Association between Anthropometric, Biochemical and Hemodynamic Variables in Cardiac Patients

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Abstract

Background: Cardiovascular diseases (CVD) are one of the leading causes of morbidity and mortality in the world and, in Brazil, they have been the first cause of death for at least four decades. They are a major cause of prolonged hospital stay and are responsible for the primary allocation of public funds in hospitalizations in Brazil. The analysis of anthropometric, hemodynamic and biochemical variables may show their importance as risk factors for CVD.

Objective: To assess the correlation of anthropometric, biochemical and hemodynamic variables of cardiac patients with chances of a new cardiovascular event.

Methods: A prospective, cross-sectional study with 50 patients ≥45 years of age, of both sexes, from April to July 2014, at Fundação Hospital de Clínicas Gaspar Vianna, in Belém, PA. Information relating to stages of life, lifestyle, anthropometry, laboratory tests and hemodynamic profile were collected.

Results: The following the anthropometric, biochemical and hemodynamic indicators were significantly high: body mass index (BMI), waist circumference (WC) and blood glucose and triglycerides (TG). There was a positive and significant correlation between the following variables: BMI with WC, systolic blood pressure (SBP), diastolic blood pressure (DBP), total cholesterol (TC) and LDL with blood glucose. BMI was the variable that most correlated in the study; WC with glucose; SBP with DBP and LDL; TC with TG and LDL.

Conclusions: BMI was the measure that most correlated with other anthropometric, biochemical and hemodynamic variables. The chances of a new cardiovascular event increase as BMI and its correlation with the other variables increase as well.

Keywords: Cardiovascular diseases; Anthropometry; Risk factors; Heart diseases

Introduction

Cardiovascular diseases (CVD) are one of the leading causes of morbidity and mortality in the world, significantly growing in developing countries. In Brazil, they have been the first cause of death for at least four decades and, according to the Ministry of Health¹, they were the most frequent cause of death in 2009, with 31.3%. According to forecasts for the year 2020, CVD will remain the leading cause of mortality and disability¹.

There is consensus among experts that CVDs have a multifactorial origin and participate in the genesis of the so-called risk factors, defined as causative agents that predispose to the emergence of heart diseases. Identifying these factors is essential for clinical practice and for the development of public health strategies for primary and secondary prevention of CVD²-⁴.

According to studies, the greater the number of risk factors either present or associated the greater will be
cardiovascular morbidity and mortality. In these cases, the identification and control of variables predicting risk factors such as anthropometric, biochemical and hemodynamic variables are fundamental in the prevention of future cardiovascular events.

Obesity and overweight are increasing problems in many countries, including Brazil, with concomitant increase in the number of cases of dyslipidemia (DLP), type 2 diabetes mellitus (T2DM), systemic arterial hypertension (SAH) and, therefore, CVD. The accumulation of fat in the abdominal region, determined by waist circumference (WC) has better predictive ability compared to body mass index (BMI) on the outcome of diseases, such as myocardial infarction (AMI). These anthropometric parameters have the advantage of easy measurement and low cost, useful in public health and clinical practice.

From an epidemiological point of view, it has been demonstrated that there is a correlation between plasma cholesterol and triglyceride levels and the increase of CVD. Dyslipidemias are risk factors related to the development of CVD as well as being the primary cause in the outcome of atherosclerosis.

The rise in serum triglycerides is associated with increased risk of coronary artery disease, thus arising evidence that hypertriglyceridemia is an independent risk factor for coronary artery disease. Hypertriglyceridemia is associated with four pathogenic conditions that accelerate the development of atherosclerosis: decreased HDL levels in serum; increased remnant lipoproteins; small rise in LDL; increase in thrombogenic conditions.

Although some aspects are still controversial, changes in lifestyle can significantly improve the development of CVD, thus being inexpensive interventions compared to the rising costs of medical treatments highly dependent on technology. The objective of this study was to evaluate the correlation between anthropometric, biochemical and hemodynamic variables of cardiac patients treated at Fundação Hospital de Clínicas Gaspar Vianna, in Belém, PA.

Methods

Observational, cross-sectional, quantitative, prospective study performed with cardiac patients treated at the nutrition clinic at the Hospital de Clínicas Gaspar Vianna, in Belém, PA.

This study has been approved by the Research Ethics Committee under no. CAAE03218512.0.2001.0016. All participants signed an Informed Consent Form (ICF).

