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Epidemiology of Peripheral Artery Disease in Elder General Population of Two Cities of Central Africa: Bangui and Brazzaville

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WHAT THIS PAPER ADDS

- This paper reports the first study investigating peripheral artery disease (PAD) in the older general population of two countries of Central Africa. The reported prevalence is very high. Adjusted to age, regular alcohol consumption was protective whereas hypertension was associated with prevalent PAD. Diabetes and smoking showed different associations according to gender and city.
- This survey highlights the burden of PAD in sub-Saharan Africa. Further studies are required to refine the specificities in terms of associated risk factors in this global region.

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ABSTRACT

Objectives: Peripheral artery disease (PAD) is a common condition in Western countries, mostly in the elderly. Little is known about the epidemiology of PAD in Africa. We sought to determine the prevalence of this condition in the elderly in two community-dwelling cohorts in Central Africa.
Design: Prospective cross-sectional survey in general population over the age of 65 years in Bangui (Central African Republic) and Brazzaville (Congo).
Methods: We conducted a systematic door-to-door survey in two representative districts of each city. Demographic, clinical and biological data were collected. The ankle-brachial index (ABI) was used to detect PAD (ABI $\leq$ 0.90).
Results: Among the 976 participants, the prevalence of PAD was 15.0% in Bangui and 32.4% in Brazzaville, increasing with age. Adjusted to age, regular alcohol consumption was protective for women in Bangui (OR = 0.50, CI95%:0.25–0.98) and men in Brazzaville (OR = 0.43, CI95%:0.21–0.88). Hypertension was associated with PAD in women (OR = 4.14, CI95%:1.65–10.42 in Bangui and OR = 2.17, CI95%:1.16–4.06 in Brazzaville). Diabetes and smoking showed different associations according to gender and city.
Conclusions: This first population study in Central Africa highlights the high prevalence of PAD in the older population, and emphasizes specificities regarding the risk factors, being different from data published in Western countries.

Introduction

The epidemiology of lower-extremity peripheral artery disease (PAD) has been extensively described, mostly in North America and

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European countries. These studies reported an increased prevalence of PAD with age, particularly after the age of 60.[1] Major cardiovascular disease (CVD) risk factors have been reported as significantly associated with PAD,[1,2] including cigarette smoking, diabetes, hypertension and dyslipidemia.[3]

Ethnicity is also suggested as a strong and independent risk factor for PAD. In the United States, people of African descent are at 2–3 fold higher risk of PAD compared to non-Hispanic Whites, even adjusted for other CVD risk factors.[3,4] Higher levels of some atherogenic, inflammatory or prothrombotic factors or greater genetic susceptibility have been suggested to explain this increased risk.[3] In contrast, data on native African people are very sparse. Only one population-based study carried out in a rural population of South Africa reported a prevalence of PAD over 25% for those >60 years of age.[5]

To date, there are no published data on the epidemiology of PAD in general populations of Central Africa. We initiated an epidemiological study to determine the prevalence and risk factors for PAD in the general population aged ≥65 years living in Brazzaville, Congo and Bangui, Central African Republic (CAR) (Fig. 1). We hypothesized that the prevalence of PAD in these populations is high, with potential specificities regarding the associated risk factors.

Methods

Study design

From September 2008 to March 2009, we performed two successive cross-sectional studies in two representative districts of Bangui and Brazzaville. Congo and the CAR have relatively different social, demographic and economic characteristics (Table 1).

A door-to-door survey was conducted by local investigators in the 3rd district of Bangui and the 4th district of Brazzaville. Multiethnic characteristics and feasibility guided the selection of these districts. Field investigators were familiar with the area they were assigned to, visiting each small community and asking for old people (aged ≥65 years). Each house visited was marked by the investigators (name of the study, number of the investigator and subject) with chalk, just above the door, ensuring exhaustive coverage, even in the absence of addresses. In case of absence of inhabitants during the day of screening, houses were revisited another day. Town halls were informed of the study, and district chiefs were visited prior to starting the screening in order to increase awareness of the study.

