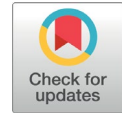




ORIGINAL ARTICLE



## Cardiovascular risk in primary care: comparison between Framingham Score and waist circumference

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### KEYWORDS

Cardiovascular diseases  
Primary health care  
Primary prevention  
Risk assessment  
Risk factors

### ABSTRACT

**Objectives:** To estimate and compare cardiovascular risk using the Framingham risk score (FRS) and waist circumference (WC) in primary care individuals and determine the main factors associated with these scores.

**Methods:** Cross-sectional study involving individuals of both sexes aged between 30 and 74 years and attended in a primary health unit. Cardiovascular risks (FRS and WC) were stratified as low, intermediate, or high. Weighted Kappa coefficient assessed agreements between scores.

**Results:** Fifty-five individuals ( $52.8 \pm 9.4$  years, 70.9% women) were evaluated. Using FRS, 40.0% of the sample presented a low risk, 45.5% intermediate-risk, and 14.5% high risk of cardiovascular disease. Conversely, the highest frequency (71%) using WC score was observed in the high-risk category. Also, no agreement ( $K = 0.36$ ;  $p = 0.55$ ) was found between scores. FRS was associated with stress in females ( $p = 0.01$ ), while WC score was associated with hypertension ( $p = 0.02$ ), obesity ( $p < 0.01$ ), and high-density lipoprotein cholesterol (HDL-c) ( $p = 0.03$ ).

**Conclusions:** Primary care individuals presented intermediate cardiovascular risk in the FRS and high risk in the WC, with no agreement between scores. Hypertension, stress, obesity, and HDL-c represented factors most associated with these scores.

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## INTRODUCTION

Cardiovascular diseases (CVD) present high morbidity and mortality rates worldwide and lead to significant social and economic impacts<sup>1</sup>. As most CVDs result from impaired vascular endothelial function, platelet activation and aggregation, and formation of atherosclerotic plaques<sup>2</sup>, prevention is based on identification and control of modifiable (i.e., smoking, physical inactivity, obesity, diabetes, hypertension, dyslipidemia, and stress) and non-modifiable (race, sex, age, and family history) risk factors<sup>3,4</sup>.

In this sense, monitoring the prevalence of risk factors allows implementing preventive actions with greater cost-effectiveness<sup>3</sup>. Predictive equations have been recommended to measure coronary and cardiovascular risks and identify individuals most likely to develop CVD<sup>5,6</sup>. Their use also promotes greater awareness regarding CVD and better communication between health professionals and patients, increases adherence to lifestyle changes and enables better health care decision-making<sup>7,8</sup>.

Although several scores combining multiple predictors have been developed<sup>9,10</sup>, the Framingham risk score (FRS) is the most used worldwide to calculate the cardiovascular risk of a population<sup>10</sup>. However, FRS was developed with North American individuals; thus, some risk factors differ (e.g., present greater weight) from the Brazilian population. Also, possible influencing variables (e.g., diet, level of physical activity, or anthropometry) are not considered to calculate the score<sup>10,11</sup>. In this context, other conditions may be associated with the development of CVDs, such as visceral adiposity<sup>12</sup>, in which the assessment of waist circumference (WC) is a widely used option because it is simple, low-cost, and has good applicability<sup>13,14</sup>. Nevertheless, studies comparing these two methods of prediction are scarce<sup>15</sup>.

Predictive scores become relevant as parameters needed to calculate the risk of future cardiovascular events are easy to obtain. Moreover, identifying possible risk factors and asymptomatic individuals in primary care settings is essential<sup>7</sup> to reduce the number of hospitalizations and public health costs<sup>16</sup>. Thus, considering the high mortality rate, the importance of CVD prevention, and the lack of studies, the main objective of this study was to estimate and compare cardiovascular risk assessed using two different scores (FRS and WC) in primary care individuals and determine the main factors associated with these scores.

