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Research Article

The Correlates of Atrial Fibrillation in a Random Sample of Congolese Inhabitants of the City of Kinshasa, the Democratic Republic of the Congo

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Abstract

Objective: To assess the prevalence of atrial fibrillation (AF) and its associated cardiovascular risk factors in the city of Kinshasa, DR Congo. **Methods:** From August to September 2022, 2641 inhabitants of Kinshasa aged ≥45years were visited at home by trained observers who collected information on lifestyle habits, use of modern or traditional medicine for chronic diseases and measured body weight, height, blood pressure and heart rate. They used Alivecor Kardia Cardia device to screen for AF and a 12-lead ECG for confirmation. The likelihood of AF was modelized in a multivariable logistic regression analysis. **Results:** Suspected in 118 participants (4.6%), AF was confirmed in 108 subjects (4.2%) arguing for intrinsic validity of the Alivecor Kardia Cardia with 100% NPV and sensitivity, and 99.6% specificity compared to standard 12 lead-ECG. AF prevalence was higher (p=0,018) in men (5.2%) than women (3.4%), in participants with higher monthly income (p<0.001) and increased with age (p<0.001). Hypertension (58,2vs39.4%), dyslipidaemia (22.2vs2.9%), heart failure (36.1vs1.9%), stroke (13vs3.3 %), previous myocardial infarction (2.8vs0.6%) and heart palpitations (64.8vs36.3%) predominated whilst diabetes mellitus (11.1vs18.9%) and tobacco consumption (4.6vs9.8%) were less frequent among participants with AF. In multivariable adjusted logistic analysis, the odds (95% CI) for AF were 5,5(2,61-8,25) for heart failure, 4.6(2,67-11,33) for overweight/obesity, 2.1(1,04-4,19) for hypertension and 3.4(1,73-6,89) for age ≥70 years. **Conclusion:** AF affects a sizable proportion of adult Congolese people with heart failure, palpitations, hypertension, and overweight/obesity as significant correlates. The association with heart failure holds in a dual register with AF as either a culprit or a consequence.

Keywords: Atrial fibrillation, Prevalence, Adult Congolese people

Introduction

Atrial fibrillation (AF) is the commonest supraventricular rhythm disorder worldwide leading to various cardiovascular complications such as heart failure, stroke and death through thromboembolic mechanism, cardiomyopathy, or atrial asystole.

In 2009 AF affected 3 to 5 million people in the United States of America and its prevalence is expected to reach 8 million by 2050 partly because of population aging [1]. About 8.8 million people suffer of AF in Europe with a projection to 18 million affected persons by 2060 [2].

Data gathered in 2019 indicate that AF affected no less than 60 million people worldwide which is an increase by more than 111% in comparison to 1990. The deaths imputable to AF had reached 0.32 million inhabitants whilst the burden of disability consecutive to AF was estimated to 8.4 million people. These rates represent a respective increase by 169.4% and 126.6% in comparison to figures reported in 1990 [4]. The same study revealed an incidence of 16,185 new cases in 2019, i.e. 32.2/100,000 inhabitants in sub-Sahara central Africa.

AF if grafted high morbidity and mortality and places a heavy economic burden on the society. Given the ensuing physical disability, it considerably reduces the professional productivity of the affected persons. The overall annual cost of managing AF and its complications is high. It is estimated between 2000 and 14200 US dollars per patient in the United States of America, and between 450 and 3000 euros in Europe [3].

The gold standard diagnosis of AF is 12-lead ECG recording. Since the examination is difficult to perform in mass field surveys, several tools have been validated for screening with convincing reliability [5-14]. We used Alivecor Kardia software embedded on a smartphone with the aim to explore the epidemiological profile of AF a poorly recognized disease among the general Congolese partly because such information is not yet available.

Methods

Study design and participant sampling

From August 1 to September 30, 2022, the present cross-sectional survey targeted for analytical purposes a random sample of the general population of the city of Kinshasa, DRC. The sample size was calculated using the basic formula for cross-sectional studies:

$n \geq (Z^2 \times (p)(1-p))/d^2$ where n = sample size, z = 1.96 (confidence coefficient), p = previous prevalence, d = 0.02 (margin of error or range of imprecision reflecting the desired degree of absolute precision).

