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Hypertension and prehypertension: prevalence and associated factors in Gabonese Youth and Adolescents

Elsa AYO BIVIGOU
Université des Sciences de la Santé
Bridy MOUTOMBI DITOMBI
Université des Sciences de la Santé
Ornella MBANG NGUEMA
Université des Sciences de la Santé
Reinne MOUTONGO
Université des Sciences de la Santé
Bedrich PONGUI
Université des Sciences de la Santé
Bernadette Bernadette EKOMI
Université des Sciences de la Santé
Noé Patrick MBONDOUKWE
Universite des Sciences de la Sante
Denise Patricia MAWILI-MBOUMBA
Université des Sciences de la Santé
Marielle Karine BOUYOU AKOTET (mariellebouyou@gmail.com)
Universite des Sciences de la Sante https://orcid.org/0000-0002-7992-4630

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Abstract

Background : Early detection of hypertension is necessary to reduce subsequent morbidity and mortality. The aim of our study was to determine the prevalence of hypertension and prehypertension in high school students from the capital city of Gabon and to identify their associated factors.

Methods : This was a cross-sectional and analytical study carried out on a population of students enrolled in two establishments in Libreville during the 2018-2019 year school. Information on hypertension family history, eating habits, alcohol and/or tobacco consumption, oral contraception, age, gender, body mass index and blood pressure were collected. The National High Blood Pressure and European Cardiology Society 2013 classifications were used for the analysis of blood pressure in children and young adults respectively.

Results : A total of 613 students with mean age of 20.3 ± 2.5 years were included. Sex ratio was 2.3. Prevalence of hypertension was 19.4% and the following factors were found to be independently associated with hypertension: overweight (aOR: 2.77 [1.29-9.99]) and male gender (aOR: 2.10, [1.22-3.62]) or not independently: overweight (OR: 2.52, [1.30-4.89] and obesity (OR: 2.62, [1.30-5.27]) (p<00.1). The prevalence of prehypertension was 23.0%, obesity (aOR:3,93 [1.02-15.2]) was independently associated with prehypertension, while overweight (OR: 2.16, [1.03-4.53]) and male sex (OR: 1.72, [1.10-2.78]) (p<00.1) were dependent factors.

Conclusions : Hypertension and prehypertension are not unfrequent in school students from Libreville. Awareness of associated factors and screening campaigns within school establishments are necessary to reduce complications in adulthood.

Background

In addition to infectious diseases, sub-Saharan Africa is marked by the rise of non-communicable diseases (NCDs) among which cardiovascular diseases are prominent. These are responsible for 15.1 % of the total NCD burden, moreover, they increasingly affect youth populations [1-2]. There are many reasons linked with this morbidity-mortality which include lack of screening on cardiovascular risk factors, delays in treatment, genetic and sociodemographic particularities [2-6]. It is therefore essential to implement control programs for cardiovascular diseases with the development of treatment strategies as well as prevention plans both on the regional, as recommended by the Pan-African Society of Cardiology, but also at national level [4]. Screening and early management or correction of modifiable cardiovascular risk factors are also key components.

Hypertension is the main risk factor in sub-Saharan Africa. In a meta-analysis reported by Bosu, its prevalence varies from 22,3% to 90% from an adult population, while the overall pooled prevalence was 57.0% [5]. In addition to this high burden, hypertension of African natives is distinguished by early and severe complications which could be partly linked with delayed or irregular treatment for hypertension through the years and the association with other risk factors such as obesity [2,5]. Early screening and management of hypertension and its associated factors, since adolescence, will allow to reduce the risk of cardiovascular diseases and related adult mortality in sub-Saharan Africa [7-8].

In another hand, prehypertension is a known predisposing factor for a subsequent hypertension, and its correct management reduces the risk of progression into hypertension [9].

In Gabon, many studies on the complications of hypertension have been published, especially cardiac and cerebral complications. However, few data are available on the effective rate of hypertension prevalence in Gabonese citizens, especially in adolescents and young adults. The aim of this study were to determine the prevalence rate of hypertension and prehypertension in a school environment in Libreville and to identify the associated factors.