## METHODS

This is a cross-sectional study conducted between September 2018 and July 2019 in the city of Macapá. The study was approved by the research ethics committee of the Universidade Federal do Amapá (CAAE 95595818.3.0000.0003, approval n. 2.876.384) and followed the Resolution 466/2012 of the National Health Council and the Declaration of Helsinki. All individuals included signed an informed consent form. A sample size of 43 individuals was calculated using FRS (high-risk ratio) and considering a margin of error of 5% and a 95%

confidence interval. A final sample of 51 was calculated considering a loss of 20%.

A consecutive non-probabilistic convenience sample of individuals who attended in a primary health care unit for routine examination (first time or return visit) was used. Data were collected on two days of the week (Wednesdays and Fridays). Individuals of both sexes and aging between 30 and 74 years were included. Those without laboratory tests for high-density lipoprotein cholesterol (HDL-c) and total cholesterol, pregnant women, or with orthopedic or cognitive impairments that could limit measurements were excluded. An evaluation form containing anamnesis data (i.e., personal data, pathological and family history, risk factors, life habits, and medications), vital signs (heart rate and systolic and diastolic blood pressure), anthropometric measurements, HDL-c, and total cholesterol was used for data collection. Systolic (SBP) and diastolic (DBP) blood pressures were assessed with individuals seated upright comfortably, with back against a chair, knees and hips flexed to 90°, left arm positioned at heart level, and palm facing up. Individuals remained at rest for a minimum of five minutes before the assessment, and the average of two blood pressure measurements was included for data analysis.

Anthropometric measurements were performed following the Brazilian Obesity Guidelines<sup>17</sup>, in which weight and height were assessed using a mechanical scale with a stadiometer (WELMI-110CH, São Paulo, SP, Brazil) and body mass index (BMI) was calculated to identify obesity<sup>18</sup>. The neck circumference (NC) was measured using a measuring tape positioned at the thyroid cartilage level with the individual standing and head oriented in the Frankfurt plane. WC was evaluated in the largest abdominal perimeter between the lowest rib and upper border of the iliac crest, whereas hip circumference (HC) was measured in the widest part of the hip at the level of the greater trochanter. These measures were used to calculate the waist-hip ratio (WHR)<sup>17</sup>.

Cardiovascular risk was considered the primary outcome of the study and calculated using the FRS. Data regarding sex, age, SBP, total cholesterol, HDL-c, diabetes, and smoking habits were included in an online calculator<sup>19</sup>. The ten-year risk of developing CVD was classified according to the percentage obtained and considered low (0-6%), intermediate (6%-20%), or high (>20%)<sup>19</sup>. Cardiovascular risk was also calculated according to WC, and the following cutoff points were considered: for females - ideal or low (<79.9 cm), moderate (between 80 and 87.9 cm), and high risk (≥88 cm); for males - ideal or low risk (<93.9 cm), moderate (between 94 and 101.9 cm), and high risk (≥102 cm)<sup>20</sup>. Assessments were conducted by previously trained researchers.

## Statistical analysis

Data were analyzed using the Statistica v.10.0 software (StatSoft, USA). Normality was verified using the Shapiro-Wilk test. Parametric and non-parametric continuous data are shown as mean ± standard deviation and median and interquartile range (25%-75%),

respectively, while categorical variables were expressed as frequencies. The unpaired t-test was used to compare data between sexes and HDL-c and total cholesterol data between two WC risk categories (low/moderate and high). Mann-Whitney test compared non-parametric variables (risk factors and scores) between sexes. The association between risk scores and the presence of comorbidities was verified using the chi-square test. Weighted Kappa coefficient (K) assessed agreements between FRS and WC, and values were interpreted as no agreement (0), none to slight (0.01-0.20), fair (0.21-0.40), moderate (0.41-0.60), substantial (0.61-0.80), or almost perfect agreement (0.81-1.00)<sup>21</sup>. Relationships between clinical and anthropometric variables were assessed using Pearson's correlation coefficient (r) associated with a simple linear regression model. For all analyses, a significance level of 5% (two-tailed) was considered.

