


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

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SUMMARY

OBJECTIVE: Analyzing the association between ABI and the main risk factors for coronary artery disease in coronary patients.

METHODS: Were selected 156 adult patients from a hospital in Maceió, Alagoas. Were evaluated with risk factors age, obesity, hypertension, diabetes mellitus, smoking, and dyslipidemia. PAOD screening was performed by the ankle-brachial index (ABI). The Mann-Whitney, chi-square, and Fisher's exact tests were used. Confidence Interval of 95% and a significance of 5%.

RESULTS: 67.3% (n=105) males, 52.6% (n=82) elderly, 23.1% (n = 34) obese, 72.4% 6% (n=113) hypertensive, 34.6% (n=54) diabetics, 53.2% (n=83) smokers, 34.6% (n=54) dyslipidemic and 70.5% (n=110) with a family history of CAD. 16.7% (n=26) of the individuals presented PAOD. Three factors were associated with PAOD: age group ≥ 60 years (OR:3.656; $p=0.005$), diabetes mellitus (OR:2.625; $p=0.024$) and hypertension (OR:5.528; $p=0.008$). No significant difference was observed in the variables smoking, dyslipidemia, family history of CAD, and obesity.

CONCLUSION: The independent risk factors for PAOD were age, diabetes mellitus, and systemic arterial hypertension.

KEYWORDS: Ankle-brachial index. Peripheral vascular diseases. Risk factors.

INTRODUCTION

Cardiovascular diseases (CVDs) represent a public health problem with high rates of morbidity and mortality, causing 17.9 million deaths per year worldwide¹. 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 risk^{3,4}.

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.

ABI is the ratio between the systolic pressure of the ankle and the arm. When there is stenosis or obstruction near the site of pressure measurement, the index value in individuals with PAOD is less than or equal to 0.9. The ABI accuracy detects stenosis greater than

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or equal to 50% of the leg arteries with 75% sensitivity and 86% specificity^{6,7}.

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 $\geq 50\%$ 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 (m^2). The cutoff values adopted for assessing the nutritional status were the ones proposed by the WHO: low weight (BMI <18.5 kg/m^2); appropriate weight

($18.5 \leq$ BMI <25 kg/m^2); overweight ($25 \leq$ BMI <30 kg/m^2); grade I obesity ($30.0 \leq$ BMI <35 kg/m^2); grade II obesity ($35.0 \leq$ BMI <40 kg/m^2); and grade III obesity (BMI ≥ 40.0 kg/m^2).

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

- SAH: arterial pressure $>140/90$ mmHg⁸;
- DM: fasting glucose ≥ 126 mg/dl or if already in use insulin or any oral anti-diabetic drug⁹;
- Dyslipidemia: total cholesterol levels ≥ 200 mg/dl and/or triglycerides ≥ 150 mg/dl¹⁰;
- 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).

Research procedures

Initially, the individuals were approached and invited to participate in the research. At that moment, we explained the objectives and procedures of the research, and they signed the Informed Consent Form (ICF). In the next step, demographic data were collected using a form designed specifically for this purpose. In the third step, we took measurements of weight and height and measured the systolic pressure in the ankle and arm for the BMI and ABI calculations, respectively.

The measurement of the ABI was taken while the patient was in dorsal decubitus. The systolic blood pressure (SBP) was measured in both the upper limb and lower limb. The measurement of the SBP for calculating the ABI was done with a Microlife BP3AC1-1PC device. The ABI calculation was obtained by the ratio of the higher systolic blood pressure (SBP) of the posterior tibial artery and/or dorsal artery of the foot, with the higher SBP of the brachial arteries, bilaterally, always considering the lower ABI. The ABI was considered abnormal when ≤ 0.90 .

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

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 \pm 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 \pm 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 \leq 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 \leq 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 resistance¹¹. In a study conducted in Africa involving 483 patients, 68.60% of those with PAOD were aged over 60 years (OR 2.03; $p = 0.004$)¹². Similar results were also observed in Brasil, where the average age of the population with ITB \leq 0.9 was 73 years, with a significant association (OR 1.07; $p < 0.001$)¹³.