Methods

Study sites

This was a cross-sectional and analytical study carried out in Libreville, capital of Gabon, a middle income country from Central Africa, bordered by Cameroon in the north and Congo in the south. Between February to June 2019, students from two technical school of a sub urban area , Owendo, located near to the capital city (Libreville) were included. Indeed, those from tenth to twelth grade had been previously invited to participate in the study through awareness campaigns led by the school officials, medical team and investigators of the study. Data on the students was then gathered randomly in the two establishments upon spontaneous presentation of the student.

Sample size calculation

The sample size was estimated by considering the data reported by Ellenga and colleagues which showed a hypertension prevalence of 10.1% in a population of 603 adolescents and young adults [10]. Using Daniel's formula (Daniel, 1999), ($n = z^2 (p(1-p)) / e^2$) with z= 95% , p= 0.101 and a precision of 0.05, a minimal population size of 140 participants was established.

Questionnaire

All the students who agreed to participate in the study were welcomed in the morning before class by a trained team and under the supervision of two school doctors. Subjects were then asked to answer a standardized questionnaire including: their individual and family history of hypertension and/or diabetes, their eating habits especially regarding salt and fat, tobacco use, alcohol consumption, and the use of oral contraception or antihypertensive drug.

Data collection

The physical parameters which were collected included: age, gender, height, weight and blood pressure. Body mass index (BMI) was calculated from the data collected. During the collection of these parameters, the students only wore their school uniforms and were asked to remove their shoes. Size was measured using a measuring rod in centimeters and weight was taken using an electronic scale. After ensuring the student's calmness by respecting a 15-minute rest, blood pressure was measured in a sitting position in which the back was supported and the feet were touching the floor according to the National High Blood Pressure Education Program (NHBP) and Pan-African Society of Cardiology (PASCAR) guidelines [4-11]. Three consecutive measures were taken at two-minute intervals with an OMRON automatic sphygmomanometer and an adjustable armband. Two different armband sizes were available. The mean value of the three measures was kept for data analysis. After the initial consultation, two other consultations spaced one month apart were scheduled. The hypertension diagnostic was retained upon the third consultation. The prehypertension diagnostic was retained upon the first measurement according the recommendations of the NHBP [11].

Definitions

For students aged less than 18 years, systolic and diastolic blood pressures were adjusted to gender, age and size percentile. These values were interpreted according to the NHBP recommendations [11]. They were considered normal for a systolic and/or diastolic blood pressure value under the 90th percentile. Prehypertension was retained between the 90th and 95th percentile. Hypertension was classified as « grade 1 » if the blood pressure was between the 95th and the 99th percentile included. It was classified as « grade 2 » if the blood pressure was higher to 5 mmHg above the 99th percentile. For students aged more than 18 years old, the diagnosis of hypertension and pre-hypertension was retained and stratified according to the 8th Joint National Committee on Prevention, Detection, Evaluation and treatment of High Blood Pressure report [12]. Obesity was defined according to BMI by dividing the weight (in kilograms) by the square of the size (in meters) for adults. The International Obesity Task Force's (IOTF) diagrams adapted to age and sex were used as reference standards for students aged less than 18 years old [13]. Obesity was defined for a BMI above the 95th percentile, and overweight between the 85th and 95th percentile, respectively. For students aged more than 18 years, the World Health Organization's (WHO) definition of obesity was used [14].Tobacco use was noted for regular consumers (more than three cigarettes per week). Alcohol consumption was noted for individuals who drank at least one alcoholic beverage per week during the ongoing school year. The type of diet was estimated based on the student's answer to the question ("how do you find your meals?") which specified the type of foods usually eaten, the means of cooking (adding salt condiment or salt when cooking) and/or adding salty when eating. The regular or systematic consumption of salty additives was noted. Adding fat additives was defined by the consumption more than three times a week of foods such as mayonnaise.

