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# Epidemiology of Peripheral Artery Disease of Lower Limbs among Workers to Cotonou in 2013

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## Abstract

**Background:** Peripheral Artery Disease (PAD) is a real silent killer with a strong predictive value for cardiovascular cause mortality. We aim to assess the prevalence and factors associated with PAD among workers Cotonou city (BENIN).

**Methods:** It was a cross-sectional study from June to September 2013 conducted within three societies in Cotonou area. We have done a systematic recruitment among workers, aged 18 and over, who signed the consent document. PAD was retained when ankle brachial index was ≤ 0.90. Other data collected were information on cardiovascular risk factor and socio-demographic data. SPSS 17 software was used to perform data quantitative analysis.

**Results:** We registered 989 workers aged 23 to 78 years with a mean age of 52.3 ± 9.4 years. PAD was diagnosed in 47 (4.7%) among whom 2 (4.2%) had intermittent claudication. In univariate analysis, a significantly higher prevalence of PAD was found among workers with age ≥ 60 years (9.5% *vs.* 4.2%; p=0.015), female sex (8.0% *vs.* 3.8%; p=0.008), history of diabetes (11.5% *vs.* 4.2%; p=0.003) and hyperglycemia the date of survey (10.2% *vs.* 2.4%; p<0.001). After logistic regression analysis, age ≥ 60 years, female and diabetes history were independently associated with PAD.

**Conclusions:** The prevalence of peripheral artery disease (PAD) among population of Cotonou was high. Some factors associated with PAD in this study are classical risk factor for PAD. But tobacco use, hypertension and dyslipidemia were not associated with high prevalence of PAD. Further investigations are needed to assess the real risk factors of PAD among black African people.

## Keyswords:

Peripheral artery disease; Workers; Diabetes; Africa

## Introduction

Over recent years, cardiovascular diseases has grown and become the leading cause of mortality worldwide. Risk factors for atherosclerosis, which is the main cause of these diseases, have reached epidemic levels in poor countries [1]. In fact, rapid unplanned urbanization has promoted the development of obesity, hypertension and diabetes. This is a result of unhealthy environment that encourage consumption of fast food, sedentary behavior, tobacco use and the harmful use of alcohol. Major clinical manifestations of atherosclerosis include transient ischemic attack, ischemic stroke, angina pectoris, myocardial infarction and peripheral arterial disease (PAD) [2]. PAD is typically asymptomatic before progressing to clinical stages such as intermittent claudication or limb ischemia [3]. This asymptomatic feature of PAD contrasts with its prognostic value. PAD patients have a widespread arterial disease and develop much more coronary artery disease and cerebro-vascular disease than healthy people [4]. So, PAD is a real silent killer with a strong predictive value for cardiovascular mortality. The screening is then necessary. Johnston et al. in their review noted that African's PAD prevalence ranged from 3.1% to 24% of adults aged 50 years [5]. In Benin, which is a poor country, it's almost impossible to perform this screening in general population. Knowing that, each year, workers have a check-up, we decide to focus this screening on this population. We report in this paper, the prevalence and factors associated with PAD among workers to Cotonou in 2013.

## Methods

### Study design, setting and sampling

It was a cross-sectional study from June to September 2013. Before we started the study, letters were sent to all companies where annual checkup was performed in Cotonou area. Only three companies accepted to participate to the survey. There was Autonomous Markets Management Society (SOGEMA), Beninese Society of Dock Work (SOBEMAP) and the Group of Retired Military (MR). All the staff of

these companies who participated to the annual checkup in 2013 where included.

The minimum sample size was estimated to 753 by using Schwartz formula n=1,962 p(1-p)/i2 where p=4% was the reported prevalence of PAD in general population [5] and i=1% was the error risk. The recruitment was systematic for all workers, aged 18 and over, who signed the consent sheet.

## Data collection

A structured interview was used by a trained seventh year medical student to record details on hypertension, diabetes, smoking, alcohol intake, and physical activity. Education was classified as illiterate, primary (up to 4 years of primary education), secondary (up to third year of secondary education) or higher (higher education with or without graduate degrees). Individuals were classified as non-smokers (never smoked) and smokers (former smokers and current smokers). Alcohol intake was categorized as none and alcoholism (social and regular). Origin, sex, education, occupation, and marital status were defined as demographic variables.