Since the prevalence of AF in DRC is yet unknown, we opted for 50% a median rate which insures a better distribution of the phenomenon.

The calculated sample size was n $\geq$ (1.96)2*0.5*0.5/(0.02)2=2401. By incorporating a 10% for non-respondents, we obtained 2641 people to be interviewed.

To accrue participants in the study we used the technique of Lot Quality Assurance Sampling (LQAS) which combines the principles of stratified and simple random sampling. Specifically, the sampling units were made up of the communes of the city-province of Kinshasa at the first degree; the districts of the commune at the second degree; the streets at the third degree; the inhabited plots at the fourth degree and the households at the fifth degree.

A trained medical team visited at home the selected households and invited people aged 45 years and over to participate in the study by informed written or oral consent. However, those who did not complete two-thirds of the survey questionnaire were excluded from the analysis.

Procedures

The data collection procedure consisted of a semi-structured questionnaire incorporated into a KOBO collect program. The first part of the procedure focused on socio-demographic characteristics (gender, age, marital status, religion, level of education, family composition, socioeconomic level of households and monthly income); the second on the clinical and anthropometric data (family and personal medical history, weight, height, body mass index, heart rate, blood pressure) and the third part on screening for AF by Alivecor Kardia software embedded on a smartphone.

Body weight measurement was taken using a removable Seca brand scale and height using a measuring rod. Body mass index (BMI) was calculated as the ratio of weight (Kg) to the square of height (m). Three blood pressure records and heart rate obtained using an Omron Hem 7 BP monitor with appropriate cuff secured on the upper arm. The mean of these records was used in the analysis. Subjects with AF positive test on Alivecor Kardia Cardia were invited for a 12-lead ECG.

Operational definitions

In the present work diabetes was defined as a known history of diabetes mellitus or use of antidiabetic treatment. Hypertension was BP ≥140/90mmHg, known history of high BP and/or use of antihypertensive drugs. Participants reporting statin use within three months of the present survey were considered dyslipidaemias. Overweight/obesity was a BMI ≥25kg/m [2]. Heart failure refers to a known history of hospitalization for episode of cardiac insufficiency. Monthly income was considered as low, middle, and high respectively when it was less than USD 200, between USD 200-500, and more than USD 500. Use of traditional drugs was any mention of having been treated by traditional practitioners within the last six months.

Statistical analysis

The data obtained on the KOBO collect program, were cracked, exported to Excel 2010 software for cleaning and

transferred for analysis to SPSS Version 21 for Windows. We presented categorical variables as absolute and relative frequency and summarized quantitative variables by measures of central tendency and dispersion. Student's t test was used to compare means of two groups, and Pearson's Chi-square test for comparison of proportions. The correlates of AF were assessed using logistic regression analysis in a bivariate and multivariate model. The calculated adjusted ORs helped to estimate the degree of association between the dependent and the independent variables.

Results

General characteristics of the participants

The study enrolled 2562 subjects, mean age 59,6±8,9 years, 44.3% males. Age group 50 to 59 years was the most represented (46.4%). As regard the educational level, most participants had reached high school (48,5%) and (58,3%) had a professional occupation. People of the Congo descent were the most represented ethnic group (60.6%) and a low monthly income was observed in nearly half of the subjects. Hip circumference and body mass index were significantly greater among females than males. Hypertension (35.5%), alcohol intake (30.8%), diabetes mellitus (18.6%) and obesity (18.4%) were the commonest cardiovascular risk factors. Heart failure and heart palpitations were reported by 3.4% and 37,5% of participants respectively.