Statistical analysis

The data were saved using Excel and statistical analysis by Statview.The quantitative and qualitative variables were analyzed with the appropriate tests. Indeed differences between groups were assessed using chi-squared or Fisher's exact tests for proportions, Student's t-test, analysis of variance (ANOVA) or Kruskal-Wallis test where appropriate. Age, gender, family history of hypertension, overweight, obesity, diet habits and alcohol consumption were used in bivariate and multivariable analysis to identify factors associated with hypertension and prehypertension. Variables for multivariable analysis were selected by specifying an inclusion criterion of p value < 0.2. Adjusted odds ratio (AOR) were obtained by mutually adjusting all minimum generated variables using a multivariable logistic regression model. Crude and adjusted odd ratios (OR and aOR) and 95% confidence intervals (95% CI) were calculated. A $p<0.05$ was considered significant.

Ethical considerations

The importance of the study for personal and public health, its objectives, the procedures used and benefits were explained to all participants. They were also informed that their personal information would be kept strictly confidential. The approvals of the Ministry of Health and the Ministry of Technical Education were obtained for this study.

All the adult students were asked to give their written consent, and participants aged below 18 gave their assent and a consent form signed by their parents or legal guardians which had been handed to them a week before.

All students benefited from advices on healthy living and eating habits at the end of the first consultation (stop smoking and alcohol consumption, practice a physical activity, adopt a diet poor in fat and salt). Those with hypertension were directed to the cardiology department of the University Hospital Center in Libreville.

Results

During the study period, 613 students aged 14 to 27 years were included. The general characteristics of this study population are presented in Table 1.

General data (table 1)

The mean age of students was 20.3 (+/-2.5) years. It was 20.1 (+/-2.5) years for females and 20.4 (+/-2.4) for males. The 18 to 24 years age group was the most represented (88.1%) and 7.3% of students were under 18 years of age. Male predominance was significant (sex ratio 2.3).

An absence of hypertension (55.6%) and diabetes (87.5%) in the family history was reported in more than half of students.

Table 1: Characteristics of the study population

	N	n	%
Age groupe (years)	613		
14-17		45	7.3
18-24		540	88.1
25-27		28	4.6
Gender	603*		
Female		181	30.1
Male		422	69.9
Family history of hypertension	603*	268	44.4
Hypertensive father	603*	128	21.2
Hypertensive mother	607*	140	23.2
Family history of diabetes	603*	75	12.3
Diabetic father	603*	57	9.4
Diabetic mother	607*	18	2.9
Distribution according to BMI	601*		
Underweight		26	4.3
Normal weight		520	86.5
Overweight		45	7.5
Obesity		10	1.7
Alcohol	609*	299	49.1
Tobacco	609*	88	14.4
Salty diet	588*	265	45.0
Salty additives	600*	446	74.3
Fat additives	598*	512	85.6
Oral contraception	169	7	4.1
	N	**Median [interquartile]**	
Age (yearss)	613	20.2 [19.3-22.2]	
BMI (kg/m2)	601*	21.0 [19.6-22.9]	
Abdominal perimeter	601*	72.3 [69.8-76.2]	
Systolic BP	613	122.7 [113.7-131.5]	
Diastolic BP	613	70.2 [62.7-81.8]	

* data were not recorded for all participants , **Blood Pressure

Hypertension

Blood pressure (BP) was normal for 54.6% of students; hypertension was diagnosed in 19.4% (Table 2). It was significantly more frequent in male students ($p < 0.01$) (Table 2).

Table 2: Prevalence of hypertension and prehypertension according to gender, age, and family history