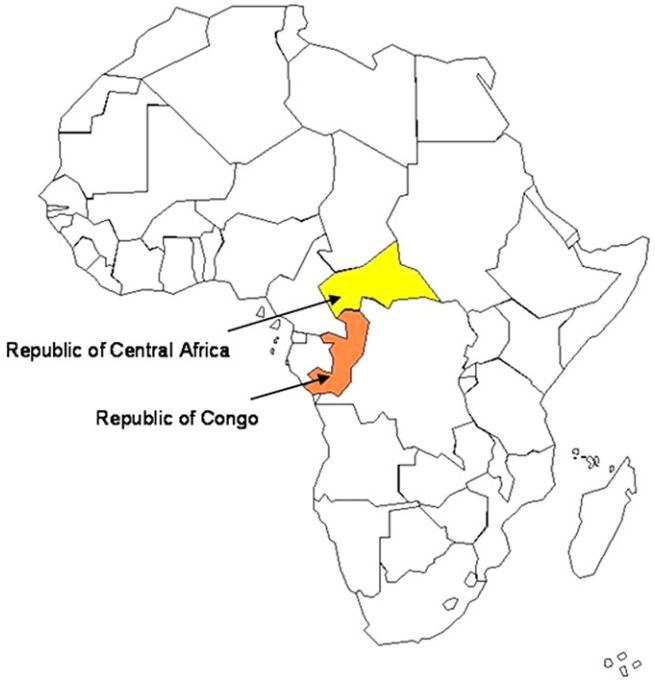

Figure 1. Republic of Central Africa and Republic of Congo.

Every subject aged ≥65 years currently living in the area was contacted and asked to participate in the research. Exclusion criteria were refusal to participate or the presence of severe comorbidities precluding interview of the subject.

The surveys were approved by ethical committees of the CAR and Republic of Congo, supervised by the Ministry of Public Health or Scientific Research. Written consent was obtained whenever feasible. For illiterate subjects, the purpose of the study was verbally explained and the consent was obtained by fingerprint marks.

Ten field investigators in each city were trained to use the questionnaire for data collection and to do the examination (including ABI measurement). The technicians, who were actually medical residents, were trained by three of the authors (MG, JS and PL) during one intensive week, and verification was obtained that their results at the end of the training were similar to those of the experts. We followed the same protocol used in our core laboratory in France, where reproducibility has already been assessed and published.[6] The whole study was supervised by local specialists (PM, AT, AMM, BB) and an epidemiologist (MG) to ensure the correct execution of the different tasks by the investigators. Briefings were done after each day of field work, when each questionnaire was checked to avoid missing data and discrepancies.

Cardiovascular risk factors

Demographic data, including marital status, education level (none versus primary school or higher) and occupation, were collected. Age was ascertained by official documents (national identity cards, passports, birth certificates). In the case of absence of these documents or discrepancy between document and participant's report, age was ascertained from an informant or through a local event calendar. Age was estimated using two historical landmarks in each country, by a validated method.[7,8]

Medical history was assessed through self-reports, particularly any history of CVD, and treatment history, if available. Alcohol consumption was assessed and classed into two groups: occasional/regular consumption versus none. For tobacco use, subjects were classed as non-smokers (former or never) and current smokers. Clinical and biological data were recorded to determine the traditional CVD risk factors. Height (cm) and weight (kg) were measured

Table 1
Global socio-economic characteristics of the two cities. Data from WHO Country Health Profiles and UNDP statistics.[a]

	Bangui	Brazzaville
Number of inhabitants	622,800	1,493,279
Estimated number of people ≥65 years	8,719	31,588
Density of population (inhabitants/km^2)	6.0	8.5
Human Development Index	0.315	0.489
Human Development Index rank 2010 (/169)	159	126
GDP per capita (PPP US$, 2008)	766	4583
Multidimensional Poverty Index	0.512	0.208
Life expectancy at birth (years)	48	55
Men	49	53
Women	48	57

