered questionnaire in an electronic data collector (PDA) that also contained other questions not used in this analysis. Age was confirmed with the aid of school records. The following anthropometric variables were measured by trained researchers: WC, measurement of the circumference of the right arm (for choosing the appropriate cuff to measure blood pressure), weight, and height. These measures were monitored throughout the collection through quality control that verified their limits and the distribution of terminal digits.

The analyses in blood samples of the biochemical parameters that make up the Metabolic Syndrome (MetS) (HDL-c, triglycerides, and glucose) were performed in a single laboratory that followed the quality standards current and required for its qualification. Fasting glycemia was assessed using the GOD-PAP enzymatic method on the Roche modular analytical equipment. Values of 100 mg / dL or over were considered to discriminate high blood glucose. Triglycerides and HDL-c were analyzed by the calorimetric enzymatic method in the Roche Modular Analytical equipment. The reference values published in the I Atherosclerosis Prevention Guideline in Childhood and Adolescence were used [10].

We used Weight (BW) and body height (BH) measurements to classify nutritional status from the calculation of body mass index (BMI = weight/height^2). The classification of nutritional status used the zIMC/age curves proposed by the World Health Organization (2007)[9] specific for age and sex. It considered adolescents with scores +1> Z ≥ -2 having adequate nutritional status, overweight adolescents with scores +2> Z ≥ +1, and those with obesity those with Z scores ≥ +2 status[11]. WC was measured with an inextensible Sanny® tape measure, with a variation of 0.1 cm, at the midpoint between the lower curvature of the last fixed rib and the upper curvature of the iliac crest with the adolescent standing, arms along the body, feet together, and abdomen relaxed. The Cardiovascular Risk (CVR) classification was used for this study, considering only the elevated WC component, according to the criteria of the International Diabetes Federation: WC = <16 years: ≥ 90th percentile ≥ 16 years, male: ≥ 90 cm ≥ 16 years, female: ≥ 80 cm 90 [12].

The clinical variable followed the Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents protocol [13]. An automatic oscillometric device of the Omron®705-IT brand performed the measurement, validated for use in adolescents [12]. Before registration, there were criteria such as not having ingested energy drinks, coffee, or soft drinks in the last hour before the measurement. The technique was applied with the adolescent seated, both feet resting on the floor and remaining at rest for 5 minutes before recording blood pressure. For the blood pressure classification, three measurements were performed with an interval of two minutes. A third measurement was performed when there was a bigger difference than five mmHg between the first two. The record was made with the average of the last two measurements.

Systemic blood pressure was considered high if systolic blood pressure was higher than or equal to 130 mmHg and diastolic blood pressure was higher than or equal to 85 mmHg [14].

The biochemical variables. In only one laboratory, which followed the current quality standards required for carrying out the research, analyzes of blood samples of the biochemical parameters that make up SM - Metabolic Syndrome (HDL-c, triglycerides and glucose) were carried out. Fasting glycemia was assessed using the GOD-PAP enzymatic method on the Roche modular analytical equipment. Values of 100 mg / dL or more were considered as high blood glucose discriminants [14]. Triglycerides and HDL-c (a more specific and powerful predictor of the death risk from coronary artery disease (CAD) were analysed by the calorimetric enzymatic method in the Roche modular analytical equipment. The reference values published in the I Atherosclerosis Prevention Guideline in Childhood and Adolescence were used. The full description of ERICA methods can be found in Bloch et al. [15]. Concerning Insulin Resistance (IR), it was assessed using the Homeostasis Model Assessment-Insulin Resistance (HOMA-IR) index [16], calculated using the following equation: HOMA-IR = fasting insulinemia (µU / ml) x fasting glycemia (mmol / l) / 22.5. People with HOMA-IR values in the 4th quartile of the distribution of this variable were identified as insulin resistant in the studied population [17,18].