Adults and the elderly, of both sexes, cardiac patients aged ≥45 with any evidence of coronary artery disease (CAD), patients with ischemic stroke, peripheral arterial disease in the last 10 years; current or previous hospitalization for unstable angina were included in the study. Those unable or refusing to participate in the study and sign the ICF have been excluded from the study.

Data collection was conducted from May to July 2014 through a research form with the following data: identification of the patient (sex and age); comorbidities: SAH, DLP and DM; presence of family history of DAC; life habits such as smoking and lifestyle; laboratory tests: fasting glucose, total cholesterol (TC), high-density lipoprotein (HDL), low-density lipoprotein (LDL) and triglycerides (TG); blood pressure; anthropometry: weight, height, BMI and WC.

The reference standards for TC, HDL, LDL and TG were the values recommended by the Brazilian Society of Diabetes on Dislipidemias; for fasting glucose, the values adopted by the Brazilian Society of Diabetes; and for blood pressure, the values adopted by the VI Brazilian Guidelines on Hypertension.

The anthropometric variables analyzed were: BMI and WC. BMI was defined as the ratio [weight(kg) / height²(m)], whose values were compared to the reference standard for adults and elderly. Waist circumference was measured with the patient standing at the medium point between the last rib and the iliac crest using an inelastic measuring tape, with no pressure applied. Reading was taken at the time of expiration. The cutoff point used to classify WC was the one recommended by the Ministry of Health.

For hemodynamic variables, blood pressure was measured in the device G.TECH Monitor Digital Pressão Arterial (Onbo Electronics Co., China). The measurement was performed on the left arm only once after the patient had been sitting for two minutes, at rest.
Table 1
Average values of anthropometric, biochemical and hemodynamic variables studied and recommended reference values

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean±SD</th>
<th>Recommended values*</th>
<th>Student’s t-test**</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood glucose (mg/dL)</td>
<td>119.22±41.19</td>
<td>&lt; 100</td>
<td>3.4359</td>
<td>0.0012*</td>
</tr>
<tr>
<td>TC (mg/dL)</td>
<td>189.14±48.30</td>
<td>&lt; 200</td>
<td>-1.429</td>
<td>0.1594</td>
</tr>
<tr>
<td>LDL (mg/dL)</td>
<td>101.93±39.32</td>
<td>&lt; 160</td>
<td>-9.7366</td>
<td>&lt; 0.0001*</td>
</tr>
<tr>
<td>TG (mg/dL)</td>
<td>188.81±129.90</td>
<td>&lt; 150</td>
<td>2.1453</td>
<td>0.0369*</td>
</tr>
<tr>
<td>HDL (mg/dL)</td>
<td>52.50±9.44</td>
<td>&gt; 50 ♀</td>
<td>0.5943</td>
<td>0.5625</td>
</tr>
<tr>
<td></td>
<td>47.60±9.91</td>
<td>&gt; 40 ♂</td>
<td>3.8227</td>
<td>0.0006*</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>126.72±20.68</td>
<td>&lt; 130</td>
<td>-1.0873</td>
<td>0.2822</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>81.20±13.98</td>
<td>&lt; 85</td>
<td>-1.8714</td>
<td>0.0672</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>28.71±4.82</td>
<td>&lt; 25</td>
<td>5.4406</td>
<td>&lt; 0.0001*</td>
</tr>
<tr>
<td>WC (cm)</td>
<td>96.55±16.06</td>
<td>&lt; 80 ♀</td>
<td>3.8549</td>
<td>0.0020*</td>
</tr>
<tr>
<td></td>
<td>98.78±9.82</td>
<td>&lt; 94 ♂</td>
<td>5.3613</td>
<td>&lt; 0.0001*</td>
</tr>
</tbody>
</table>

TC — total cholesterol; LDL — low-density lipoprotein; TG — triglycerides; HDL — high-density lipoprotein; SBP — systolic blood pressure; DBP — diastolic blood pressure; BMI — body mass index; WC — waist circumference; (♀) male sex; (♂) female sex; SD — standard deviation

*According to the Guidelines of the Brazilian Society of Diabetes; IV Brazilian Guidelines on Dyslipidemia and Prevention of Atherosclerosis; VI Brazilian Guidelines on Hypertension; World Health Organization.

**Student’s t-test p<0.05 significant differences.
Table 2 presents data about the analysis of correlation between anthropometric, biochemical (TC, HDL, LDL and glucose) and hemodynamic (SBP and DBP) variables. There was a positive and significant correlation among the following variables: BMI with WC, SBP, DBP, TC, LDL with blood glucose; WC with glucose; SBP with DBP and LDL; TC with TG and LDL.