Multidimensional Poverty Index measures mean percentage of deprivation if deprivation of poor households were uniformly reported in the population.
GDP: Gross domestic product.
[a] http://www.who.int/countries/en/ and http://hdr.undp.org/en/statistics/.

in order to determine the body mass index (BMI = weight divided by squared height). Hypertension was defined in the case of history of hypertension and/or when systolic blood pressure at rest was ≥140 mmHg and/or diastolic blood pressure was ≥90 mmHg. Diabetes was defined according to medical history or in the case of elevated capillary blood glucose level (Accu-Chek® Performa, Roche), above 140 mg/dL if the fasting period >2 h or above 200 mg/dL in non-fasting participants.

ABI measurements and PAD definition

Systolic blood pressure (SBP) was measured in both arms with the subject in the supine position. Hand-held Doppler ultrasound devices (SuperDopplex II, Huntleigh Technology, Luton, UK) were used to measure SBPs of posterior tibial and dorsal pedis arteries in each leg. In each ankle the ABI was determined using the highest ankle artery SBP, except if an ABI was ≤0.90 while the other was ≥1.40. In this case, the leg was categorized with an ABI ≤0.90. For each subject, ABI was determined by the lowest ABI between the two ankles, except when one leg had an ABI ≥1.40 while the other presented a normal ABI (>0.90). Only in this case, the participant was categorized in the ABI ≥1.40 group. We defined PAD by an ABI ≤0.90.

Participants with leg ulcers, fractures, sores, edema, amputations or hemiplegia, preventing any ABI measures, were excluded from this analysis. For the analysis of risk factors for PAD, subjects with an ABI ≥1.40, indicative of medial calcinosis, have been excluded. In fact, in these patients we were unable to detect potential obstructive PAD.

Statistical analysis

The mean and standard deviation (SD) were used as summary statistics for quantitative variables (e.g. age, ABI), and compared using the Student's *t*-test. Numbers and percentage counts were used for all qualitative variables of interest, and Fisher's exact test was used for comparisons.

In order to determine independent risk factors associated with PAD, a multivariate logistic regression model with backward stepwise selection procedure included education level and CVD risk factors (BMI, hypertension, diabetes, alcohol and tobacco use) adjusted for age. Interactions between independent variables in the final model were examined. The level of significance for all the statistical analyses was fixed at 0.05.

Statistical analyses were carried out using SAS® software (version 9.2, SAS Institute, Cary, NC, USA).

Results

One-thousand and fifty-five people were contacted, out of whom 1016 (96.3%) agreed to participate. We screened 520 participants in Brazzaville and 496 in Bangui. Forty (3.9%) individuals (35 in Bangui, 5 in Brazzaville) were excluded because of non-attendance on the day of ABI measurement after acquired approval for participation ($n = 24$) or impossibility of measuring pressures (1 hemiplegia, 6 edema, 2 fractures, 2 sores, 1 leg ulcers, 2 Kaposi sarcoma and 1 technical problems). The remaining 976 participants (388 men and 587 women, age 73.6 ± 6.5 yrs) composed our study population. Mean age was significantly lower in Bangui than in Brazzaville (respectively 72.6 ± 6.1 yrs and 74.4 ± 6.7 yrs, $p < 0.001$). The characteristics of both cohorts are presented in Table 2.

Overall, the prevalence of PAD (ABI ≤ 0.90) in both countries was estimated at 24.2% (CI95%:21.5–27.0). Also, 127 participants (13.0%, CI95%:11.0–15.3) presented an ABI ≥1.40.

In Bangui, the prevalence of PAD was 15.0% (CI95%:11.8–18.5) (17.2% in women and 11.9% in men, $p = 0.15$). This value was

Table 2
Characteristics of study population, Central Africa, 2008–2009.