Statistical treatment

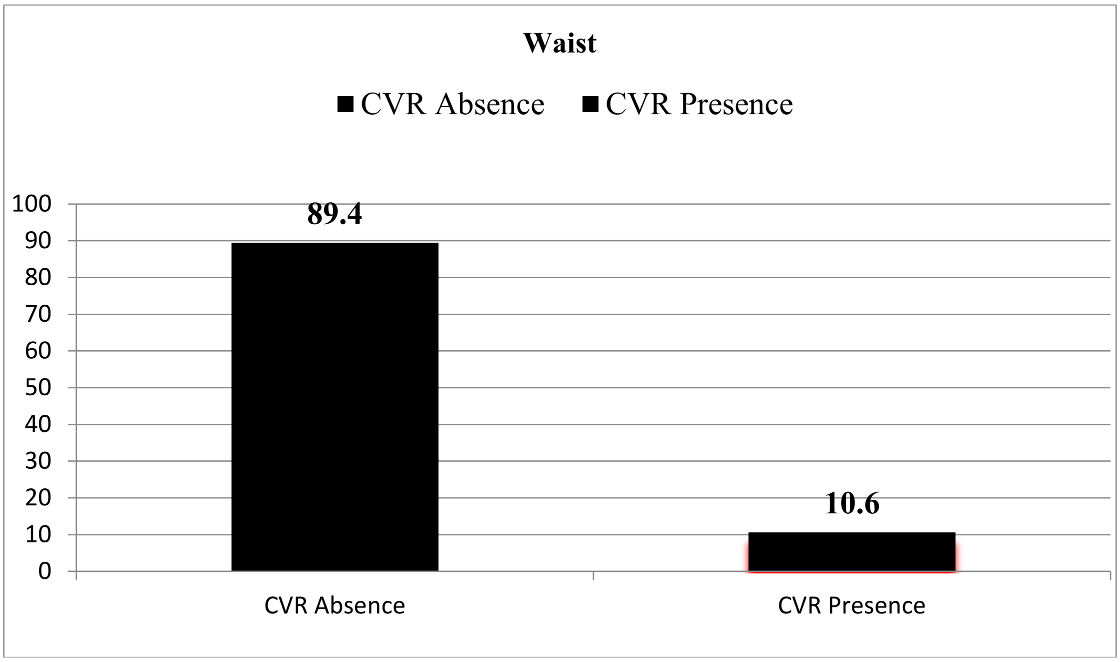
The studied sample was characterized by the absolute and relative frequencies presentation of the demographic, behavioral, anthropometric, and biochemical variables. To calculate the prevalence (%) chi-square test was used.

The modeling process was based on two steps. Initially, variables that had a p-value <0.25 in the bivariate analysis were selected. Subsequently, a multivariate analysis was performed in which the Poisson regression technique with robust variances was used. The magnitudes of the associations were estimated by calculating the Prevalence Ratio (PR), using the 95% confidence interval as a measure of accuracy. The variables that showed levels of statistical significance less than 5% were maintained in the final model. The final model quality evaluation was made by calculating its determination coefficient (R2), the applications of the goodness-of-fit test, the linktest, and the analysis of the residues, based mainly on the influential points. Collinearity and the interaction between variables that remained in the final model were also tested. The Stata version 11 program was used for data analysis.