	Population		Gender			Age group (years)				Family history	
			M	F		14-17	18-24	>25			
	n	%	%	%	p	%	%	%	p	%	P
Hypertension	119	19.4	21.8	12.7	*<0.01*	10.0	18.3	32.2	*0.11*	16.8	*0.11*
Hypertension type					*<0.01*				*0.23*		*0.09*
Systolic	33	5.4	7.1	1.1	=	4.4	5.5	3.6	=	5.6	=
Diastolic	59	9.6	8.8	11.5	=	2.2	8.9	14.3	=	6.7	=
Systo-diastolic	27	4.4	5.9	1.1	=	4.4	3.9	14.3	=	4.5	=
Degree of hypertension					*0.01*				*0.59*		*0.23*
Grade 1	110	17.9	20.1	12.2	=	10.0	16.8	28.6	=	15.7	=
Grade 2	7	1.2	1.4	0.5	=	0.0	1.1	3.6	=	0.7	=
Grade 3	2	0.3	0.5	0.0	=	0.0	0.4	0.0	=	0.4	=
Prehypertension	141	23.0	25.1	18.7	*<0.01*	24.4	23.1	17.8	*0.23*	20.9	*0.23*

The median age of students with hypertension was 20 years [19-22]. In groups with grade 1, 2 and 3 hypertension, it was 20 years [18-22], 22 years [19.2-23] and 21 years [20-22] respectively.

Diastolic hypertension was more frequently found (Table 2). Its rate was higher in female students (11.5%) comparatively to male students who were more often prone to systo-diastolic hypertension (5.9%) ($p < 0.01$) (Table 2). It was also more frequent in students which added salty ($p=0.02$) and fat additives ($p=0.02$) in their meals (Table 3).The median BMI was 21[19.6-22.9] kg/m^2 in the case of hypertension. It was significantly higher in students with a systolic hypertension (23.3 [20-24.4] kg/m^2) than those with a diastolic (21.1 [19.4-22.8] kg/m^2) or systo-diastolic (21.9 [19.4-22.8] kg/m^2) ($p < 0.01$) hypertension. Among obese students, 20% had a systo-diastolic hypertension whereas students with normal weight mainly had a diastolic hypertension (Table 3).

Of the seven girls under hormonal contraceptives, two (28.5%) had hypertension but none had prehypertension. None of the participants took antihypertensive treatments.

While 16.8% (n=268) of students with a family history of hypertension, had hypertension, this proportion was 21.5% (n= 149) for those without family history of hypertension (Table 3).

Among students with salty diet, diastolic hypertension was the most frequent form (10.5%) ($p=0.02$). It was also more frequent in students which added fat additives ($p=0.02$).

Bivariate analysis revealed that associated factors for hypertension were: obesity, overweight, male gender (Table 4). After the multivariate logistic regression analysis, only overweight and male gender were found independently associated with hypertension ($p < 0.01$) (Table 4). The female gender and an age below 18 years were protective (Table 4). Salt consumption and family history of hypertension did not significantly increase the risk of hypertension (Table 4).

Prehypertension

Prehypertension was found in 24, 4% of students and it predominated in male students ($p< 0.01$) (Table 2). The median age of students with prehypertension was 20 years (20[19-22] years), similar to that of students with hypertension (20[19-22] years) and those with a normal blood pressure (20[19-22] years).

Table 3: Prevalence of hypertension and prehypertension according to diet, BMI, alcohol and tobacco use

	Salty diet		Salty additives		Fat additives		BMI					Alcohol	
							LW	NW	OW	O			
	%	*p*	%	*p*	%	*p*	%	%	%	%	*p*	%	*p*
Hypertension	16.2	*0.11*	17.9	*0.33*	19.5	*0.21*	11.5	18.6	31.1	20.0	*0,16*	18.7	*0.7*
Type of hypertension		*0.09*		*0.02*		*0.02*					*<0.01*		*0.9*
Systolic	4.1	-	4.3	-	5.6	-	0.0	5.2	11.1	0.0	-	5.7	-
Diastolic	7.6	-	10.5	-	10.5	-	11.5	9.4	11.1	0.0	-	9.0	-
Systo-diastolic	4.5	-	3.3	-	3.7	-	0.0	4.0	8.9	20.0	-	4.5	=
Hypertension degree		*<0.01*		*0.05*		*0.07*					*<0.01*		*0.6*
Grade 1	16.2	-	16.8	-	18.7	-	11.5	17.6	11.0	10.0	-	17.7	-
Grade 2	0.0	-	1.1	-	0.8	-	0.0	0.7	20.1	10.0		1.3	-
Grade 3	0.0	-	0.2	-	0.2	-	0.0	0.3	0.0	0.0	-	0.0	-
Prehypertension	20.3	*0.01*	21.1	*<0.01*	-	*0.02*	2.9	83.5	10.1	3.6	*0.01*	22.7	*0.7*