### Prevalence and determinants of atrial fibrillation

AF was suspected by use of the KARDIA device in 118 participants (4.6%). The condition was confirmed on a 12-lead ECG recording in 108 subjects (4.2%). As an AF diagnostic tool, the Alivecor Kardia device demonstrated 99,6% of specificity, 100% of sensitivity and negative predictive value and 91,5% of positive predictive value when compared with 12 lead-ECG. (Figure 1) illustrates the prevalence of AF by use of the two diagnostic tools whilst Figure 2 highlights AF repartition according to gender, age categories, ethnic groups, and participant monthly income.
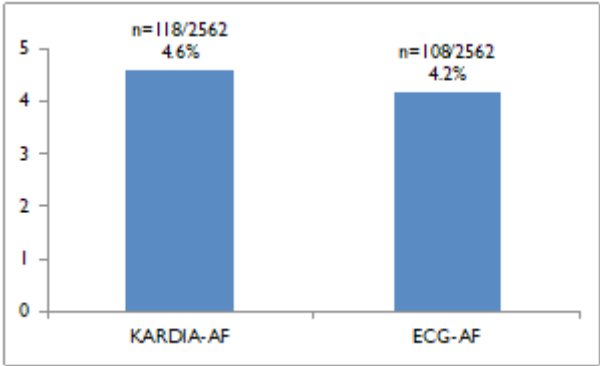
Figure 1: Prevalence of atrial fibrillation in the general Congolese.

Atrial fibrillation in various participant categories

The frequency of AF was higher (p=0.018) in males than females (Figure 2A) and significantly (p<0.001) increased with age (Figure 2B) from 1.1% below age 50 years to 9.7% in participants aged 70 years and over. It was also greater (22.4%) in high economic income participants (Figure 2D). The Luba (6.2%) and Ngala (6.1%) ethnic groups were more affected (p=0.016) compared to the Congo (3.4%) and the Swahili (2.9%) groups (Figure 2C).
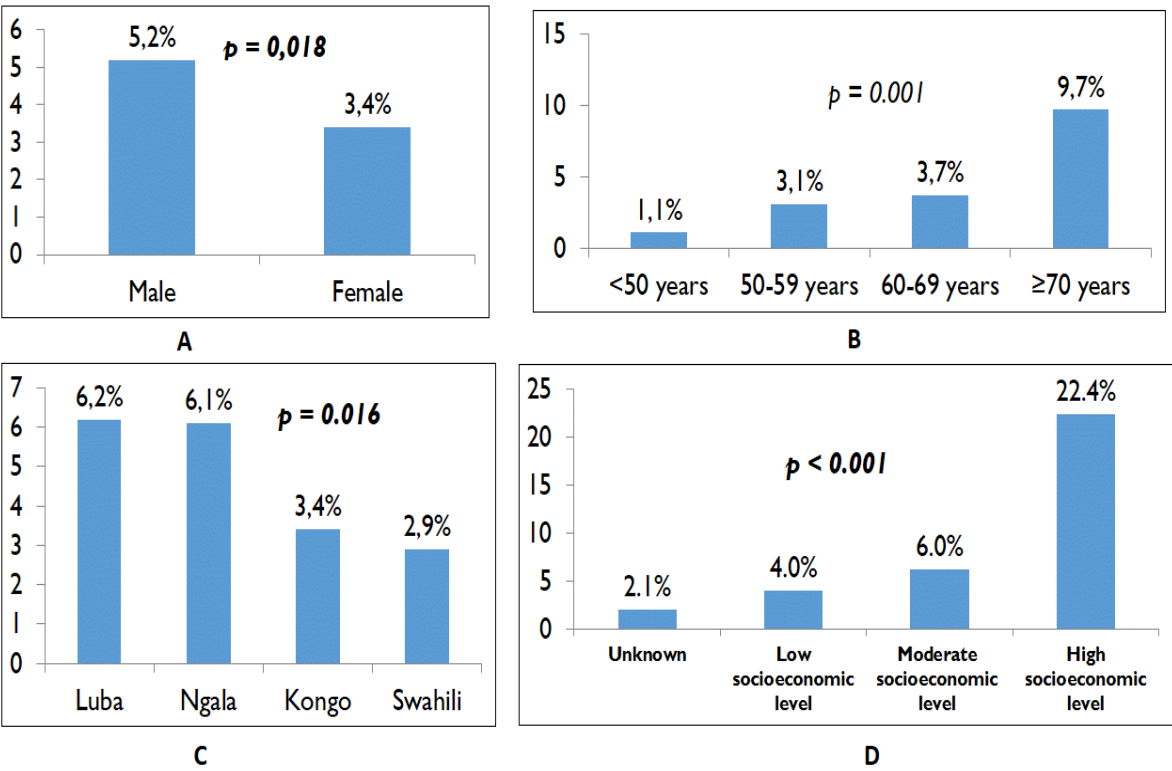
Figure 2: Specific prevalence of atrial fibrillation by gender (A), age group (B), linguistic space (C) and income category (D).