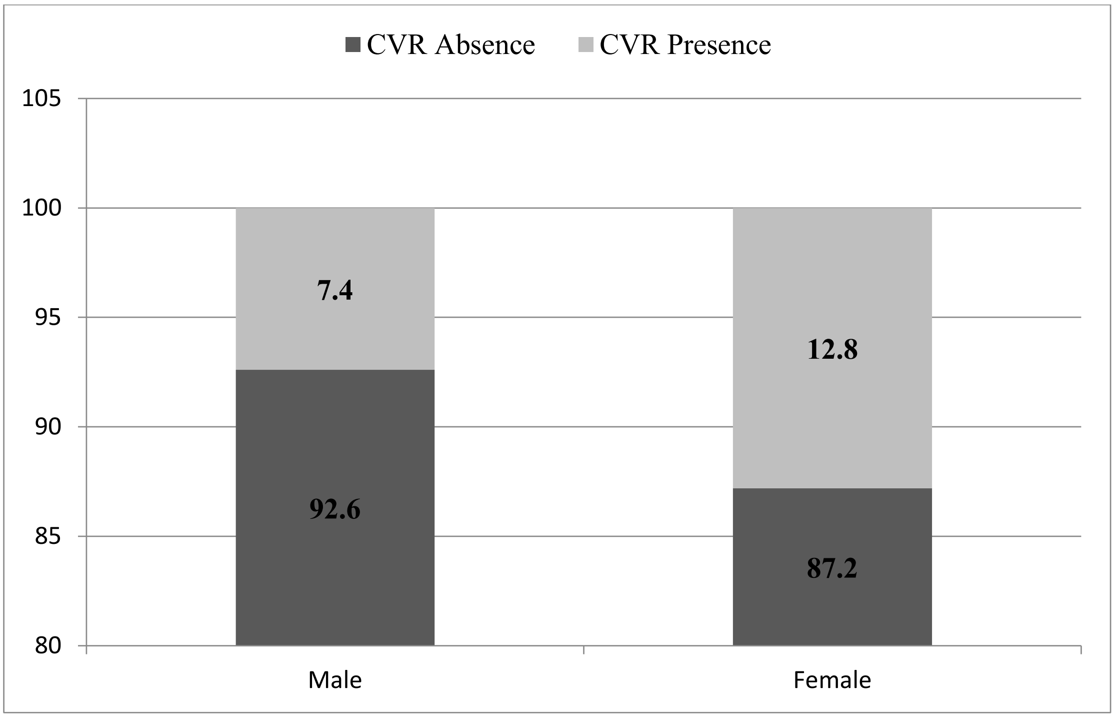
Results

The sample consisted of 706 adolescent students from 12 to 17 years old, 40.1% (n = 283) male and 59.9% (n = 423)female, and 87.0% (n = 614) public school students and 13,0% (n=92) private individuals.

The proportion of cardiovascular risk by waist measurement was 10.6% (n = 75) (Graph 1), and we observed a higher prevalence of risk in females of 12.8% (n = 90) (Graph 2).



Graph 1. Proportion of cardiovascular risk (CVR) in adolescents aged 12 to 17 years, in the municipality of Porto Velho-RO, 2014 (n=706).



Graph 2. Prevalence (%) of Cardiovascular Risk (CVR) in adolescents from 12 to 17 years of age by sex in the municipality of Porto Velho-RO, 2014 (n=706).

The prevalences (%) and prevalence ratios (PR) associated with the presence of CVR with sociodemographic variables were higher in females 12.8% (PR = 1.83; $CI_{95\%}$: 1.08-3.10; p = 0.026), private school 18.5% (PR = 1.39; $CI_{95\%}$: 1.09-1.79; p = 0.008) and age 15 to 17 years 13.9% (PR = 2.16; $CI_{95\%}$: 1.29-3.61; p = 0.003), and in the behavioral ones the only one that showed to be at risk was alcohol consumption 13.0% (PR = 1.71; $CI_{95\%}$: 1.04-2.80 ; p = 0.035) (Table 1).

Table 1. Prevalence (%) and Prevalence Ratio (PR) of the presence of Cardiovascular Risk (CVR) and its 95% confidence intervals (95% CI) according to sociodemographic and behavioral variables. Porto Velho-RO, 2014.