	Total		Total women		Total men		Bangui		Bangui women		Bangui men		Brazzaville		Brazzaville women		Brazzaville men	
	$n = 976$		$n = 587$		$n = 389$		$n = 461$		$n = 268$		$n = 193$		$n = 515$		$n = 319$		$n = 196$	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Sex																		
Men	389	39.9					193	41.9					196	38.1				
Women	587	60.1					268	58.1					319	61.9				
Age																		
65–69	329	33.7	196	33.4	133	34.2	185	40.1	108	40.3	77	39.9	144	28.0	88	27.6	56	28.6
70–74	253	35.9	149	25.4	104	26.7	126	27.3	72	26.9	54	28.0	127	24.7	77	24.1	50	25.5
≥75	394	40.4	242	41.2	152	39.1	150	32.6	88	32.8	62	32.1	244	47.3	154	48.3	90	45.9
Marital status																		
Single	31	3.2	10	1.7	21	5.4	19	4.1	7	2.6	12	6.2	12	2.3	3	0.9	9	4.6
Married/living as married	388	39.7	124	21.1	264	67.9	192	41.7	65	24.3	127	65.8	196	38.1	59	18.5	137	69.9
Divorced	73	7.5	50	8.5	23	5.9	30	6.5	17	6.3	13	6.7	43	8.3	33	10.3	10	5.1
Widowed	484	49.6	403	68.7	81	20.8	220	47.7	179	66.8	41	21.2	264	51.3	224	70.2	40	20.4
Primary education or higher	462	47.4	154	26.3	308	79.2	198	43.0	62	23.2	136	70.5	264	51.3	92	28.8	172	87.8
Job																		
Employed	302	30.9	30	5.1	272	69.9	123	26.7	4	1.5	119	61.7	179	34.8	26	8.2	153	78.1
Storekeeper	231	23.7	170	29.0	61	15.7	67	14.5	38	14.2	29	15.0	164	31.8	132	41.4	32	16.3
Farmer/breeder	339	34.7	328	55.9	11	2.8	214	46.4	205	76.5	9	4.7	125	24.3	123	38.6	2	1.0
No activity	17	1.7	17	2.9	0	0.0	7	1.5	7	2.6	0	0.0	10	1.9	10	3.1	0	0.0
Other	87	8.9	42	7.2	45	11.6	50	10.9	14	5.2	36	18.7	37	7.2	28	8.8	9	4.6
Mean BMI (±SD) kg/m²	22.7 ± 4.8		23.3 ± 5.3		21.8 ± 4.0		20.8 ± 3.8		21.0 ± 4.1		20.5 ± 3.4		24.5 ± 5.0		25.3 ± 5.4		23.2 ± 4.0	
Hypertension	632	64.8	411	70.0	221	56.8	259	56.2	168	62.7	91	47.2	373	72.4	243	76.2	130	66.3
Diabetes	144	14.7	87	14.8	57	14.7	30	6.5	18	6.7	12	6.2	114	22.1	69	21.6	45	23.0
Alcohol consumption																		
None	408	41.9	288	49.1	120	31.0	172	37.5	110	41.0	62	32.5	236	45.8	178	55.8	58	29.6
Occasionally/regularly	566	58.1	299	50.9	267	69.0	287	62.5	158	59.0	129	67.5	279	54.2	141	44.2	138	70.4
Tobacco use																		
Non-smoker	811	83.3	496	84.5	315	81.6	337	73.6	198	73.9	139	73.2	474	92.0	298	93.4	176	89.8
Smoker	162	16.7	91	15.5	71	18.4	121	26.4	70	26.1	51	26.8	41	8.0	21	6.6	20	10.2
PAD	236	24.2	156	26.6	80	20.6	69	15.0	46	17.2	23	11.9	167	32.4	110	34.5	57	29.1

significantly ($p < 0.001$) higher in Brazzaville: overall 32.4% (CI95%:28.4–36.6), with respectively 34.5% and 29.1% in women and men. In both cities, within the 65–69 yr age range the prevalence of PAD was higher in men than in women, and the sex ratio inverted in the older age groups (Fig. 2). The overall prevalence of PAD was found to be increasing with age in both cities (Fig. 2). However, an interaction between age and gender was found in Bangui, with increasing prevalence of PAD in women with age, while this prevalence decreased in older men (Fig. 2).