(Table 1) summarizes the characteristics of participants with and without AF. On average participants with AF were older (64.4±11.0 years vs 59.4±8.7 years) with men being more affected than women. Among the subjects with AF, 35.2% were unemployed, 39.8% had a university educational level and 73.1% were married. Difference in BP, body mass index and HC were not significant.

Variables	n	No AF n=2454	AF n=108	P
Age	2562	59.4±8.7	64.4±11.0	<0.001
Gender				
Male	1135	1076 (94.8)	59 (5.2)	0.018
Female	1427	1374 (96.6)	49 (3.4)	
Profession				

Yes	1069	1037(97.0)	32(3.0)	0.095
No	1493	1427(95.6)	66(4.4)	
Educational level				
No and primary	389	377(96.9)	12(3.1)	0.597
Secondary	1243	1197(96.3)	46(3.7)	
University	930	890(95.7)	40(4.3)	
Marital status				
Single	219	213(97.3)	6(2.7)	0.580
Married	1758	1685(95.8)	73(4.2)	
Divorce	124	123(99.2)	1(0.8)	
Widow	461	443(96.1)	18(3.9)	
Linguistic group				
Kongo	1536	1488(96.9)	48(3.1)	**0.013**
Ngala	277	261(94.2)	16(5.8)	
Luba	515	487(94.6)	28(5.4)	
Swahili	207	202(97.6)	5(2.4)	
Monthly Income				
low	524	503(96.0)	21(4.0)	**<0.001**
Moderate	450	422(93.8)	28(6.2)	
High	76	59(77.6)	17(22.4)	
SBP. mmHg	2562	137.8±21.6	134.1±21.5	0.083
DBP. mmHg	2562	83.8±13.4	82.2±15.3	0.257
MBP. mmHg	2562	101.7±14.9	99.5±15.9	0.137
PP. mmHg	2562	54.1±16.2	51.9±15.9	0.159
HC. cm	2562	86.9±15.4	89.3±17.3	0.238
BMI. Kg/m^2	2562	26.4±5.2	26.9±7.3	0.345
SBP=systolic blood pressure; DBP=diastolic blood pressure MBP=mean blood pressure: PP=pulse pressure; HC=hip circumference and BMI=body mass index				

Table 1: Characteristics of participants according to AF status

Cardiovascular risk factors, diseases and symptoms encountered among subjects with and without AF are highlighted in (Table 2). Arterial hypertension (58,2 vs39.4 %), dyslipidaemia (22,2 vs 2.9%), history of heart failure (36,1 vs 1.9%), stroke (13 vs 3.3 %), previous myocardial infarction (2.8 vs 0.6%) and heart palpitations (64.8 vs 36.3%) predominated among participants with AF whilst the trend was just not significant for history of gout. Diabetes mellitus (11.1 vs 18.9%) and tobacco use (4.6 vs 9.8%) were less frequent in participants with than those without AF. The difference between the two groups in the other variables was not significant.