Variables	N	%	RCV (%)	RP	$IC_{95\%}$	p-value
Sociodemografic						
Gender						
Male	283	40.1	7.4	1		
Female	423	59.9	12.8	1.83	1.08 – 3.10	0.026
Type of School						
Public	614	87.0	9.4	1		
Private	92	13.0	18.5	1.39	1.09 – 1.79	0.008
Region						
Urban	598	84.7	10.9	1.19	0.59 – 2.41	0.618
Rural	108	15.3	9.3	1		
Skin color						
White	193	27.3	13.5	1.71	0.71 – 4.12	0.229
Brown	429	60.8	9.8	1.19	0.52 – 2.77	0.678
Others	84	11.9	8.3	1		
Age						
12 to 14 years	331	46.9	6.9	1		
15 to 17 years	375	53.1	13.9	2.16	1.29 – 3.61	0.003
Behaviors						
Physical activity						
Inactive	319	48.6	12.2	1.28	0.78 – 2.10	0.320
Active	337	51.4	9.8	1		
Alcohol consumption						
Yes	370	52.4	13.0	1.71	1.04 – 2.80	0.035
No	336	47.6	8.0	1		
Use of computer						
< 2h	170	24.1	10.0	1		
≥2h	536	75.9	10.8	1.09	0.62 – 1.93	0.762

The variables associated with the presence of CVR were: overweight 41.3% (PR = 7.59; $CI_{95\%}$: 6.02-9.56; p = <0.001), altered systemic blood pressure 37.5% (PR = 5.67; $CI_{95\%}$: 3.27-9.84; p = <0.001), altered total cholesterol 20.2% (PR = 3.42; $CI_{95\%}$: 2.19-5.32; p = <0.001), altered HDL 13.1% (PR = 1.96; $CI_{95\%}$: 1.96-3.23; p = 0.008), altered LDL 29.1% (PR = 2.78; $CI_{95\%}$: 2.16-3.58; p = <0.001), triglycerides 41.5% (PR = 4.82; $CI_{95\%}$: 3.10-7.48; p = <0.001) and HOMA- IR 4^{th} percentile 34.7% (PR = 3.25; $CI_{95\%}$: 2.11 - 5.01; p = <0.001) (Table 2).

Table 2. Prevalence (%) and Prevalence Ratio (PR) of the presence (+) of Cardiovascular Risk (CVR) and its 95% confidence intervals (95% CI) according to the categorized classification of anthropometric and biochemical variables. Porto Velho-RO, 2014.

Variables	N	%	CVR (%)	PR	$IC_{95\%}$	p-value
Anthropometric						
BMI						
Adequate weight	534	75.6	0.7	1		
Overweight	172	24.4	41.3	7.59	6.02 – 9.56	< 0.001
Biochemicals						
Systemic Blood Pressure						
Desirable	626	65.3	7.8	1		
Altered	80	34.7	32.5	5.67	3.27 – 9.84	< 0.001
Total cholesterol						
Desirable	445	67.6	5.9	1		
Altered	228	32.4	20.2	3.42	2.19 – 5.32	<0.001

HDL cholesterol						
Desirable	284	40.4	6.7	1		
Altered	419	59.6	13.1	1.96	1.19 – 3.23	0.008
LDL cholesterol						
Desirable	593	84.4	7.1	1		
Altered	110	15.6	29.1	2.78	2.16 – 3.58	< 0.001
Triglycerides						
Desirable	662	94.2	8.6	1		
Altered	41	5.8	41.5	4.82	3.10 – 7.48	< 0.001
Glucose Levels						
Desirable	694	98.4	10.7	1		
Altered	11	1.6	9.1	0.85	0.13 – 5.59	0.868
HOMA-IR						
< 4th quartile	443	62.7	10.4	1		
≥4th quartile	263	37.3	34.7	3.25	2.11 – 5.01	< 0.001

The final Poisson regression model remained associated with CVR by measuring WC, so we found the following variables: female gender (PR = 2.17; $CI_{95\%}$: 1.47-3.18; p = <0.001), age between 15 to 17 years (PR = 1.94; $CI_{95\%}$: 1.30-2.89; p = 0.001), overweight (PR = 3.03; $CI_{95\%}$: 2.05-4, 49; p = <0.001), altered systemic blood pressure (PR = 2.48; $CI_{95\%}$: 1.09-5.64; p = 0.031), altered HDL cholesterol (PR = 1.50; $CI_{95\%}$: 1, 09-2.24; p = 0.046), altered LDL cholesterol (PR = 2.49; $CI_{95\%}$: 1.08-5.64; p = 0.031), altered triglycerides (PR = 4.26; $CI_{95\%}$: 1 , 72-9.81; p = 0.002), and HOMA-IR ≥ 4th quartile (PR = 1.92; $CI_{95\%}$: 1.28-2.88; p = 0.002) (Table 3). No significant interactions were observed between the variables that remained in the final model.