We found some disparities regarding risk factor distribution according to PAD status between the two cities. In Bangui, hypertension was significantly more frequent in subjects with PAD, while in Brazzaville alcohol consumers were less frequent among subjects with PAD.

Given these disparities between the two cities and genders, we ran four separate models adjusted for age to determine risk factors associated with PAD. In Bangui (Table 3a), the only risk factor significantly associated with PAD in males was diabetes. In female residents of Bangui, hypertension was significantly associated with PAD, while an inverse association was found with regular alcohol consumption. In male residents in Brazzaville, tobacco use was associated with PAD whereas regular alcohol consumption was protective (Table 3b). A borderline relationship between hypertension and PAD was also found. Among women in Brazzaville, only hypertension was significantly associated with PAD.

For sensitivity analysis, we performed a new set of multivariate analyses using an ABI $\leq$0.80 rather than $\leq$0.90, and found only an association between PAD and gender (OR = 1.65 for women, CI95%:1.01–2.72) and a borderline association for diabetes (OR = 1.56, CI95%:0.96–2.54) adjusted on city (data not shown).

Discussion

In line with the epidemiological transition observed in low income countries, this population-based study in Central Africa highlights the elevated prevalence of PAD in the elderly, respectively 15.0% in Bangui and 32.4% in Brazzaville.

Prior to this study, the only available data from a general African population were issued by the Southern African Stroke Prevention Initiative (SASPI) study in the sub-district of Agincourt in South Africa, where PAD was found in more than 25% of residents >60 years.[5] This prevalence rate is comparable with the average rates found in our two study cohorts. The prevalence of PAD in Central Africa is higher than reported in some North American studies. In the Multi-Ethnic Study of Atherosclerosis (MESA), the prevalence of PAD was 9.3% in participants >70 years,[9] and it was 12.4% in participants $\geq$65 years in the Cardiovascular Health Study (CHS).[2] In a literature review of the epidemiology of PAD (defined by an ABI <0.90), the prevalence of this condition was estimated at around 10% by age 65 years.[1] However, in the United States, the prevalence of PAD in the African American older population was higher, respectively 24.4% and 59.0% for men at age 70–79 and $\geq$80 years and 20.0% and 35.1% for women at age 70–79 and $\geq$80 years.[10]

By excluding from our estimates participants who did not have an ABI measurement because of leg ulcers or amputations, we might have excluded cases with symptomatic PAD. However, the causes of edema, sores and ulcers are multiple, especially in these countries with low levels of medical care. Notably, only 9 participants were excluded for these reasons. Also, an ABI $\geq$1.40 impedes the detection of obstructive PAD, although many participants with an ABI $\geq$1.40 may have this condition. We acknowledge that the prevalence of PAD reported might even have been underestimated.

Another important finding of this study is that within the same global region a high disparity regarding PAD prevalence may be observed. Albeit in neighboring countries, Brazzaville is overall more urban, with increased development of a Western way of life and higher socio-economic conditions compared to Bangui. We noticed substantial differences between the two cities regarding the prevalence of CVD risk factors. The prevalence of hypertension, diabetes and obesity was significantly higher in Brazzaville, while alcohol consumption and tobacco use were significantly more frequent in Bangui. Furthermore, the higher prevalence of PAD in Brazzaville is partly explained by a higher mean age compared to Bangui.

Among men living in Bangui, the prevalence of PAD decreases sharply with age, from 18% at 65–69 years to 3% at $\geq$75 years, whereas among women the prevalence increases from 11% to 24%. We hypothesize that the survival rate for men with PAD should be poorer than for women, because of low life expectancy and earlier occurrence of PAD in men than in women. Given the low life expectancy in this country (49 years for men, 48 years for women),[11] one could expect a selection process whereby subjects at very old ages were initially at low risk. This natural selection of subjects at low risk for PAD was less obvious in Brazzaville, where life expectancy is at least 5 years higher.[12] Such results here have never been found in Western cohorts where life expectancies are much higher. The low prevalence of PAD in men living in Bangui is also partly explained by the fact that the rate of medial calcinosis (ABI $\geq$1.40) were significantly higher in male participants in Bangui (data not shown). Although our findings require further confirmation, they highlight specificities of PAD epidemiology in developing countries, indicating that the data from industrialized countries cannot be extrapolated to countries with different social, economic and demographic characteristics.

