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Epidemiology of lower extremity artery disease in a rural setting in Benin, West Africa: The TAHES study☆

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1. Introduction

Cardiovascular diseases (CVD) are the leading cause of death worldwide and are mainly due to atherosclerosis [1]. Lower extremity artery disease (LEAD) is one of the main localizations of atherosclerosis, but also a risk marker of cardiovascular events. Globally, 202 million people were living with LEAD in 2010 (more than people living with HIV), and 69.7% of them in Low and Middle-Income Countries (LMIC). During 2001–2010 the number of individuals with LEAD increased respectively by 28.7% in LMIC and 13.1% in High Income Countries (HIC) [2]. LEAD has been widely studied in HIC. In those studies, LEAD often appears after the age of 50 years old [3], and is associated with a high level of cardiovascular risk factors such as smoking, diabetes or hypertension [4,5]. When diagnosed by the ankle-brachial index (ABI), it affects more frequently women than men, more old than young people [2,6] and more often Blacks individuals than non-Hispanic Whites [7]. In addition, LEAD impairs quality of life and increases risk of major cardiovascular events (coronary and cerebral arterial diseases), amputation (>60%) and death [8,9].

Data available in Sub-Saharan Africa (SSA) are generally from specifics populations (surgery, diabetes, elderly) and show higher prevalence than in HIC (range from 15% to 32,4%), but with fairly marked disparities between neighboring countries, rural and urban areas [10–15]. Those disparities make it difficult to draw accurate conclusions about the burden of LEAD in Africa. There is a need for more comprehensive data that accounts for high prevalence of CVD in young subjects in LMIC [16]. Therefore, gathering additional evidence using standardized methods to measure LEAD is critical to better assess the disease distribution in LMIC [9].

Symptoms of LEAD are often absent, atypical or underestimated, leading to diagnosis in the most severe stages [17,18]. The use of ABI gives an objective measure with high level of specificity (83.3–99.0%) but variable levels of sensibility (15–79%) [19]. The ABI has been developed to facilitate detection of cases since it does not require expensive equipment. It is also considered to be the first-line screening test to define both symptomatic and asymptomatic LEAD, objectively in epidemiological studies, as well as in clinical settings [9]. It was therefore adopted as part of this work which aimed to describe the prevalence of LEAD and analyze associated factors in the “Tanve Health Study” (TAHES) cohort in Tanve, a village of Benin.

2. Methods

2.1. Study design and population

This study is part of TAHES, a population-based prospective CVD's cohort study started since 2015 at Tanve, a rural setting situated at 150 km north of Cotonou, the capital of Benin (West Africa). TAHES involved adults above 25 years old living in Tanve [20]. This study was based on the third annual visit of the cohort in 2017. Pregnant women were excluded. Informed consent was obtained from each patient and the study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a priori approval of the Benin national health's research ethics committee.

☆ Authors' statement: All the authors take responsibility for all aspects of the reliability and freedom from bias of the data presented and their discussed interpretation.

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2.2. Data collection

Demographic, lifestyle (alcohol, tobacco, sedentary, intake of fruit and vegetable), medical history (hypertension, diabetes), weight, height, blood pressure and blood glucose data were collected by 8 team of 3 trained investigators, using a questionnaire adapted from WHO STEPS tools [21] during a systematic door-to-door 15-days long survey in April 2017. The ABI measurements were performed from April to September 2017, by two experimented investigators (DS and MH) trained by a senior (PL).

2.3. Cardiovascular risk factors

The CVD risk factors were defined according to WHO STEPS Surveillance manual [22]. Tobacco smoking was defined as current or former smoker. Low intake of fruit and vegetable was defined as consuming less than five total servings (400 g) of fruit and vegetables per day. Sedentary behavior was defined as <150 min of moderate-intensity activity (walk, bicycle) per week, or equivalent. Harmful use of alcohol was defined as consumption of >60 g of alcohol for men or 40 g for women in one occasion within the last 30 days. Raised blood pressure (RBP) was defined as systolic and/or diastolic blood pressure ≥ 140/90 mm Hg in one of the two arms, or by currently receiving medication for hypertension. Raised blood glucose (RBG) was defined by fasting capillary whole blood glucose value ≥6.1 mmol/L or currently receiving diabetes medication. Body mass index (BMI) was calculated as weight divided by the square of tail in meters. Underweight was defined as BMI < 18.5 kg/m^2, overweight as 25 kg/m^2 ≤ BMI < 30 kg/m^2 and obesity as BMI ≥ 30 kg/m^2.

2.4. ABI measurements and LEAD definition

A standardized method following recommendations by the American Heart Association was used for ABI measurements [6]. Arm and ankle Systolic Blood Pressure (SBP) were measured using aneroid sphygmomanometer (SECA®, Chino, CA, United States) with accurate cuff size, and a hand-held Doppler ultrasound devices (Super Dopplex®II, Huntleigh Healthcare, Luton, UK). The SBP was measured on the subject in supine position after at least 15 min of rest, in each arm using brachial artery, and each ankle using posterior tibial (PT) and dorsal pedis (DP) arteries, following this sequence: right arm, right PT artery, right DP artery, left PT artery, left DP artery, and left arm. When SBP of the right arm exceeds the SBP of the left arm by >10 mm Hg, the SBP of the right arm have been repeated, and the first measurement disregarded.

