Ankle-brachial Index and associated factors in individuals with coronary artery disease

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http://dx.doi.org/10.1590/1806-9282.66.4.407

INTRODUCTION

Cardiovascular diseases (CVDs) represent a public health problem with high rates of morbidity and mortality, causing 17.9 million deaths per year worldwide³. CVDs include coronary artery disease (CAD), cerebrovascular disease (CBVD), peripheral arterial occlusive disease (PAOD), and aortic atherosclerosis. CAD represents approximately a third of half of the total number of CVD cases². Individuals with CAD are often diagnosed with PAOD, increasing their cardiovascular risk³,4.

PAOD is a presentation with manifestations that are often asymptomatic⁵ and can be diagnosed by the ankle-brachial index (ABI). This noninvasive method can provide early therapeutic interventions to reduce mortality and the risk of cardiovascular events⁶.

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PAOD is a presentation with manifestations that are often asymptomatic⁵ and can be diagnosed by the ankle-brachial index (ABI). This noninvasive method can provide early therapeutic interventions to reduce mortality and the risk of cardiovascular events⁶.
or equal to 50% of the leg arteries with 75% sensitivity and 86% specificity.

Considering the magnitude of cardiovascular diseases worldwide, the importance of early identification of high-risk groups, and the need for intervention strategies, this study aimed to analyze the association between the ankle-brachial index and the main risk factors for coronary artery disease in individuals with coronariopathies.

METHODS

Study design

This is a cross-sectional observational study.

Time and place of the study

The study was carried out in the Hospital Foundation of the Sugar and Alcohol Agro-industry of Alagoas, in Maceió - AL, involving patients treated between 2011 and 2014.

Study population

The study population consisted of 156 patients, based on the following inclusion criteria: i) adult individuals with coronary artery disease (vessel with stenosis diameter ≥50% on cardiac catheterization examination), ii) with an indication for myocardial, percutaneous, or surgical revascularization, iii) asymptomatic or not for peripheral arterial occlusive disease. The following exclusion criteria were adopted: i) individuals who had peripheral lesions that prevented the measurement of the ABI, such as lesions in a lower limb.

Study variables

The following variables were analyzed: gender (male and female), age (<60 and ≥60), body mass index (BMI) (underweight, healthy, overweight, obesity grade I, II, and III), systemic arterial hypertension (SAH) (hypertensive and non-hypertensive), diabetes mellitus (diabetic and non-diabetic), smoking (smokers and nonsmokers), dyslipidemia (dyslipidemic and not dyslipidemic), family history of CAD (FH CAD) (with FH CAD and without FH CAD), and ankle-brachial index (ABI) (≤0.90 and >0.90).

The BMI was calculated based on the ratio between the body mass (kg) divided by the squared height (m²). The cutoff values adopted for assessing the nutritional status were the ones proposed by the WHO: low weight (BMI <18.5 kg/m²); appropriate weight (18.5 ≤ BMI <25 kg/m²); overweight (25 ≤ BMI <30 kg/m²); grade I obesity (30 ≤ BMI <35 kg/m²); grade II obesity (35 ≤ BMI <40 kg/m²); and grade III obesity (BMI ≥40.0 kg/m²).

The following parameters were considered for the diagnosis of comorbidities and risk factors:

- SAH: arterial pressure >140/90 mmHg;
- DM: fasting glucose ≥126 mg/dl or if already in use insulin or any oral anti-diabetic drug;
- Dyslipidemia: total cholesterol levels ≥200 mg/dl and/or triglycerides ≥150 mg/dl;
- Smoker: an individual who smoked at least one cigarette per day over the previous month;
- FH CAD: self-reported (history of angina, myocardial infarction, coronary angioplasty, myocardial revascularization surgery, or sudden death of father, mother, siblings, and uncles).