The anthropometric indices measured included waist circumference, height, body weight, and the body mass index (BMI) in weight/height ($kg/m^2$). Waist circumference was determined by applying a tape measure to the midpoint between the inferior margin of the last rib and the crest of the ilium.

Fasting blood samples were taken for the determination of the parameter of the lipid profile: total cholesterol (chT), high density lipoprotein cholesterol (chHDL) and triglyceride (TG). Total cholesterol, HDL cholesterol and triglycerides were measured through standard enzymatic methods with an automated multi-parameter analyzer (Rayto Chemray 120). The low density lipoprotein cholesterol (ch LDL) level was obtained through calculation by using the Friedewald's formula (chLDL=chHDL-1/5TG) when the values of TG were less than 4 g/L [6].

### Measurement of ankle brachial index (ABI)

Measurement of systolic pressures of the four limbs was performed in all patients. A standard sphygmomanometer (Spengler) with a manually operated blood pressure cuff (15 cm-wide bladder) and a handheld Doppler ultrasound (Vascular Doppler 8 MHz, Hedeco, Japan) were used for ankle pressure. OMRON electronic manometer served for humeral systolic pressure. The participant was installed in a quiet room, supine for at least 5 min before measurement. Right and left arm and ankle (posterior tibial artery and dorsalis pedis artery) systolic blood pressures were measured by the trained investigator. A cycle of measurements (right arm, right ankle, left ankle, left arm) was repeated. The ABI of each leg was calculated by dividing the higher of the dorsalis pedis or posterior tibial pressure by the higher of the right or left arm blood pressure [7].

### Diagnostic criteria

The diagnostic of PAD was based on the ABI which is interpreted as follows [7]

- PAD if ABI ≤ 0.90 (moderate obstruction if 0.40–0.90; severe obstruction if <0.40)
- Artery poorly compressible if >1.30
- Normal if 0.91–1.30.

The diagnosis of diabetes was based on past medical history, drug treatment or diabetes (insulin or oral hypoglycemic agents), and/or if fasting glycemia level was 1.26 g/L and/or the 2 hour post prandial glycemia level was 2 g/L. Hypertension was said to be present in the person known to have a history of hypertension, or who was using medication, or whose blood pressure was ≥ 135/85 mmHg after ambulatory self blood pressure monitoring. Dyslipidemia was retained when total cholesterol >2 g/L and/or HDL cholesterol <0.40 g/L and/or triglycerides >1.50 g/L and/or LDL cholesterol >1.30 g/L [8].

Body mass index (BMI) was estimated by dividing kilograms of weight by height in meters squared and was categorized according to the classification system established by the National Institutes of Health (<25.0 to 30 and ≥ 30.0 $kg/m^2$) [9].

### Statistical analysis

SPSS 17 software (SPSS for Windows, Version 17.0, IL, USA) was used to perform data quantitative analysis. The qualitative variables were presented in the form of percentage and the quantitative ones were in the form of average and standard deviation. Student t test helped compare the averages. Chi-square independence test was used to determine the relationship between outcome and predictive variables. Significance level was 5%.

## Results

### General characteristics of study sample

We recruited 1024 persons and 35 of them were excluded for missing variables of interest. Thus, the sample size was 989 participants (Figure 1). The age range was 23 to 78 years with a mean age of 52.3 ± 9.4 years and the modal age range was 50 to 59 years. There were 765 men (77.3%) giving a sex-ratio of 3.41. According to risk factors, 78 (7.9%) were diabetics, 259 (26.2%) had hypertension, 77 (7.8%) were tobacco users, dyslipidemia was seen among 54 (5.5%) participants and 285 (28.8%) have abdominal obesity. At least one risk factor was present in 563 (56.9%) participants. Other clinical parameters are shown in Table 1.