Variables	No AF n=2454	AF n=108	P
Diabetes mellitus	464(18.9)	12(11.1)	**0.023**
Hypertension	850(34.6)	57(58.2)	**<0.001**
CKD	39(1.6)	4(3.7)	0.105
Overweight/Obesity	969(39.4)	43(39.8)	0.658
Gout	45(1.8)	5(4.6)	0.057
Heart palpitations	891(36.3)	70(64.8)	**<0.001**
Previous Heart failure	47(1.9)	39(36.1)	**<0.001**
Dyslipidemia	71(2.9)	24(22.2)	**<0.001**
Myocardial infarction	15(0.6)	3(2.8)	**0.037**
Previous Stroke	82(3.3)	14(13.0)	**<0.001**
Tobacco use	240(9.8)	5(4.6)	**0.044**
Alcohol consumption	753(30.9)	31(28.7)	0.358
NSAI	637(26.1)	33(31.1)	0.150
Traditional drugs	260(10.7)	13(12.0)	0.379
NSAI: Non-Steroidal Anti Inflammatory			

Table 2: Cardiovascular risk factors and history according to AF status

Determinants of atrial fibrillation

In bivariate analysis, the high socio-economic level, obesity, arterial hypertension, heart failure, dyslipidaemia and history of ischemic stroke stand out distinctly as determinants of AF. On the other hand, in multivariate analysis only overweight/obesity and previous heart failure emerged as the independent determinants of AF. (Table 3)

Variables	Bivariate analysis		Multivariate analysis	
	p	OR (IC95%)	p	ORa (IC95%)
Sex				
Female		1		1
Male	0.028	1.54(1.05-2.27)	0.318	1.43(0.71-2.91)
Age				
<50 years		1		1
50-59 years	0.097	3.35(0.84-9.27)	0.168	1.77(0.57-42.49)
60-69 years	0.172	2.75(0.64-11.70)	0.051	2.42(0.18-4.86)
≥70 years	0.002	9.36(2.23-13.28)	**0.026**	3.39(1.73-6.89)
Socioeconomic level				
Low		1		1

Moderate	0.203	1.41(0.83-2.39)	0.537	1.26(0.61-2.58)
High	<0.001	5.30(2.73-10.30)	0.354	1.82(0.51-6.47)
Obesity				
No		1		1
Yes	<0.001	6.87(3.87-12.18)	**<0.001**	4.56(2.67-11.33)
Hypertension				
No		1		1
Yes	<0.001	2.77(1.87-4.10)	**0.038**	2.09(1.04-4.19)
Heart palpitations				
No		1		1
Yes	<0.001	2.62(1.77-3.88)	0.085	1.81(0.92-3.55)
Heart failure				
No		1		1
Yes	<0.001	4.95(2.78-7.12)	**<0.001**	5.47(2.61-8.25)
Dyslipidemia				
No		1		1
Yes	<0.001	9.59(5.75-15.99)	0.428	1.50(0.55-4.05)
Stroke				
No		1		1
Yes	<0.001	4.31(2.36-7.87)	0.122	2.49(0.78-7.93)

Table 3: Determinants of AF in the study population

Discussion

The purpose of the present study was to assess the prevalence and epidemiological profile of AF in the city-province of Kinshasa. We approached a 2562 random sample of adult inhabitants and used the Alivecor Kardia software embedded on smartphone to screen for AF and confirmed the diagnosis by a 12-lead ECG recording. The salient results indicate a prevalence of 4,2% that was higher in men than women and increased with age. AF tended to predominate in more educated and high-income class. In the multivariable adjusted logistic model, the likelihood to present AF was higher in participants with previous heart failure, overweight/obesity, age ≥70 years and high blood pressure.

Using an Alivecor Kardia device AF was suspected in 4,6% of the adult population of Kinshasa aged 45 years or more and a definite prevalence of 4,2% was confirmed by standard 12-lead ECG recording. These results obtained with the two examination procedures are very close and this surely attests the intrinsic validity of the Alivecor Kardia device as a reliable tool for population-based screening of AF. In our study the elevated negative predictive value and specificity of the Alivecor Kardia procedure constitute strong arguments to this regard. Shaan Khurshid et al. demonstrated that the use of a more prolonged screening on the one hand and/or of photophlethysmography tools is always associated with an increase in the prevalence of AF in large-scale screening studies. This might explain in addition to the cases of paroxysmal AF, for our higher prevalence of AF on Kardia versus 12-lead ECG [14].