Some correlations presumable in the literature were observed, since there are inseparable variables, such as total cholesterol and LDL, in which the first corresponds to the sum of all lipoproteins (LDL+HDL). Others such as systolic and diastolic blood pressure are markers of blood pressure and the alteration of a value usually interferes with the other.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Correlation between anthropometric, biochemical and hemodynamic variables of the study population</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BMI</td>
</tr>
<tr>
<td>BMI</td>
<td></td>
</tr>
<tr>
<td>p value</td>
<td></td>
</tr>
<tr>
<td>WC</td>
<td>0.8214</td>
</tr>
<tr>
<td>p value</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>SBP</td>
<td>0.3223</td>
</tr>
<tr>
<td>p value</td>
<td>0.0308*</td>
</tr>
<tr>
<td>DBP</td>
<td>0.3443</td>
</tr>
<tr>
<td>p value</td>
<td>0.0205*</td>
</tr>
<tr>
<td>TC</td>
<td>0.4151</td>
</tr>
<tr>
<td>p value</td>
<td>0.0045*</td>
</tr>
<tr>
<td>TG</td>
<td>0.0952</td>
</tr>
<tr>
<td>p value</td>
<td>0.5338</td>
</tr>
<tr>
<td>LDL</td>
<td>0.3088</td>
</tr>
<tr>
<td>p value</td>
<td>0.0389*</td>
</tr>
<tr>
<td>HDL</td>
<td>-0.1521</td>
</tr>
<tr>
<td>p value</td>
<td>0.3184</td>
</tr>
<tr>
<td>Blood glucose</td>
<td>0.3684</td>
</tr>
<tr>
<td>p value</td>
<td>0.0127*</td>
</tr>
</tbody>
</table>

*p<0.05 — significant correlations (Pearson’s correlations)
TC — Total cholesterol; LDL — low-density lipoprotein; TG — triglycerides; HDL — high-density lipoprotein; SBP — systolic blood pressure; DBP — diastolic blood pressure; BMI — body mass index; WC — waist circumference
Discussion

The prevalence of male patients found here is consistent with other studies involving cardiac patients, such as in Quiri et al.\textsuperscript{18} (65.0%), Lobato et al.\textsuperscript{19} (58.0%) and Marcadenti et al.\textsuperscript{20} (71.4%). By analyzing cardiovascular risk, it is observed that men have a higher risk in initial evaluation\textsuperscript{21}. One of the pioneers in research on inequality of the sexes, the Framingham study identified a set of factors that predisposed to a higher risk of developing atherosclerosis, including, among the most important ones, male sex\textsuperscript{22}.

The average age of patients was 62. This result resembles those of the studies of Chang et al.\textsuperscript{23} and Santos et al.\textsuperscript{24}, who found values of 65.7 years and 67.0 years, respectively. Age has been identified as an independent risk factor for CVD. The elderly are more vulnerable to degenerative diseases of insidious beginning, such as the cardiovascular diseases\textsuperscript{25}.

Among the comorbidities found, the most prevalent was SAH, the same finding observed in the studies of Chang et al.\textsuperscript{23} (77.6%) and Lemos et al.\textsuperscript{26} (75.7%), both involving patients with CAD. These results confirm the importance of SAH as a risk factor for the occurrence of ACS\textsuperscript{21}.

A prevalence of family history of CAD was found in most of the population, agreeing with the findings of Chagas et al.\textsuperscript{27} (72.0%), Lemos et al.\textsuperscript{28} (56.6%) and Soares et al.\textsuperscript{29} (52.7%) in studies involving cardiac patients.

In this study, most of the population self-reported as physically inactive. Feijó et al.\textsuperscript{29} found the same prevalence in their study (75.0%). Other similar results were observed by Quirino et al.\textsuperscript{18} (78.0%) and Lemos et al.\textsuperscript{26} (86.8%). The findings reinforce the estimate that a physically inactive lifestyle, although depending on other factors, accounts for 22.0% of ischemic heart diseases\textsuperscript{30}.

Smoking increases the risk of premature death and physical limitations from coronary heart diseases, among others\textsuperscript{31}. In this study, most patients self-reported as a smoker, which is consistent with the studies of Chagas et al.\textsuperscript{27} (55.5%) and Chang et al.\textsuperscript{23} (65.7%).

Several anthropometric indices have been proposed to determine the association between overweight and cardiovascular risk factors. Among the anthropometric parameters used to assess the nutritional status, the most widely used in clinical practice today is BMI because of the sensitivity in identifying generalized obesity\textsuperscript{32}.