## RESULTS

One hundred and twenty-four individuals were included, but sixty-five were excluded due to lack of laboratory tests; two were pregnant, and two presented orthopedic limitations. The final sample (N = 55) presented mean age of 52.8 ± 9.4 years (most females, 70.9%), grade I obesity (30.2 ± 10.4 kg/m<sup>2</sup>), and mean

WC of 96.0 ± 10.3 cm. When stratified by sex, females presented higher BMI (p < 0.001) and SBP (p = 0.04) than males (Table 1).

Most individuals (n = 25; 45.5%) were categorized as intermediate risk, according to FRS; however, a higher frequency of individuals was categorized as high risk (n = 39, 71.0%) when using WC (Table 2). No agreement (K = 0.36, p = 0.55) was found between scores. Regarding risk factors, a sedentary lifestyle was the most prevalent (n = 31, 56.3%), followed by stress (n = 28, 50.9%), dyslipidemia (n = 22, 40.0%), hypertension (n = 21, 38.1%), obesity (n=18, 32.7%), diabetes (n = 14, 25.4%), alcoholism (n = 9, 16.3%), and smoking (n = 4, 7.2%), with no significant differences between sexes (p > 0.05). WC score associated significantly with hypertension (p = 0.02) and obesity (p < 0.01). Stress was also associated with FRS (p = 0.01) in females.

Significant and weak correlations were found between SBP and WC (r = 0.32, p = 0.01), DBP and HC (r = 0.33, p = 0.01) and WC (r = 0.42, p < 0.01), and between HDL-c and NC (r = -0.31, p = 0.01). Regression analysis demonstrated a reduction of 1.15 mg/dL of HDL-c per 1 cm increase in NC (Figure 1). We also observed that individuals with high cardiovascular risk, according to WC, presented lower HDL-c values (p = 0.03) than those with low/moderate risk, but with no significant difference in total cholesterol (p = 0.50) (Figure 2).