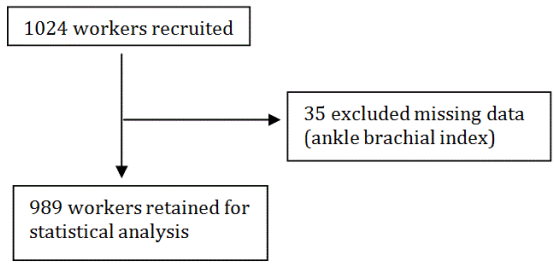


**Figure 1:** Recruitment of workers for screening of Peripheral Artery Disease (PAD) among workers to Cotonou in 2013.

### Prevalence and clinical features of PAD of lower limbs

The mean value of ABI was 1.1 (right and left side). The interpretation of ABI values is presented in Table 2. PAD was diagnosed in 47 workers giving a prevalence of 4.7%. Among workers with PAD, 2 (4.3%) had intermittent claudication. The PAD was

bilateral in 40.4%. No case of severe obstruction was recorded. These data are detailed in Table 2.

| | Frequency | Percentage |
|---|---|---|
| Age rage (years) | | |
| ≤ 40 | 129 | 13.0 |
| 41 to 59 | 755 | 76.4 |
| ≥ 60 | 105 | 10.6 |
| Sex | | |
| Male | 765 | 77.4 |
| Female | 224 | 22.6 |
| Level of education | | |
| Illiterate | 239 | 24.2 |
| Primary | 108 | 10.9 |
| Secondary | 388 | 39.2 |
| Higher | 254 | 25.7 |
| Cardiovascular risk factors | | |
| High blood pressure | 259 | 26.2 |
| Diabetes | 79 | 8 |
| Hyperglycemia the day of the survey | 293 | 29.6 |
| Tobacco use | 73 | 7.4 |
| Dyslipidemia | 236 | 23.9 |
| Body Mass Index ≥ 30 kg/m² | 333 | 33.3 |
| Abdominal obesity | 285 | 28.8 |
| Number of cardiovascular risk factor | | |
| 0 | 426 | 43.1 |
| 1 | 226 | 22.9 |
| 2 | 199 | 20.1 |
| ≥ 3 | 138 | 13.9 |

**Table 1:** General characteristics of study sample on epidemiology of Peripheral Artery Disease among workers to Cotonou (Benin) in 2013.

## Determinants of PAD within workers

In univariate analysis, a significantly higher prevalence of PAD was found among workers with age ≥ 60 years (9.5% *vs.* 4.2%; p=0.015), female sex (8.0% *vs.* 3.8%; p=0.008), history of diabetes (11.5% *vs.* 4.2%; p=0.003) and hyperglycemia the date of survey (10.2% *vs.* 2.4%; p<0.001). There were no significant differences in prevalence of PAD among workers with and without other classical cardiovascular risk factors such as hypertension, tobacco use, dyslipidemia and obesity (Table 3).

In logistic regression, age ≥ 60years, female and diabetes history were independently associated with PAD (Table 4).

| | Frequency | Percentage |
|---|---|---|
| Ankle Brachial Index (n=989) | | |
| <0.9 | 47 | 4.7 |
| 0.9 to 1.3 | 893 | 90.3 |
| ≥ 1.3 | 49 | 5 |
| Clinical features of PAD (n=47) | | |
| Asymptomatic | 45 | 95.7 |
| Intermittent claudication | 2 | 4.3 |
| Ulcer | 0 | 0 |
| Side of PAD (n=47) | | |
| Right | 14 | 29.8 |
| Left | 14 | 29.8 |
| Bilateral | 19 | 40.4 |

**Table 2:** Prevalence and clinical features of peripheral artery disease (PAD) of lower limbs among workers to Cotonou in 2013.

| | PAD N(%) | No PAD N(%) | p value |
|---|---|---|---|
| Age (years) | | | 0.015 |
| <60 | 37(4.2) | 847(95.8) | |
| ≥ 60 | 10(9.5) | 95(90.5) | |
| Sex | | | 0.008 |
| Male | 29(3.8) | 736(96.2) | |
| Female | 18(8.0) | 206(92) | |
| Level of education | | | 0.143 |
| Illiterate | 18(7.5) | 221(92.5) | |
| Primary | 0(0.0) | 108(100.0) | |
| Secondary | 20(5.1) | 368(94.9) | |
| Higher | 9(3.5) | 245(96.5) | |
| High blood pressure | | | 0.36 |
| Yes | 15(5.9) | 244(94.1) | |
| No | 32(4.4) | 698(95.4) | |
| Diabetes | | | 0.003 |