Statistical treatment

The data were stored in a Microsoft Excel® database and analyzed using the statistical package SPSS 22.0 (SPSS Inc., Chicago, USA). The normality of the data was initially evaluated using the Kolmogorov-Smirnov test. Continuous variables were described as mean and standard deviation and categorical variables as simple and relative frequencies. The ABI was categorized into ≤0.90 and >0.90 for the association...
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analysis. The comparison of the ABI values, based on the presence/absence of risk factors, was performed using the Mann-Whitney U-test. The association was tested by the chi-square or Fisher’s exact test, as indicated. We also calculated the odds ratio. We considered a confidence interval of 95% (95% CI) and 5% significance.

Ethical aspects
The research was approved by the Research Ethics Committee of the Hospital Foundation of the Sugar and Alcohol Agro-industry of Alagoas, Decision No. 001/2011.

RESULTS
Of the 156 patients studied, the mean age was 60.1 years (SD ± 10.0), and 67.3% (n=105) were males. Among the risk factors, 41% (n=64) were overweight and 23.1% (n=36) obese (the average weight was 72.7±13.8), 72.4% (n=103) were hypertensive, 34.6% (n=54) had diabetes mellitus, 53.2% (n=83) were smokers, and 34.6% (n=54) had dyslipidemia; 70.5% (n=110) had a history of coronary artery disease, and 16.7% (n=26) had ABI ≤0.90 and were, therefore, diagnosed with PAOD (Table 1).

Among the risk factors evaluated, the Mann-Whitney U-test showed that the ABI median values were lower among the elderly, diabetic, and hypertensive patients (p<0.001). No significant difference was observed in the ABI values regarding the variables smoking, dyslipidemia, family history of CAD, and obesity (Figure 1).

The factors associated with PAOD (ABI ≤0.90) were age greater than or equal to 60 years (OR 3.656; 95% CI 1.38-9.69), presence of diabetes (OR 2.625; 95% CI 1.11-6.18), and systemic arterial hypertension (OR 5.528; 95% CI 1.25-24.51) (Table 2).

DISCUSSION
The study analyzed the association between ABI and the main risk factors for PAOD. The prevalence of PAOD was 16.7% (n=26) and the main factors associated with it were age, diabetes mellitus, and systemic arterial hypertension.

Among the elderly population, the development of PAOD is attributed to changes in the blood vessel walls, interfering in the perfusion of tissues with a reduction of nutrients and oxygen. These changes make the vessels more rigid, resulting in increased peripheral resistance. In a study conducted in Africa involving 483 patients, 68.60% of those with PAOD were aged over 60 years (OR 2.03; p=0.004) Similarly results were also observed in Brazil, where the average age of the population with ITB ≤0.9 was 73 years, with a significant association (OR 1.07; p<0.001).

The second risk factor for PAOD relates to the presence of diabetes mellitus. The prolonged state of hyperglycemia in diabetes results in damage to the endothelial cells of blood vessels, thrombosis, and lipid deposition, with the additional formation of atherosclerotic plaque. In a national study with 1,610

| Variable                        | n   | %     |
|--------------------------------|-----|-------|
| Sex                            |     |       |
| Male                           | 105 | 67.3  |
| Female                         | 51  | 32.7  |
| Age range                      |     |       |
| <60                            | 74  | 47.4  |
| ≥60                            | 82  | 52.6  |
| Mean ± SD                      | 60.1±10.0 |     |
| Body mass index (BMI)          |     |       |
| Low weight                     | 2   | 1.3   |
| Normal                         | 54  | 34.6  |
| Overweight                     | 64  | 41.0  |
| Obesity grade I                | 28  | 18.0  |
| Obesity grade II               | 8   | 5.1   |
| Obesity grade III              | 0   | 0.0   |
| Mean ± SD                      | 72.7±13.8 |     |
| Systemic arterial hypertension (SAH)|   |       |
| Hypertensive                   | 113 | 72.4  |
| Not hypertensive               | 43  | 27.6  |
| Diabetes mellitus              |     |       |
| Diabetic                       | 54  | 34.6  |
| Non-diabetic                   | 102 | 65.4  |
| Smoking                        |     |       |
| Smoker                         | 83  | 53.2  |
| Non-smoker                     | 73  | 46.8  |
| Dyslipidemia                   |     |       |
| Dyslipidemic                   | 54  | 34.6  |
| Not dyslipidemic               | 102 | 65.4  |
| Family history of CAD (FH CAD) |     |       |
| With FH CAD                    | 110 | 70.5  |
| No FH CAD                      | 46  | 29.5  |
| Ankle-brachial index (ABI)     |     |       |
| ≤0.90                          | 26  | 16.7  |
| >0.90                          | 130 | 83.3  |