**Table 1** – Sociodemographic, clinical, and anthropometric characteristics of the study population.

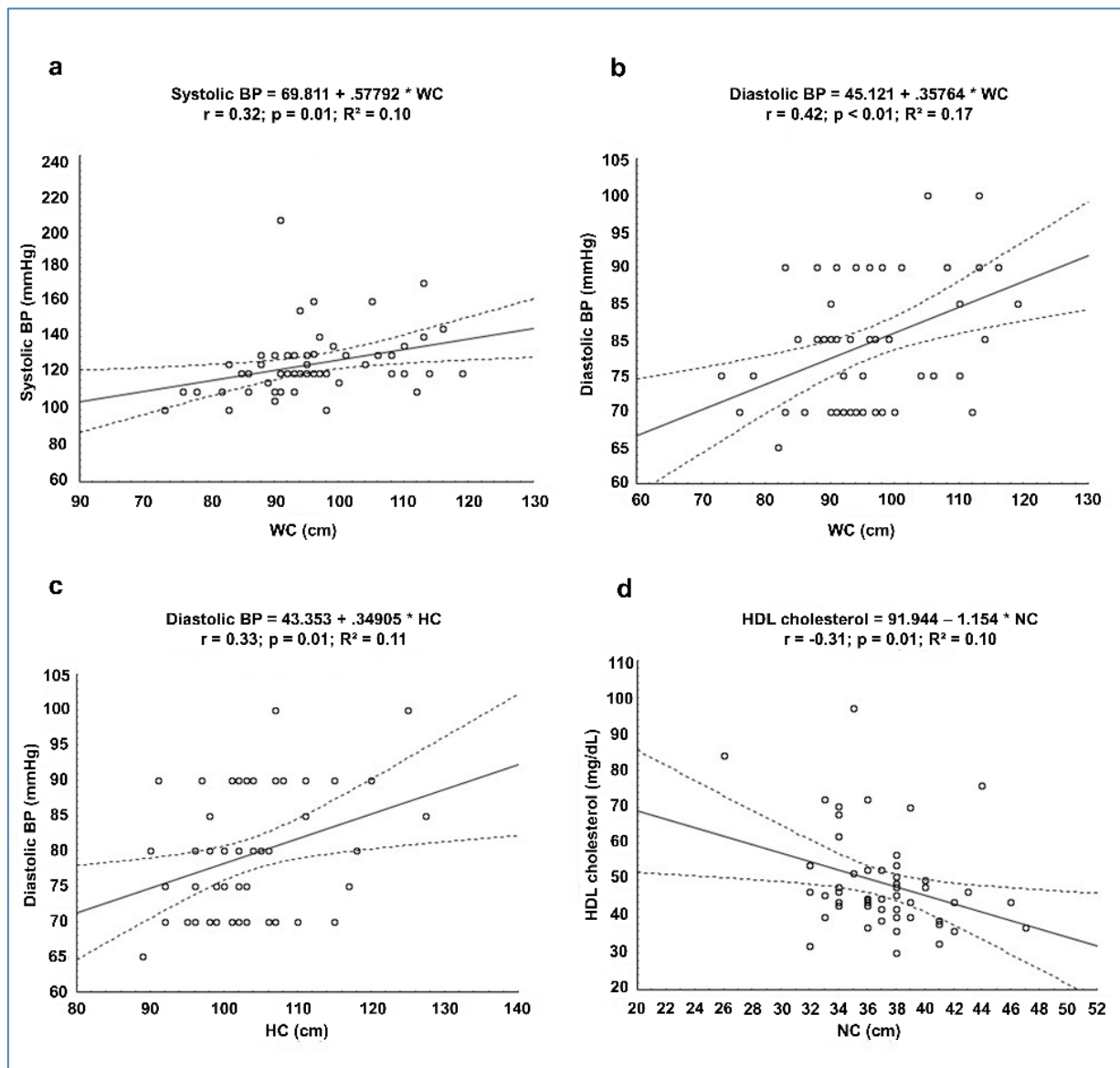
Variables	Total (N = 55)	Males (n = 16)	Females (n = 39)	*p-value
Age (years)	52.8 ± 9.4	52.7 ± 9.7	52.9 ± 10.0	0.94
WC (cm)	96.0 ± 10.3	98.3 ± 10.8	95.0 ± 10.1	0.71
NC (cm)	37.1 ± 3.6	39.7 ± 3.6	36.0 ± 3.1	0.42
HC (cm)	103.0 ± 8.4	102.6 ± 9.1	103.7 ± 8.3	0.62
WHR	0.93 ± 0.08	0.95 ± 0.05	0.92 ± 0.09	0.26
Weight (kg)	72.2 ± 14.2	79.0 ± 16.4	69.5 ± 12.4	0.16
Height (cm)	157.0 ± 9.0	166.0 ± 7.0	153.3 ± 6.8	<0.001
BMI (kg/m <sup>2</sup> )	30.2 ± 10.4	28.4 ± 4.5	30.9 ± 12.0	<0.001
SBP (mmHg)	125.2 ± 18.2	123.4 ± 12.3	126.0 ± 20.2	0.04
DBP (mmHg)	79.4 ± 8.8	79.3 ± 7.7	79.4 ± 9.3	0.44
HDL-c (mg/dL)	49.1 ± 13.4	49.4 ± 13.0	48.9 ± 13.7	0.86
Total cholesterol (mg/dL)	201.6 ± 45.3	189.7 ± 32.5	206.6 ± 49.2	0.08

Data are expressed as mean ± standard deviation. BMI, body mass index; DBP, diastolic blood pressure; HC, hip circumference; WHR, waist-hip ratio; HDL-c, high density lipoprotein cholesterol; NC, neck circumference; SBP, systolic blood pressure; WC, waist circumference. \*Unpaired t-test.

**Table 2** – Cardiovascular risk according to FRS and WC score.

Genre	FRS			WC*		
	Low	Intermediate	High	Low	Moderate	High
Males	5 (31.2%)	7 (43.7%)	4 (25.0%)	6 (37.5%)	3 (18.7%)	7 (43.8%)
Females	17 (43.6%)	18 (46.1%)	4 (10.3%)	2 (5.1%)	5 (12.9%)	32 (82.0%)
Total**	22 (40.0%)	25 (45.5%)	8 (14.5%)	8 (14.5%)	8 (14.5%)	39 (71.0%)

Data are expressed in absolute and relative frequency (%). FRS, Framingham risk score; WC, waist circumference. \*p = 0.01 (Mann-Whitney test between sexes for WC score). \*\*K = 0.36; p = 0.55.