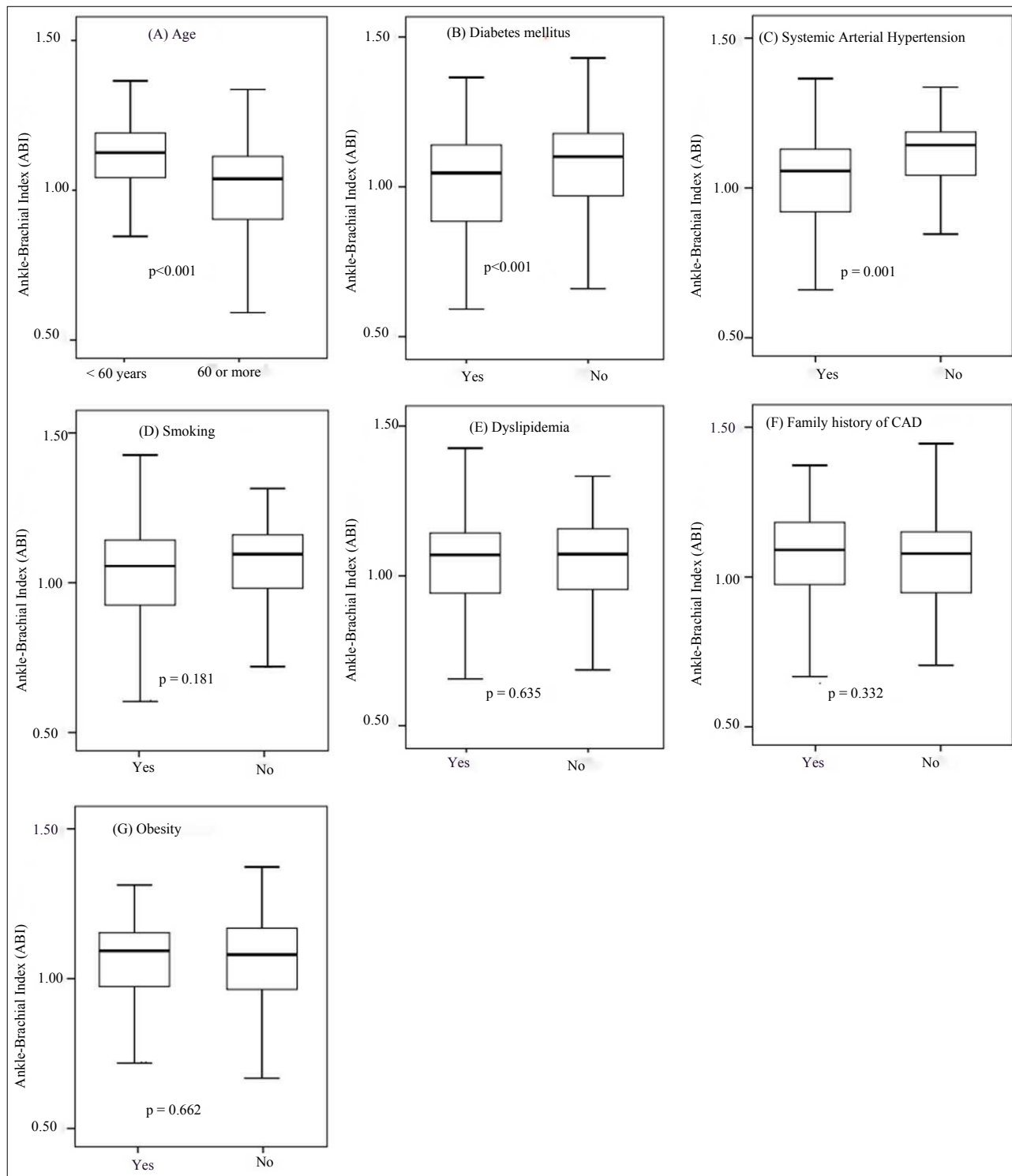
The second risk factor for PAOD relates to the presence of diabetes *mellitus*. The prolonged state of hyperglycemia in diabetes results in damage to the endothelial cells of blood vessels, thrombosis, and lipid deposition, with the additional formation of atherosclerotic plaque¹⁴. In a national study with 1,610