Legend: CAD: Coronary artery disease.
individuals, 41.2% of patients with PAOD had diabetes (OR 8.77; p<0.001). An investigation by Saleh et al. conducted in the Middle East involving 2,120 patients found diabetes as a factor associated with an increased risk for PAOD, however, with a lower OR than that found in our study (OR 1.827; p=0.04).

Hypertension is a third factor associated with a low ABI. It is believed that high-pressure levels result in a dysfunction of blood vessel endothelial cells, increasing the PAOD risk. In a study conducted with 100 patients of a tribe in India, hypertensive individuals presented an odds ratio 3.71 times higher of developing PAOD when compared to normotensive individuals. Similar results were also observed in pre-hypertensive individuals, whose OR was 3.28, in a comparative study with normotensive individuals.

Although smoking is another risk factor, only 20.5% (n=17) of smokers presented PAOD (ABI ≤0.90),
with no significant association (p=0.173). This non-significance also was reported by Sarmento et al.\textsuperscript{13}, whose smoking rate was 18.8%. Data from the 2018 Vigitel survey show advances in the reduction of smoking in Brasil: between 2006 and 2017, the proportion of smokers decreased from 15.7% to 10.1%, and adults who smoke 20 or more cigarettes per day decreased from 4.6% to 2.6%\textsuperscript{19}.

In a retrospective cohort study conducted in Matsumoto, Japan, with 3,056 patients hospitalized for cardiovascular disease between 2005 and 2012, 41% of individuals with ABI ≤0.90 presented dyslipidemia\textsuperscript{20}, corroborating our study, in which 38.46% of individuals with PAOD were dyslipidemic. However, although dyslipidemia is a risk factor, the data did not present statistical significance. It is possible that the size of the POAD population could have influenced the results of the regression.

Most individuals with POAD had a family history of CAD (61.53%; n=16), but there was no significant association (OR 0.613; CI 0.25-1.47). Similar results were observed in a cross-sectional study with 250 individuals in a district of Izmir, Turkey, in which 49.2% (n=123) of individuals with POAD had a family history of CAD\textsuperscript{21}, and in research performed in Porto Alegre-RS, in which the ratio was 56.6% (n=17)\textsuperscript{22}.

Although the literature points to obesity as an important risk factor, in our study, only 26.92% (n=7) of individuals with PAOD were obese, with no significant association. Similar results were reported in a recent Italian study involving 319 patients, in which the odds ratio was 0.98 (p=0.20)\textsuperscript{23}, and in the study conducted by Kock et al.\textsuperscript{24} on 93 elderly patients treated in the specialty outpatient clinic of the University of Southern Santa Catarina (p=0.551).