| | | | |
|---|---|---|---|
| Yes | 9(11.5) | 69(88.5) | |
| No | 38(4.2) | 873(95.8) | |
| Hyperglycemia the day of the survey | | | <0.001 |
| Yes | 30(10.2) | 263(89.8) | |
| No | 17(2.4) | 679(97.6) | |
| Tobacco use | | | 0.454 |
| Yes | 5(6.3) | 72(93.7) | |
| No | 42(4.6) | 870(95.4) | |
| Dyslipidemia | | | 0.259 |
| Yes | 8(3.4) | 228(96.6) | |
| No | 39(5.2) | 714(94.2) | |
| Body Mass Index ≥ 30 kg/m² | | | 0.71 |
| Yes | 17(5.1) | 316(94.9) | |
| No | 30(4.6) | 626(95.4) | |
| Abdominal obesity | | | 0.857 |
| Yes | 13(4.6) | 272(95.4) | |
| No | 34(4.8) | 670(95.2) | |
| Number of cardiovascular risk factors | | | 0.095 |
| 0 | 15(3.5) | 411(96.5) | |
| 1 | 11(4.9) | 215(95.1) | |
| 2 | 16(8.0) | 183(92.0) | |
| ≥ 3 | 5(3.6) | 133(96.4) | |

**Table 3:** Factors associated with Peripheral Artery Disease (PAD) among workers to Cotonou in 2013.

| Factors | RR [CI 95%] | Significance |
|---|---|---|
| Age ≥ 60 years | 1.257 | <0.0001 |
| Sex Female | 2.224 | <0.0001 |
| Diabetes | 3 | <0.0001 |
| Hyperglycemia the day of the survey | 2.928 | 0.0789 |
| Tobacco use | 1.344 | 0.1237 |
| Dyslipidemia | 0.291 | 0.5431 |
| Body Mass Index ≥ 30 kg/m² | 1.121 | 0.1222 |
| Abdominal obesity | 0.987 | 0.0999 |
| Number of cardiovascular risk factors ≥ 3 | 1.921 | 0.3477 |

**Table 4:** Results of logistic regression analysis for factors associated with Peripheral Artery Disease (PAD) among workers to Cotonou in 2013.

## Discussion

This study carried out in Cotonou city, was the first community based prevalence survey in Benin. Our previous in hospital study showed that this disease was more prevalent, precocious and severe among diabetics in Benin [10,11]. This population based study was necessary to assess the real prevalence of PAD in general population in one Beninese city. Because of financial limitations, we were obliged to conduct it in societies where annual checkup was performed in Cotonou area. This study may be subject to survival/selection bias, in that individuals with chronic disease or severe risk factors were less likely to participate in the survey. So, it is possible that the prevalence of PAD in the present study underestimates the right prevalence in the general population. However, this study provides arguments for the implementation of policies to combat this life threatening disease which is PAD [4] in Benin. For this screening, we used ABI and a values of ABI ≤ 0.9 allowed us to make the diagnosis of PAD. This test is validate for such kind of screening because its sensibility and specificity are high [7].

We found out the prevalence of 4.7% for PAD in the city of Cotonou. This prevalence is widely lower than those reported in hospitals. In fact, we obtained 41.9% among diabetics to Parakou's teaching hospital in 2013 [10]. For Houenassi et al. it was 25.9% among hypertensive patients and 33.3% among diabetics to teaching hospital of Cotonou [11,12]. There is a dearth of study in general population on PAD using ABI from West Africa. Johnston et al. in their review noted that African's PAD prevalence ranged from 3.1% to 24% of adults aged 50 years and older and 39% to 52% of individuals with known risk factors (eg, diabetes) [5]. In their systematic door-to-door survey, Guerchet et al. reported prevalence of 15% and 32.4% in general population over the age of 65 years in Bangui (Central African Republic) and Brazzaville (Congo) [13]. In our study PAD was noted in 9.5% of subjects aged 60 years and other. From these data, PAD seems less prevalent in our population. The prevalence reported in the present study was lower than that reported in studies from European countries [14]. However, we have to consider the wide variation of prevalence of PAD through studies. For example, despite using similar diagnostic criteria, estimates of PAD prevalence in the United States have ranged from 3% to 30% in US adult populations [15,16]. In Sri Lanka, estimated prevalence of PAD among the age group of 40–74 years was 3.6%. This variation is the fact of age ranges which are different in studies. We included in our survey workers aged from 23 to 78 years, contrary to other studies where subjects were often aged 40 years and more. The benefit of our work is that it allowed us to know that 10/47 cases of PAD (21.3%) were aged between 23 and 40 years. This interval of younger subjects was neglected in other works. Studies should henceforth take into account the precocity and severity of cardiovascular diseases in black study as shown by Turner et al. [17].