TABLE 1. SOCIODEMOGRAPHIC CHARACTERIZATION OF INDIVIDUALS WITH CORONARY ARTERY DISEASE (CAD) INCLUDED IN THE STUDY, ALAGOAS, BRASIL, 2019. (N=156)

Variable	n	%
Sex		
Male	105	67.3
Female	51	32.7
Age range		
<60	74	47.4
\geq 60	82	52.6
Mean \pm SD	60.1 \pm 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 \pm SD	72.7 \pm 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)		
\leq 0.90	26	16.7
>0.90	130	83.3

Legend: CAD: Coronary artery disease.

FIGURE 1



individuals, 41.2% of patients with PAOD had diabetes (OR 8.77; $p < 0.001$)¹⁵. An investigation by Saleh et al.¹⁶ 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 risk¹⁷. 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 individuals¹⁷. Similar results were also observed in pre-hypertensive individuals, whose OR was 3.28, in a comparative study with normotensive individuals¹⁸.

Although smoking is another risk factor, only 20.5% ($n = 17$) of smokers presented PAOD ($ABI \leq 0.90$),

with no significant association ($p=0.173$). This non-significance also was reported by Sarmiento et al.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%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 dyslipidemia²⁰, 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 CAD²¹, and in research performed in Porto Alegre-RS, in which the ratio was 56.6% ($n=17$)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 ($p=0.20$)²³, and in the study conducted by Kock et al.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		p-value ¹	OR ²	CI 95%
	≤ 0.90 n=26 (16.7%)	> 0.90 n=130 (83.3%)			
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 ($p<0.05$); ¹ Chi-square or Fisher exact; 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 and arterial hypertension. Therefore, the utilization of the ABI to identify and stratify the risks of asymptomatic PAOD in CAD patients is a tool that should be valued in clinical practice. In addition, further studies

with a larger population should be conducted to clarify the effects of dyslipidemia, smoking, family history, and obesity on the risk of PAOD.

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.

RESUMO

OBJETIVO: Analisar a associação entre o ITB e os principais fatores de risco para doença arterial coronariana em indivíduos coronariopatas.

MÉTODOS: Foram selecionados 156 pacientes adultos de um hospital de Maceió, Alagoas. Foram avaliados como fatores de risco idade, obesidade, hipertensão, diabetes mellitus, tabagismo e dislipidemia. A triagem da DAOP foi realizada pelo índice tornozelo-braquial (ITB). Foram utilizados os testes de Mann-Whitney, qui-quadrado e exato de Fisher. Intervalo de Confiança de 95% e significância de 5%.

RESULTADOS: 67,3% (n=105) do sexo masculino, 52,6% (n=82) idosos, 23,1% (n=34) obesos, 72,4% (n=113) hipertensos, 34,6% (n=54) diabéticos, 53,2% (n=83) tabagistas, 34,6% (n=54) dislipidêmicos e 70,5% (n=110) com história familiar de DAC; 16,7% (n=26) dos indivíduos apresentaram DAOP. Três fatores foram associados à DAOP: faixa etária ≥ 60 anos (OR:3,656; $p=0,005$), diabetes mellitus (OR:2,625; $p=0,024$) e (OR:5,528; $p=0,008$). Não foi observada diferença significativa nas variáveis tabagismo, dislipidemia, história familiar de DAC e obesidade.

CONCLUSÃO: Os fatores de risco independentes para DAOP foram idade, diabetes mellitus e hipertensão arterial sistêmica.

PALAVRAS-CHAVE: Índice tornozelo-braço. Doenças vasculares periféricas. Fatores de risco.

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