**Figure 1** – Correlations and simple linear regression between clinical variables and anthropometric measurements considering total sample (n=55). (A). Systolic BP and WC. (B). Diastolic BP and WC. (C). Diastolic BP and HC. (D). HDL cholesterol and NC. BP, blood pressure; HC, hip circumference; HDL, high density lipoprotein; NC, neck circumference. WC, waist circumference.

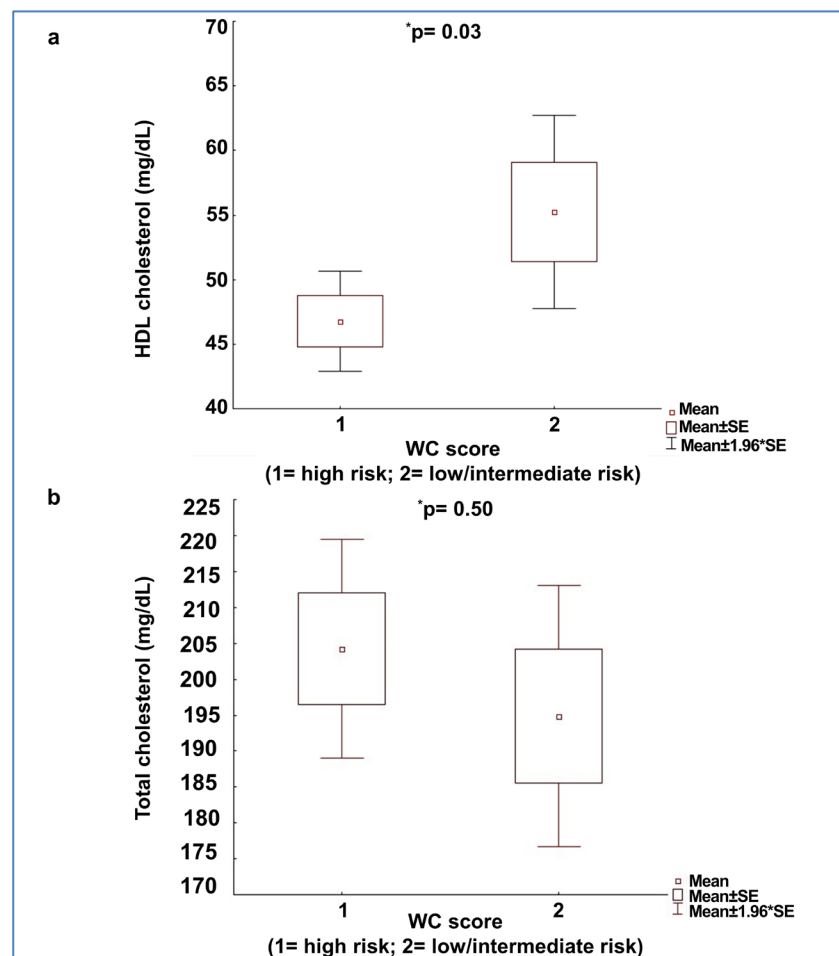
## DISCUSSION

The main finding of this study is the lack of agreement between FRS and WC cardiovascular risk classifications. Specifically, WC measurement classified most individuals as high risk, whereas FRS classified as intermediate risk. Hypertension, stress, obesity, and HDL-c represented factors most associated with these scores.