On average, our AF population was aged 64,4 ± 11,0 years with men more affected than women. The prevalence of AF significantly increased with age. These observations are in keeping with the findings by Xin-jiang D et al. that the peak of AF incidence in their work was noted between age 65-69 years for both genders; the incidence being more marked in men below age 65 years and in women above age 65 years.4 Schnabel RB et al. noted that the prevalence of AF in men and women > 75 years is greater in women due partly to their increased longevity, but the absolute number of men and women with AF is similar on a population basis [15].

Hypertension (58,2% of cases), dyslipidemia (22,2%), overweight/obesity (39,8%), history of heart failure (36,1%), stroke (13%), myocardial infarction (2.8%) and heart palpitations (64,8%) were the CV risk factors, disease or complaint mostly encountered among people with AF in the present work. This appears in line with the literature where the history of heart failure does constitute a remarkable correlate of AF. Pallisgaard J et al. found an association between AF and heart failure in 25,8% of cases;8 Santhanakrishnan R et al. noted the presence of AF in nearly half of patients followed for heart failure.11 To this relationship between AF and heart failure various CV risk factors such as dyslipidaemia [7], hypertension and diabetes mellitus [8] were reported to largely contribute. In addition, systolic hypertension (34%) and obesity (20,2%) emerged as the cardiovascular risk factors most tied to mortality from AF in the work of Xin-jiang D et al [4]. Moreover, Vaziri SM et al. reported that people affected by heart failure with reduced ejection fraction have 6 times more risk to develop AF within 5 years [12]. Likewise, in our context history of a previous heart failure had the potential to multiply the risk of AF by 5.5. The ejection fraction was however, not assessed in our HF participants and the delay from heart failure episode to occurrence of AF given the cross-sectional design of our study.

Overweight/obesity and hypertension respectively increased 4,6 and 2,1 times the risk of AF in agreement with the report by Dagfinn A et al of a 1.50 RR to develop AF for hypertensive people in comparison to normotensive counterparts[16]. Diabetes mellitus did not show a significant independent influence on the probability of AF. By contrast age ≥70years was associated with a 3.4 times higher probability of AF. Indeed, the prevalence of AF that was 3.7% at age 60-69 years, rose to as high as 9.7% above 70 years. This is even somewhat higher than the 5,3% found by Gladstone DJ et al in a population aged 75 and over after an ECG recording of at least 2 weeks [13].

Finally, the history of ischemic stroke appears in 13% of subjects with AF in our work and this rate is of the same magnitude as the incidence of 12,4% Sanna T et al. reported among patients with ischemic cerebrovascular accident [9].

The present work has some limitations. The relatively modest sample size albeit random does not allow a generalization of the results to the entire Congolese population. Moreover, the short duration of heart rhythm recording could have missed potential cases among those with paroxysmal heart palpitations. Nevertheless, this cross-sectional study is the first to screen for AF in Kinshasa and to offer an estimate of the magnitude of this disorder in our context.

Conclusion

Our data indicate AF is a heart rhythm disorder observed in a sizable proportion of adult Congolese people living in the city of Kinshasa with heart palpitations as the commonest symptom, hypertension and overweight/obesity among significant correlates. Its strong association with heart failure should be perceived in a dual register where AF could be culprit or consequence of the occurrence of that condition. As the use of Alivecor Kardia has proven reliable in detecting AF, this simple methodology could be applied to establish our countrywide prevalence of AF.

Ethical Consideration

Our study obtained the agreement of the ethics committee of the school of public health of the University of Kinshasa

Authors' Contribution

YLN was the principal investigator, head of project; YLN and KMC wrote the first draft of the manuscript; JRM'BK was the co-investigator and scientific coordinator of the project; AN prepared the database and performed statistical analyses; OKR, KNC and KKR supervised the field work; JRM'BK, MRJR, PE, and BBN reviewed the manuscript; all authors approved the final version of the manuscript.

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