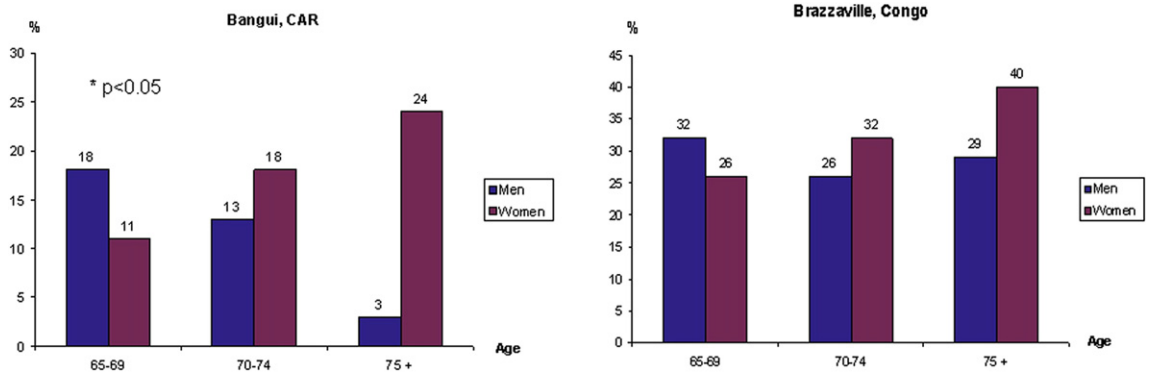

Figure 2. Prevalence of PAD by city and sex in Central Africa, 2008–2009.

Table 3
a: Models for risk factors associated with PAD, Bangui (CAR), 2008.

			Univariate analysis			Multivariate analysis adjusted for age		
			Unadjusted OR	95% CI	*p*-value	Adjusted OR	95% CI	*p*-value
Men ($n = 144$)	Schooling		1.12	0.42–2.96	0.820	2.63	0.83–8.37	0.102[a]
	Hypertension		1.67	0.66–4.23	0.280			
	Diabetes		4.39	0.91–21.09	0.065	5.56	1.02–30.23	0.047
	Alcohol consumption		2.01	0.70–5.79	0.196	3.02	0.92–9.87	0.067
	Tobacco use		0.89	0.30–2.62	0.837			
Women ($n = 230$)	Schooling		1.12	0.57–3.05	0.517			
	Hypertension		4.15	1.67–10.29	0.002	4.14	1.65–10.42	0.003
	Diabetes		0.85	0.23–3.10	0.808			
	BMI	<18.5	1.43	0.68–3.01	0.174			
		18.5 ≤ BMI ≤ 24.9	1.00	(reference)				
		25 ≤ BMI ≤ 29.9	2.67	1.05–6.79				
		≥30	2.67	0.46–15.60				
	Alcohol consumption		0.49	0.25–0.94	0.031	0.50	0.25–0.98	0.044
	Tobacco use		1.00	0.48–2.10	0.984			
b: Models for risk factors associated with PAD, Brazzaville (Republic of Congo), 2009.								
Men ($n = 180$)	Schooling		0.79	0.29–2.13	0.637			
	Hypertension		0.61	0.32–1.18	0.142	0.56	0.28–1.13	0.105
	Diabetes		1.39	0.68–2.85	0.372			
	BMI	<18.5	2.04	0.81–5.13	0.256			
		18.5 ≤ BMI ≤ 24.9	1.00	(reference)				
		25 ≤ BMI ≤ 29.9	0.70	0.31–1.56				
		≥30	1.27	0.35–4.66				
	Alcohol consumption		0.51	0.26–1.01	0.052	0.43	0.21–0.88	0.021
	Tobacco use		2.12	0.81–5.54	0.126	2.93	1.05–8.11	0.039
Women ($n = 294$)	Schooling		1.35	0.80–2.28	0.260			
	Hypertension		2.19	1.18–4.08	0.013	2.17	1.16–4.06	0.016
	Diabetes		1.09	0.62–1.93	0.758			
	BMI	<18.5	1.97	0.88–4.38	0.250			
		18.5 ≤ BMI ≤ 24.9	1.00	(reference)				
		25 ≤ BMI ≤ 29.9	1.38	0.77–2.47				
		≥30	1.70	0.89–3.26				
	Alcohol consumption		0.73	0.45–1.17	0.192			
	Tobacco use		1.18	0.44–3.20	0.742			