Table 3. Final Poisson regression model with cardiovascular risk (CVR) as a dependent variable. Porto Velho-RO, 2014.

Variable	PR ($IC_{95\%}$)	p-value
Gender		
Male	1	
Female	2.17 (1.47 – 3.18)	< 0.001
Age		
12 to 14 years	1	
15 to 17 years	1.94 (1.30 – 2.89)	0.001
BMI		
Adequate weight	1	
Overweight	3.03 (2.05 – 4.49)	< 0.001
Systemic Blood Pressure		
Desirable	1	
Altered	2.48 (1.09 – 5.64)	0.031
HDL cholesterol		
Desirable	1	
Altered	1.50 (1.09 – 2.24)	0.046
LDL cholesterol		
Desirable	1	
Altered	2.49 (1.08 – 5.64)	0.031
Triglycerides		
Desirable	1	
Altered	4.26 (1.72 – 9.81)	0.002
HOMA-IR		
< 4th quartile	1	
≥4th quartile	1.92 (1.28 – 2.88)	0.002

DOI: https//doi.org/10.13037/ras.vol19n68.7495

Original Article

Recebido em: 23/11/2020 | Aceito em: 05/03/2021

Discussion

The purpose of this study was to verify if WC is a good predictor of cardiovascular risk factors in adolescents.

WC is a measure of abdominal obesity associated with visceral fat, stimulated by lipogenic activity that tends to accumulate in other body compartments. Thereby, it provides the flow of substances released by the visceral adipose tissue to the liver, resulting in a rapid increase in gluconeogenesis and VLDL-c secretion, in a decrease in hepatic insulin clearance and IR [7,13].

Because of this situation, some international groups have chosen to incorporate the WC measure as an MetS and CVR component. On the other hand, in other studies, it was shown that abdominal obesity as measured by WC is strongly correlated with the overall adiposity identified by the BMI. Thus, in the most recent definition of MetS, the use of high WC levels (≥ 90th percentile) and/or zIMC (≥ 95th percentile) is recommended, considering sex and age as components of obesity [10-15].

The findings of the present study showed a prevalence of 10.6% of CVR by measuring WC in adolescents, with a predominance in the group of girls 59.9%. Probably girls have a higher WC due to several genetic factors such as the period of puberty, increasing progesterone and estrogen hormones, environmental elements caused by the increase in a sedentary lifestyle, such as low levels of regular physical activity, excessive time connected to social networks and increased levels of anxiety and depression [2]. Analyzes of biochemical and clinical examinations associated with the final model showed: altered HDL cholesterol (high-density lipoprotein) and LDL (low-density lipoprotein), altered triglyceride, HOMA-IR ≥4th quartile, and altered systemic blood pressure. International[19.20] and national[21.22] studies corroborated the research findings showing that the results were similar to the variables associated with cardiovascular risks by measuring WC.

A study conducted with adolescents aged 11 to 16 years found a prevalence of abdominal obesity (RCE> 0.50) of 11.7% [23]. On the other hand, NHANES showed a higher prevalence of central obesity in females, with the use of both isolated WC (> P90) and CER (> 0.50) (17.8 versus 36.4%, respectively) [24]. Such difference can be associated with the fact that the investigation mentioned above uses another location to measure waist circumference (immediately above the iliac crest). The lack of methodological standardization requires caution when comparing results to avoid under or overestimation of prevalence. Regardless of the controversies presented by some authors [9,1], the use of isolated WC in this study was able to identify the largest number of possible factors associated with cardiovascular risk in these adolescents.