Concerning cardiovascular risk assessment obtained using FRS, Lima-Júnior et al. (2016)<sup>22</sup> evaluated 135 males ( $55.35 \pm 9.17$  years) and observed that 47.8% was categorized as intermediate risk, corroborating with our results. Conversely, in another study analyzing 160 patients (66.2% males) with metabolic syndrome, 77.5% was at low risk<sup>10</sup> probably due to a sample of younger individuals ( $44.0 \pm 10.0$  years). Likewise, Oliveira et al.<sup>15</sup> studied a population with central obesity (n = 54, 83.0%

women) and observed that most (91.0%) were at low risk, according to FRS. However, different from our study, the FRS score may have been influenced by the presence of only four individuals (7.4%) with diabetes mellitus.

Few studies estimated cardiovascular risk using the WC score. A previous survey evaluated 231 Brazilian individuals (54.1% males) and observed that most females (42.0%) were categorized as high risk, whereas 53.9% of males were at low risk<sup>11</sup>. More recently, 3,201 Iranians were analyzed, and significantly higher WC values were found in females ( $96.3 \pm 11.5$  cm; high risk) than males ( $93.8 \pm 11.2$  cm; moderate risk)<sup>23</sup>. It is worth noting that males included in the study presented lower weight, BMI, SBP, and DBP values than observed in our sample, justifying the moderate cardiovascular risk. Similar to our findings, a study involving 133 Brazilian individuals found that males ( $102.5 \pm 10.1$  cm) and



**Figure 2** – Comparison of HDL cholesterol (A) and total cholesterol (B) levels between WC risk categories considering total sample (n = 55). HDL, high density lipoprotein; SE, standard error; WC, waist circumference. \*Unpaired t-Test

females ( $100.2 \pm 11.9$  cm) were at high risk, according to WC measurements<sup>24</sup>. The heterogeneity of these studies regarding sex, age, sample size, and comorbidities may justify differences between results.

To our knowledge, only one study<sup>15</sup> compared these two cardiovascular risk scores. However, the sample was composed of individuals with abdominal obesity, and cardiovascular risk according to WC was not categorized as low, moderate, or high, precluding the possibility of performing the agreement between FRS and WC. In our study, no agreements were observed between these two scores. Given the critical influence of central obesity on CVDs and the low-cost and easy applicability of WC<sup>24</sup>, some studies criticized the lack of inclusion of this anthropometric measure in cardiovascular risk scores (including the FRS)<sup>21,23</sup>. However, Bozorgmanesh et al.<sup>25</sup> studied 8,248 Iranians and observed that associations between FRS and anthropometric measures (e.g., body shape index, BMI, WHR, and waist-to-height ratio) were not superior to FRS alone in predicting cardiovascular risk, despite these variables provide important information and are recommended due to practicality (especially where information regarding traditional risk factors is not available).

In a multicenter study, abdominal adiposity and

the influence of BMI on CVD incidence were assessed in 4,061 healthy young adults followed for 25 years<sup>26</sup>. Authors concluded that general and abdominal obesity were good predictors of CVD, but these predictors were more accurate when combined<sup>25</sup>. Another study<sup>27</sup> investigated whether central and abdominal adiposity markers, combined or alone, influence coronary risk in Brazilian individuals aged between 35 and 74 years. They concluded that WHR alone was the most influential marker of coronary risk. However, associations with coronary risk were higher when combining at least one marker of central obesity with one marker of general obesity (e.g., BMI + WHR).

When dealing with central obesity, morbidity and mortality rates and the chances of developing CVD become even high<sup>15</sup> since visceral fat facilitates lipolysis and expression of more glucocorticoid receptors sensitive to catecholamines. This leads to less insulin receptor substrate expression and greater deterioration of insulin sensitivity, increasing blood pressure and atherosclerotic process<sup>28</sup>. Therefore, WC may represent a valuable parameter for assessing CVD development, mainly in the primary health care context since obesity levels are increasing worldwide<sup>12</sup>.

Some studies addressed the influence of WC on hypertension<sup>29-31</sup>, corroborating our results regarding

SBP and DBP. Although biological mechanisms responsible for the association between WC and hypertension are little known, the influence of metabolic products in the intra-abdominal adipose tissue (i.e., inflammatory adipokines, angiotensinogen, cortisol, or reactive oxygen species) linked to hypertension may also be considered<sup>30</sup>. Furthermore, HC correlated positively with DBP, corroborating with previous studies assessing the influence of this variable on obesity and hypertension<sup>32,33</sup>.