[a] Variable kept in the model due to confounding effects with alcohol consumption.

The association between hypertension and PAD was highly significant among the women of both cities, and borderline for men in Brazzaville. Hypertension is frequently associated with PAD in other populations, including in the elderly.[13,14] In the SASPI study, a higher systolic and diastolic blood pressure was also associated with a low ABI.[5] In Bangui, diabetes was found to be a strong risk factor associated with PAD in male participants. Most studies investigating diabetes and PAD in the elderly have found a significant and independent association between these two conditions.[2,15,16] The negative effects of tobacco smoking are confirmed for men living in Brazzaville. Surprisingly, tobacco use was more prevalent in Bangui (26.5% vs 8.0%, $p < 0.001$), although we did not find a significant association with PAD in this city. Past and current smoking has been associated with PAD in several studies from other countries, and seems to be the most consistent factor in Western countries.[2,12,14–16] Current smoking was the second risk factor for PAD in the SASPI study.[5] We did not assess the different modes of tobacco use, which may differ from one country to another in Africa.

Evidence for a protective effect of light-to-moderate alcohol consumption was found in several European or American cross-sectional studies.[14,17–19] Alcohol consumption was inversely associated with PAD in women in the Strong Heart Study[14] as well as the Rotterdam Study.[18] In contrast, alcohol consumption was not associated with ABI in women in the Edinburgh Artery Study.[20] A negative association between alcohol consumption and PAD was found to be significant in women living in Bangui and men living in Brazzaville, whereas a borderline positive association was found in men from Bangui. In the multivariate analysis, we found an interaction between gender and alcohol consumption in Bangui. This may be explained by different habits regarding alcohol consumption between genders: men are more regular drinkers than women (Table 2). Also, types and quantities of alcohol consumed may also differ between the sexes.

In our study, some limitations should be underscored. The differences observed in risk factor prevalences between the two cities and the presence of interactions with gender in multivariate analysis lead us to run several multivariate regression models. In consequence, the number of subjects included in each model was reduced (Table 3a and b), leading to a lower statistical power in our analyses. The lack of statistical power may have concealed the association of some 'traditional' risk factors with PAD, such as for smoking in some sub-populations of the study.

A few possible risk factors related to PAD were not collected during this study. Data on lipids are missing. We initially planned to assess blood cholesterol levels using capillary measurement, but we observed a high rate of missing data, inherent to technical issues in this specific setting (mainly related to elevated temperature altering the reactives). Consequently, we decided to exclude these data from the analysis. Similarly, data on renal function are lacking. Chronic kidney disease and PAD share several risk factors[1] but are also reported to be associated.[4]

This first population-based study in Central Africa emphasizes the high prevalence of PAD among the elderly. We show that rates vary substantially from one country to another, given differential rates of CVD risk factors as well as demographic, social and economic issues that may affect the development and progression of CVD. In addition, risk factors for PAD may differ substantially

compared to epidemiological data from Western countries. We advocate further and specific epidemiological studies from this continent, rather than implementing CVD prevention strategies in these countries issued from data obtained elsewhere.

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Conflict of Interest Statement

We have no conflict of interest.

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