LW: low weight, NW: normal weight, OW: overweight, O: obesity, BMI: body masss index

Table 4: Factors associated with hypertension and prehypertension (bivariate and multivariate analysis)

	Hypertension						Prehypertension					
	Bivariate analysis			Multivariate analysis			Bivariate analysis			Multivariate analysis		
	OR	CI 95%	P	AOR	CI 95%	P	OR	CI 95%	P	AOR	CI 95%	P
Age < 18 years	0.07	0.04-0.15	< 0.01	0.60	0.37-0.97	0.04	1.21	07-26	0.69	-	-	-
Age > 18 years	13.5	6.60-27.4	< 0.01	1.67	1.02-2.69	0.04	-	-	-	-	-	-
Female sex	0.52	0.32-0.87	0.01	0.47	0.28-0.82	< 0.01	0.58	0.37-0.90	0.02	0.55	0.36-0.86	< 0.01
Male sex	2.13	1.29-3.52	< 0.01	2.10	1.22-3.62	< 0.01	1.72	1.10-2.78	0.02	1.80	1.16-3.80	< 0.01
Obesity	2.62	1.30-5.27	< 0.01	1.56	0.30-7.93	0.58	4.38	1.03-18.6	0.04	3.93	1.02-15.2	0.04
Overweight	2.52	1.30-4.89	< 0.01	2.77	1.29-9.99	< 0.01	2.16	1.03-4.53	0.03	1.86	0.94-3.68	0.07
Hypertension family history	0.72	0.47-1.09	0.14	0.85	0.54-1.33	0.48	0.71	0.48-1.06	0.10	0.94	0.62-1.32	0.32
Salty diet	0.71	0.47-10.9	0.14	-	-	-	0.65	0.43-0.97	0.04	0.83	0.23-1.99	0.77
Salty additives	0.80	0.51-1.27	0.40	-	-	-	0.80	0.51-1.26	0.40	-	-	-
Fat consumption	1.50	0.78-2.86	0.14	1.42	0.73-2.78	0.29	0.71	0.42-1.21	0.26	-	-	-
Alcohol consumption	0.94	0.63-1.40	0.80	-	-	-	0.94	0.63-1.39	0.76	-	-	-

Significant p value <0.05; CI = confidence interval; OR = odds ratio, AOR; adjusted odds ratio

The median BMI of students with prehypertension was 21.5[19.8-23.5] kg/m2. Among them, 3.6% were obese and 10.1% were overweight (Table 3). Among the obese students, 50%

had prehypertension. The regular consumption of salty or fat food was more frequent in patients with prehypertension (p< 0.01) (Table 3).

Bivariate analysis revealed that associated factors for prehypertension were: obesity, overweight, male gender, and an age below 18 years (Table 4). After the multivariate analysis, only male gender and obesity remained independent factors (p=0.04) (Table 4).

Discussion

This study is the first to report data on hypertension and its associated factors in a school environment in Gabon. The mean age of participants (20.3 years) was higher than that reported by others in sub-Saharan Africa in which it varied between 11 and 18 years [10,15-17]. The fact that the selected schools were professional technical institutions could partly explain this difference. However, this study offers preliminary data in two target populations for hypertension prevention: adolescents and young adults who represent 7.3% and 88.1% of the study population, respectively. Male predominance (69.9%) is also linked to the choice of the establishment. It differs from other studies in which girls and young women predominates [10, 15, 17-19,].