The findings reported in the present study must be interpreted in light of some methodological limitations. Sociodemographic variables were collected by self-reported questionnaires, which, therefore, are subject to response bias. The collection of anthropometric and biochemical data was a weak point in the study due to the possible measurement error between and within the evaluators. As it is a cross-sectional study, there is a possibility of establishing a causal relationship between the study variables. Another limitation as a highlight is the cut-off points adopted in the research, which in some may overestimate or underestimate the results. But despite these limitations, it is believed that there was no harm to this large ERICA study, probably the possible fluctuations in the data collection and the analyzes in no way compromised the quality of the data.

The data found in the research were consistent with other studies, which relate cardiovascular risks and overweight in adolescents [22-24], being a recommended measure (WC) of the easy procedure, non-invasive, providing an acceptable diagnosis by the scientific literature [25-27]. The adverse impact of being overweight on multiple cardiovascular risk factors requires primary prevention at an early age and, in addition to this evidence, studies indicate that overweight in adolescence tends to persist into adulthood [2].

National studies [28-30] showed a variation of 20% to 30.0% in the prevalence of overweight. The ERICA Study showed that the prevalence of overweight in Brazil was 25.5%, by country region the prevalence in adolescents was 21.9% in the North, 24.2% Northeast, 23.6% Central West, 26.0% Southeast, and 29.8% South, with a higher prevalence of overweight and obesity in the Southern region of the country (S = 18.7% and W = 11.1%) [31]. These results show that 24.4% of weight excess corresponds to the variation margin mentioned above.

Despite its well-known multifactorial origin of overweight, the need for special attention by health managers to implement actions to encourage the promotion of a healthy lifestyle is emphasized to contain possible advances in the prevalence of overweight in adolescents in the Northern region.

The prevalence of high SBP levels was 32.5% and was considered a cause for concern in this age group because if uncontrolled, it tends to increase over the years. The number of individuals in the different age groups is a factor that contributes to the different prevalences described by the studies.

Similar results have also been found in developing countries. In a study conducted by Chiolero et al. [32], in the Republic of Seychelles, of the 15,612 children and adolescents from 5 to 16 years of age, the prevalence of arterial hypertension in the obese group was 25.0% and 33.2% for boys and girls, respectively. In the multiple regression analysis, it was observed that adolescents with a high waist measure and excess weight were approximately four times more likely to have altered blood pressure than eutrophic adolescents, even after adjusting for total cholesterol, triglycerides, and basal insulin [33]. Probably the high SBP that occurred in these adolescents is due to hormonal changes and associated with other external factors such as physical inactivity, poor diet, stress, and others.

Therefore, the high prevalence of SAH in this study can be explained by the high frequency of overweight and alteration of the lipid profile, as well as the sedentary lifestyle. SAH can be considered a risk predictor for other cardiovascular diseases and is directly related to anthropometric measures for the diagnosis of overweight and obesity. SAH showed a significant association with CVR. Anthropometric indicators of abdominal obesity, especially WC, seem to have a better performance in predicting high blood pressure [4,7].

The main dyslipidemias associated with cardiovascular risk were: altered HDL cholesterol 13.1%, probably influenced by sedentary behavior habits (low levels of regular physical activity), increased LDL 29.1%, and altered triglycerides (41.5%), due to the increase in overweight, physical inactivity, alcohol consumption, excessive time in front of social networks and the very period of puberty where both behavioral and genetic changes occur with hormonal changes in the pubarche in both sexes [34].

Associations of biochemical tests of HDL, LDL, and triglycerides cholesterol were found with waist measurement to check cardiovascular risk. Some studies [3-9] with adolescents have shown significant associations and a direct relationship between anthropometric measures of BMI and WC with biochemical tests, which are considered very acceptable parameters to assess CVR.