Some authors also discussed the influence of stress on CVDs, which also corroborates our findings since stress influenced FRS in females. In a study conducted with older Afro-American females, authors found that stressful life events were associated with CVD<sup>34</sup>. Another study also showed that prolonged exposure to stress could result in cerebral hyperactivity and increased levels of neurohumoral hormones, leading to inflammatory responses, atherosclerosis, and other CVDs<sup>35</sup>.

In this study, total cholesterol levels were not associated with cardiovascular risk assessed using WC, but this result is still debated in the scientific community. Relationships between total cholesterol and CVD were found in the study that defined the FRS<sup>36</sup>; for this reason, the need for reducing total cholesterol levels has been advocated. However, the same group conducted a 30-year follow-up study<sup>37</sup> and observed that elevated total cholesterol levels were directly associated with overall and CVD mortality in individuals aged < 50 years. Conversely, high total cholesterol levels did not influence mortality in individuals aged > 50 years (14% CVD mortality increase per 1 mg/dL per year drop in cholesterol level). Schatz et al.<sup>38</sup> conducted a study with elderly individuals (n = 3,572) and found an association between low total cholesterol levels and mortality, corroborating findings of a 10-year follow-up study conducted with 207 older adults<sup>39</sup>.

In this sense, the frequent occurrence of atherosclerotic disease has been discussed, even with low levels of low-density lipoprotein cholesterol<sup>40,41</sup>, and greater attention must be paid to HDL-c since it is considered a cardiovascular protective factor<sup>42</sup>. This may occur due to its anti-atherogenic function (i.e., reverse cholesterol efflux, oxidative stress attenuation, and inhibition of endothelial cell apoptosis) that contributes to endothelial repair<sup>43</sup>. Although relationships between cardiovascular risk (assessed using WC) and HDL-c and NC were weak, we hypothesize that individuals with altered anthropometric measures may present low levels of HDL-c, increasing the risk of cardiovascular events. Thus, this reflection raises the following: should we pay too much attention to increased total cholesterol levels, or should we be more concerned with low HDL-c levels? We, therefore, highlight the need for more in-depth investigations on

this topic.

Preventive measures and early screening are essential to improve clinical decision-making and reduce costs and complications caused by the late diagnosis of CVD. Therefore, we emphasize the need to measure WC in primary care individuals during routine consultations since it requires only a tape measure and can be performed at any age, facilitating its use compared to FRS. Those individuals classified as intermediate or high risk should be referred to a specialized multidisciplinary team to perform specific exams and prevent disease development or progression or both. We also recommend more specific screening and preventive measures for those presenting low cardiovascular risk but with associated risk factors. This early action favors the reduction of the burden of hospitalizations at the tertiary level, avoiding the collapse of health systems. Thus, we suggest future studies analyzing combined or isolated anthropometric measurements to assess cardiovascular risk.

Some limitations of our study need to be addressed. First, the relatively small sample size prevented a more accurate comparison between scores, especially regarding sex. The difficulty found to perform laboratory tests necessary for FRS was the main factor influencing the reduced sample. However, this is the first study analyzing the agreement between FRS and WC scores. Second, the presence of some risk factors, such as diabetes and hypertension, were self-reported. However, we believe that the data collected are reliable because all individuals evaluated participated in periodic medical consultations with primary health unit professionals. Last, our results cannot be extrapolated to other populations. We emphasize the need for further studies involving more individuals and long-term follow-up to better investigate differences between FRS and WC and main associated risk factors.

## CONCLUSION

This study showed no agreement between FRS and WC scores. Primary care individuals presented an intermediate risk of developing CVD according to FRS, and stress (in females) represented the leading risk factor associated with this score. Regarding WC, high risk was the most prevalent, and the score was associated with hypertension, obesity, and HDL-c. More studies with larger samples are needed to support and confirm these results.

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 Writing of the manuscript: NVSSA, IMN, TO  
 Critical revision of the article: FS  
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