In each ankle, the ABI was calculated by dividing the highest ankle artery SBP between PT and DP artery by the highest SBP between the two arms, 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 ankle had an ABI ≥ 1.40 while the other presented a normal or borderline ABI (>0.90). Only in this case, the participant was categorized in the ABI ≥ 1.40 group. LEAD has been defined by an ABI ≤ 0.90. ABI between 0.91 and 1.00 was considered as borderline and between 1.01 and 1.39 as normal. Subjects with an ABI ≥ 1.40 were defined as incompressible artery and excluded from the analysis of risk factors for LEAD.

2.5. Statistical analysis

The Shapiro-Wilk test was used to assess if the quantitative variables were distributed in a normal mode. If so, the mean and standard deviation (SD) were used as summary statistics, and compared between 2 groups using the Student's *t*-test. If not, median and percentile were used and the Mann Whitney's test performed for comparisons. Numbers and percentage counts were used for qualitative variables, and Fisher's exact test was used for comparisons. A multivariate logistic regression model was performed to identify associated factors for LEAD within demographic variables and CVD risk factors when *p*-value <0.20 in univariate logistic regression. Interactions between independent variables in the final model were examined. The threshold of significance for *p*-value was defined as $p < 0.05$. Statistical analyses were carried out using EPI INFO® 7.1.5.2 software.

3. Results

3.1. Sample description

A total of 1003 subjects were included out of 1407 individuals followed in TAHES in 2017. The missing ones were busy and were not examined until the time of analysis. A comparison of respondents and non-respondents showed no significant difference in age, sex and risk factors. The women represented 61.4% of the sample. The mean age was 44.4 ± 15.7 years (range: 25–96 years) and 49.9% were under 40 years. The mean age was comparable between men (44.5 ± 15.6) and women 44.4 (±15.7).

Modifiable behavioral risk factors estimations were 96.0% (95% of confidence interval (CI): 94.6%–97.1%) for low fruit and vegetable intake, 68.2% (95%CI: 65.2%–71.0%) for sedentary behavior, 3.9% (95%CI: 2.8%–5.3%) for harmful use of alcohol, and 5.2% (95%CI: 3.9%–6.8%) for tobacco smoking. For metabolic risk factors, prevalence were estimated at 36.8% (95%CI: 33.8%–39.9%) for RBP, 5.4% (95%CI: 4.1%–7.0%) for RBG, 10.7% (95%CI: 8.9%–12.8%) for underweight and 27.7% (95%CI: 25.0%–30.6%) for overweight or obesity. Significant differences were observed between male and female in the repartition of BMI, tobacco smoking and harmful use of alcohol (Table 1).

3.2. LEAD prevalence

The distribution of ABI was similar between the two legs: median (1st–3rd percentile) of ABI were respectively 1.07 (1,01–1,13) and 1.08 (1,00–1,12) for the right and the left leg. Prevalence of LEAD (ABI ≤ 0.90) was estimated at 5.5% (95%CI: 4.2%–7.1%) for the sample, 7.0% (95%CI: 5.1%–9.4%) for women and 3.1% (95%CI: 1.7%–5.5%) for men. Five individuals (0.5%; 95%CI: 0.2%–1.2%) had incompressible artery (ABI ≥1.40), including four men. (Table 1). Fig. 1 shows the distribution of ABI.

3.3. Associated factors

Univariate logistic regression showed a higher prevalence of LEAD among female ($p = 0.01$), subjects aged 55 and above ($p = 0.0004$) or with sedentary behavior ($p = 0.02$). But only age and sex were associated with LEAD after adjustment for others variables in multivariate logistic regression. No significant association was showed for the others explored risk factors (Table 2). An increase in prevalence of LEAD according to age range had been observed among women, when in men LEAD distribution seemed not related to age with the highest prevalence in the two extremes of age and the lowest in the middle (Fig. 2).

4. Discussion

This study presents an estimation of prevalence of LEAD among the largest sample thus far in a general adult population in SSA using ABI, including young adult from 25 years old. The LEAD prevalence was estimated at 5.5% and was related to gender and age.

The study then confirmed the lower prevalence of LEAD in LMIC than in HIC, the trend of higher prevalence with age, as much as the higher prevalence among women in SSA [2]. It also contributes to filling a gap of information about LEAD prevalence among adults in SSA as numerous previous studies were conducted among specifics populations like surgery, diabetes and subject >40 years old [23–26]. Beyond its cross-sectional design, this study was part of a cohort. Data gathered will then serve as a baseline prevalence for monitoring of LEAD's incidence afterward and assessing the prognostic value of the ABI in CVD incidence among this population. The study was conducted using standards tools; this will facilitate comparability and aggregation with data from others studies to contribute to a better understanding of LEAD distribution in SSA.

The prevalence of LEAD in this study is consistent with the previously reported in other studies conducted in SSA, especially in Benin [27]. Indeed, as oppose to the observations in Western countries, LEAD prevalence seemed to be higher in SSA among women than men. It corroborates observations that in SSA, more women live with LEAD (9.85 versus 4.39 million) [28]. An age-related upward trend was also observed among women. On the other hand, for men, a decreasing prevalence of LEAD was observed from the lowest age groups up to 44–55 age range, followed by an increase, resulting in a comparable LEAD prevalence among the youngest men 25–35 age range and the oldest >65 years old. It may confirm that compared to Europe and North America, where the bulk of people with lower extremity artery disease is above 55 years, most LEAD cases in sub-Saharan Africa were noted among younger people (<55 years) [28]. High prevalence of LEAD (rate from 3.69% to 7.08%) was also estimated for 25–54 ages

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