The prevalence of PAD grows with age. Our data confirmed this trend. According to Framingham study, age ≥ 60 years was a great risk factor for PAD [16]. We noted that PAD was more prevalent in females and the difference was significant. There is consistent evidence to support an age-related increase in trend [18]. Literature reveals no consistent evidence to support differences in the prevalence of PAD between the sexes. Some studies have found a significant difference in the prevalence between males and females [18], while others have not [19]. This study showed positive association between PAD and diabetes. This association is common and epidemiological studies have confirmed an increased prevalence of PAD among diabetics [10,20]. The risk of PAD is markedly increased among individuals with diabetes, and ischemic event rates are higher in diabetic individuals with PAD than in comparable non-diabetic populations. Consequently, early diagnosis and treatment of PAD in patients with diabetes is critically important in order to reduce the risk of cardiovascular events, minimize the risk of long-term disability, and improve quality of life. We noted higher prevalence of PAD among patient with high level of glycemia the date of the survey. According to Selvin et al. the degree of diabetic control is an independent risk factor for PAD; with every 1% increase in glycosylated hemoglobin, the risk of PAD has been shown to increase by 28% [14]. The risk of PAD is associated with advancing age and the presence of peripheral neuropathy or other cardiovascular disease [10,21,22]. Our study found no association between tobacco use and PAD, hypertension and dyslipidemia. We observed this lack of association in our previous work among diabetics [10]. Houenassi et al. reported same data whereas [11,12]. Pessinaba et al. found out a slight difference of PAD prevalence among smokers and non smokers [22]. Contrary to these data, Fowkes et al. found smoking to be associated with a significantly higher relative risk for PAD compared with other cardiovascular disease [23]. In the Health Professionals Follow-up Study (HPFS), smoking was associated with increased risk of incident clinical PAD even after 20 years of smoking cessation, although this association was substantially diminished beyond 10 years after quitting smoking cigarettes [24]. These surprising data from our study may be due to many reasons. First, the low prevalence of smokers in this population [10-12]. Secondly, the particularity of PAD in Blacks. According to Genetic Epidemiology Network Of Arteriopathy (GENOA), black people were at high risk of PAD and this risk was not explained by traditional risk factors [25]. Criqui et al. reported that black ethnicity was a strong and independent risk factor for PAD, which was not explained by higher levels of diabetes, hypertension, and body mass index. There was no evidence of a greater susceptibility of blacks to cardiovascular disease risk factors as a reason for their higher PAD prevalence. The reason of this excess risk of PAD in blacks remains unexplained and requires further study [26]. The third reason might be related to inflammation. Inflammation is an established risk factor for the development of atherosclerosis and elevated levels of C-reactive protein (CRP) are strongly associated with the development of PAD. In fact, CRP has procoagulant effects related to its ability to enhance expression of tissue factor [27]. It also inhibits endothelial cell nitric oxide (NO) synthase, resulting in abnormal regulation of vascular tone, and increases production of plasminogen activator inhibitor [21,28]. Thus inflammation leads to endothelial cell dysfunction which increases arterial susceptibility to atherosclerosis. Futhermore, Murabito et al. had demonstrated that Interleukin-6 and TNFR2 were significantly associated with PAD independent of established risk factors [29]. Unfortunately, the assay of these inflammatory markers where not possible at the moment of this study and were not considered in our analysis.

## Conclusion

The prevalence of peripheral artery disease (PAD) in population of Cotonou was as high as in other country of Africa. Some factors associated with PAD in this study are classical risk factor for PAD. But tobacco use, hypertension and dyslipidemia were not associated with high prevalence of PAD. Further investigations are needed to assess the real risk factors of PAD among black African people.

## Ethical Considerations

The Ethics Review Committee to Faculty of Health Sciences in Cotonou approved the survey design. Informative notice of consent was obtained from all workers prior to participation. Data confidentiality was guaranteed.

## Conflict of Interest

None

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