Even when considering the methodology adopted, the study has limitations, among which stand out the size of the population, time of diagnosis, and severity

### TABLE 2. RISK FACTORS FOR PERIPHERAL ARTERIAL OCCLUSIVE DISEASE (PAOD) IN THE POPULATION STUDIED. ALAGOAS, BRASIL, 2019. (N=156)

| Variable                        | ABI ≤0.90 (n=26 (16.7%)) | ABI >0.90 (n=130 (83.3%)) | p-value\textsuperscript{1} | OR\textsuperscript{2} | CI 95%   |
|--------------------------------|---------------------------|-----------------------------|-----------------------------|-----------------------|----------|
| Sex                            |                           |                             |                             |                       |          |
| Male                           | 15 (14.3)                 | 90 (85.7)                   | 0.252                       | 0.606                 | 0.26-1.43|
| Female                         | 11 (21.6)                 | 40 (78.4)                   |                             |                       |          |
| Age range*                     |                           |                             |                             |                       |          |
| <60                            | 6 (8.1)                   | 68 (91.9)                   | 0.005                       | 3.656                 | 1.38-9.69|
| ≥60                            | 20 (24.4)                 | 62 (75.6)                   |                             |                       |          |
| Diabetes mellitus*             |                           |                             |                             |                       |          |
| Yes                            | 14 (25.9)                 | 40 (74.1)                   | 0.024                       | 2.625                 | 1.11-6.18|
| No                             | 12 (11.8)                 | 90 (88.2)                   |                             |                       |          |
| Systemic arterial hypertension (SAH)* |                     |                             |                             |                       |          |
| Yes                            | 24 (21.2)                 | 89 (78.8)                   | 0.008                       | 5.528                 | 1.25-24.51|
| No                             | 2 (4.7)                   | 41 (95.3)                   |                             |                       |          |
| Smoker                         |                           |                             |                             |                       |          |
| Yes                            | 17 (20.5)                 | 66 (79.5)                   | 0.173                       | 1.832                 | 0.76-4.41|
| No                             | 9 (12.3)                  | 64 (87.7)                   |                             |                       |          |
| Dyslipidemias                  |                           |                             |                             |                       |          |
| Yes                            | 10 (18.5)                 | 44 (81.5)                   | 0.652                       | 1.222                 | 0.51-2.91|
| No                             | 16 (15.7)                 | 86 (84.3)                   |                             |                       |          |
| Family history of CAD          |                           |                             |                             |                       |          |
| Yes                            | 16 (14.5)                 | 94 (85.5)                   | 0.272                       | 0.613                 | 0.25-1.47|
| No                             | 10 (21.7)                 | 36 (78.3)                   |                             |                       |          |
| Obesity                        |                           |                             |                             |                       |          |
| Yes                            | 7 (19.4)                  | 29 (80.6)                   | 0.610                       | 1.283                 | 0.491-3.35|
| No                             | 19 (15.8)                 | 101 (84.2)                  |                             |                       |          |

Legend: *Statistical significance (p<0.05); \textsuperscript{1}Chi-square or Fisher exact; \textsuperscript{2}Odds Ratio
of the cases. In this study, only 26 individuals presented PAOD, which may have compromised the statistical results.

**CONCLUSION**

The study showed an association between the presence of PAOD and age, the presence of diabetes mellitus, tabagismo, and dislipidemia. A triagem of the DAOP was performed using the ankle-brachial index (ITB). For the evaluation of the subjects the test of Mann-Whitney, chi-square, and Fisher’s exact test were used. Confidence Interval of 95% and significance of 5%.

**OBJECTIVES**: To analyze the association between ITB and the main factors for coronary artery disease in individuals.

**METHODS**: Selected 156 adult patients from a hospital in Maceió, Alagoas. The evaluated risk factors were age, sex, body mass index, smoking, dyslipidemia, diabetes, hypertension, and family history of PAOD.

**RESULTS**: 52.6% (n=82) of the patients were males, 52.6% (n=82) were aged 67.3% (n=105) of the cases. In this study, only 26 individuals presented PAOD, which may have compromised the statistical results.

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**CONTRIBUTION OF THE AUTHORS**

Carlos Dornels Freire de Souza, Saulo Henrique Salgueiro de Aquino, Isabelle Tenório Melo, Francisco de Assis Costa: Participated in the development of the concept, planning of the study, data collection and analysis, discussion of the results, scientific writing, as well as in the review and approval of the final version of the work.
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