These results suggest that the increase in body fat, especially at the abdominal level, tends to cause changes in serum lipid variables. The prevalence of SAH found was associated with CVR. The prevalence of overweight associated with CVR was high (41.3%), with changes in biochemical variables (HDL, LDL cholesterol, and triglycerides). Therefore, the present study had a great impact, which may cause an increase in SBP for these young people in the future, if they are not oriented to change their lifestyles, reducing sedentary lifestyle, reducing screen time and poor diet as Fast- Food. In addition to these reductions, it is necessary to adhere to the usual practice of physical activity and changes in eating habits, preferably a diet balanced in protein, carbohydrates and rich in vegetables and fruits, as these factors favor protection against cardiovascular risks [30,34].

It is pertinent to highlight that the diagnosis of insulin resistance is relevant in the evaluation of CVR. Thus, the variable HOMA-IR ≥4th quartile showed an association of 1.92 (1.28-2.88) in the possibility of adolescents developing CVD disease. HOMA-IR has widely been used, representing one of the alternatives to evaluate these parameters, mainly in studies involving a high number of participants, as it is a fast method, easy to apply, and of lower cost[20].

In recent years, there has been a growing interest in measuring the degree of insulin resistance in clinical practice. This determination can be useful not only in the evaluation of diabetics but also in the obese, as well as in the characterization of metabolic syndrome and in the investigation of polycystic ovaries and other conditions in which it is desired to evaluate the function of this hormone [35].

Moreira et al. [36], in a study with 109 individuals, from seven to eleven years old, from the public school in Taguatinga, DF, observed that, for the diagnosis of alteration in HOMA-IR, the value was moderate with WC (0,67/0,46–0,87). Besides, insulin resistance was associated with adolescence in a study with 196 children and adolescents aged two to eighteen years old from Campina Grande, PB, also being associated with altered levels of triglycerides, HDL, and metabolic syndrome. This result confirms that, in adolescence, insulin resistance is already present, and low-cost anthropometric measures, such as BMI, CP, and WC, can predict such alteration.

Although there are discussions about the value of fasting glucose and insulinemia in detecting variations in glucose homeostasis, some studies that used only glycemia, both in fasting and in the glycemic test, showed low value to identify abnormalities in glucose homeostasis. In this sense, Viner et al. [37], studying children and adolescents aged two to eighteen years, found that the fasting glucose and insulin assessments could identify the metabolic syndrome with 88% sensitivity and 100% specificity. No adolescents had type two diabetes mellitus during the study. Other authors have also found few cases of type 2 diabetes mellitus in obese individuals aged 4 to 18 years [38,39,36,10,20].

As has been demonstrated in recent decades, there is a dramatic increase in the incidence of type 2 diabetes mellitus in adolescents, which is linked to the prevalence of obesity increase in this age group. It could be a warning sign for an epidemic rise in cardiovascular disease in an epidemic in the coming decades [35,36].

Adolescence stands out as an opportune moment to put these measures into practice. They have a positive impact in the future since this group is relevant and strategic in terms of Public Health, health promotion, and disease prevention. The most important limitation of the study relates to the cutoff point used for the HOMA-IR indicator, because to date, there are no internationally accepted cutoff points for this variable.

Conclusion

We found that the prevalence of the presence of CVR by the measurement of WC was 10.6%, with a predominance of females (12,8%). The factors that remained associated with the final model were female gender, age between 15 to 17 years, overweight, altered SBP, altered HDL and LDL cholesterol, triglycerides, and HOMA-IR equal to or greater than the fourth quartile.

These risk factors demonstrated a significant association with WC, therefore the WC measure proved to be a good predictor to be used in the assessment of CVR in adolescents, and with this, the importance of implanting and implementing the waist measurement is reinforced as a means of evaluation for preventive measures and control of CVR in children and adolescents, in schools and basic health units.

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How ro cite this article:

Gonçalves LGO, Santos JP, Farias ES. Waist circumference as a predictor of cardiovascular risk factors in adolescents: Erica Study in the municipality of Porto Velho (RO). Rev. Aten. Saúde. 2021; 19(68): 51-64.