A common manifestation in patients with heart disease is increase in BMI, which was confirmed with the findings of this study. Quirino et al.\textsuperscript{18} in their study also obtained higher average BMI than recommended. According to Carneiro et al.\textsuperscript{33}, in the aging process, BMI >27 kg/m\textsuperscript{2} indicates obesity, becomes a risk factor for hypertension, favoring the appearance of cardiovascular events in this group.

Average WC was above the recommended, being statistically significant for both sexes, proving to be a marker in this population. WC is a measure that indicates central obesity, characterized by fat accumulation in the mesenteric region and associated with increased risk of CVD. This measure has been considered one of the best predictors of cardiovascular risk\textsuperscript{34}.

In the study of Avezum et al.\textsuperscript{1}, the average fasting plasma glucose was statistically high, similar to that found in this study, compared to the recommendations of the Brazilian Society of Diabetes\textsuperscript{13}. There is increasing evidence to suggest that the mere presence of glucose intolerance during fasting is considered a cardiovascular risk factor\textsuperscript{33,34}.

As for metabolic evaluation, there was a significantly high average of TG, similar to the results found by Martins et al\textsuperscript{35}. Several studies determined an association between high triglyceride levels and cardiovascular disease. However, it remains controversial whether high levels of triglycerides directly promote cardiovascular disease or whether they represent only one risk biomarker\textsuperscript{35}.

In this study, among the anthropometric variables studied, BMI was the one that most correlated with other variables. There was a significant positive correlation between BMI and WC, also found in other reference studies\textsuperscript{36,37}. It is known that excess weight associated with the accumulation of fat in the mesenteric region is associated with increased risk of atherosclerotic disease\textsuperscript{37}.

Obesity is highly associated with other cardiovascular risk factors such as SAH, DM and DLP\textsuperscript{38}. The findings of this study corroborate the literature, since there was a statistically positive correlation between BMI and blood pressure (SBP r=0.3223, p=0.0308; DBP r=0.3443, p=0.0205) BMI and blood glucose r=0.3684 (p=0.0127); BMI and CT r=0.4151 (p=0.0045); BMI and LDL r=0.3088 (p=0.0389).

In this study, we observed that TC and LDL-c correlated most significantly with BMI, suggesting that total body
fat seems to be more relevant in relation to these variables (TC and LDL-c) than the fat deposit in the central area of the body. These findings were similar to the results found by other researchers\(^7,\)\(^{39,40}\).

The literature states that excessive deposition of visceral abdominal fat is associated not only with increased risk of coronary events, but also to the development of T2DM in both sexes and in different ethnicities\(^22\). In this study, there was a positive and significant correlation between WC and glucose \(r=0.3273\) (\(p=0.0281\)).

The reduction of TC values can contribute to reducing other risk factors associated with it, such as LDL-c and TG, a result found in this study between TC and TG, \(r=0.481\) (\(p=0.0007\)); and TC and LDL \(r=0.4301\) (\(0.0032\)). Although the values of biochemical variables are not significantly high (except for TG), they were positively correlated in most cases.

The mechanisms by which the levels of plasma lipoproteins and BP do not seem to be entirely clear in the literature. Guedes and Guedes\(^4\) suggest a predominance of fat in the central region of the body as a causal factor, in which the central provision of body fat may represent an increase in size and/or number of metabolically more active intra-abdominal or visceral fat cells. There was a significantly positive correlation of SBP with DBP, \(r=0.6095\) (\(p<0.0001\) and LDL \(r=0.3401\) (\(0.0222\)).

According to Soares et al.\(^28\), despite these findings, knowledge about the prevalence of risk factors in different populations is still small, so the most effective way to reduce the impact of cardiovascular disease at the population level is the development of preventive actions and treatment of risk factors.

**Conclusion**

In conclusion, BMI is the measure that most correlated with the other anthropometric and biochemical and hemodynamic variables.

These data support the hypothesis that the chances of a new cardiovascular event increase with increasing BMI, since all variables studied are associated with risk factors for cardiovascular disease.

**Conflict of Interest**

This study has no relevant conflicts of interest.

**Sources of Funding**

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**Academic Association**

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38. Coelho MSPH, Assis MAA, Moura EC. Aumento do índice de massa corporal após os 20 anos de idade e associação com indicadores de risco ou de proteção para doenças crônicas não transmissíveis. Arq Bras Endocrinol Metab. 2009;53(9):1146-56.