Hypertension was found in 19.1% of students. Data on high school hypertension prevalence are highly variable in sub-Saharan Africa, from 1.2 % to 21.2 % [10, 15, 17-20]. Indeed, these disparities could be due to methodological differences, especially the type of measurement (oscillometric or auscultatory), the number of measures, the norms admitted, but also the age range of the study population (including or not subjects aged above 18 years). Even though American and European institutions recommend the auscultatory method**,** automatic measurement of blood pressure was chosen for this work as in other studies [11, 17, 19, 21]. This technique presents advantages among which ease of use and the minimization of the “white coat effect”, especially in young students.

A 10% hypertension prevalence was found in adolescents (less than 18 years of age), which is higher than the values reported by Rao (4.5%) in the USA and N’goran in Côte d’Ivoire (1.2%) [15, 22]. It is however close to data reported in Central Africa, such as in Congo (10.1%) and Cameroon (17.9%) [17, 23]. Indeed, low prevalence (1.2 to 3.5%) are frequently reported in young populations (mean age between 11.8 to 14.4 years) [10, 15, 18]. Hypertension in adolescents is known to be associated with an increase of cardiovascular mortality in adulthood, especially by cerebrovascular strokes with a risk multiplied by 3.12 [8]. In Libreville, strokes are the main cardiovascular emergency at the emergency unit [24]. Patients are often young and the main described etiology (52%) is neglected or unknown hypertension [24]. The present results show the importance of leading early hypertension screenings during adolescence or even childhood in Gabon. Taking blood pressure during the clinical exams of children and adolescent should become a reflex among pediatricians. This study also reports hypertension prevalence in the 18-24 year age group. It was 18.3% and young adults were more frequently at risk. These data corroborate the link between age and the increased risk of hypertension previously described [18]. This young adult population should definitely be also considered as a target in the fight against hypertension. Indeed, in this age group, hypertension is often associated with an irregular treatment and a lower control rate than in middle-aged adults, this contributes to the early occurrence of cardiovascular complications [25]. Implementing early treatments and therapeutic education for these young adults is, therefore, a priority. In the absence of data on the real prevalence of hypertension in the adult population in Gabon, the prevalence obtained for students aged more than 25 years old (32.2%) is a good indication of the extent of this public health problem in the capital city.

Hypertension was twice as likely to be diagnosed in male students compared to young women who were found to be less at risk of hypertension as also observed with adolescents. These results corroborate those of other studies, with the exception of young ladies for whom the low susceptibility to hypertension has been rarely described [15, 22, 26].

Even though family history did not increase the risk of hypertension, the relatioship between them is well established [27]. The development of hypertension in children and adolescents depends on genetic and environmental factors [27-29]. Many studies report a higher frequency of hypertension in African and Hispanic children, as is the case for adults [22, 27]. In a study performed in Côte d’Ivoire, nearly two thirds of students (64%) reported a family history of hypertension [15]. Early lifestyle and dietary changes and the monitoring of students would diminish their risk of developing ulterior hypertension [29].

Obesity and overweight are two modifiable risk factors frequently associated with hypertension in this study. This association was stronger in Elenga’s study in Congo, in which the risk of hypertension was increased by 6.67 in obese students and 5.65 in overweight ones [11]. Overweight was found to be an independent risk factor for hypertension. The association between excess weight and hypertension is already well established. Hypertension frequency correlatively increases with BMI, in both children and adults as observed in many studies performed in developing countries as well as in sub-Saharan Africa [10,18-20, 22,29-32]. The absence of an independent relationship between obesity and increased blood pressure is probably due to the low prevalence of obesity. Furthermore, obesity is responsible for a hypersensitivity to salt which increases the risk of hypertension [33]. A genetic hypersensitivity to salt already described in African subjects [5]. All these data show that the expected risk of hypertension in children and adolescents in sub-Saharan Africa rises with obesity. According to a WHO 2016 report, the prevalence of obesity has increased by nearly 50% in Africa since 2000 [34]. Reducing the risk and the frequency of excess weight must be one of the targets in hypertension prevention and control in children and adolescents [35].

Alcohol consumption was not associated with the risk of hypertension, even though it slightly predominated in a study in Cameroon [17]. The relatioship between alcohol and the risk of hypertension has been the subject of many controversies. The effect of alcohol would be dependent on dosage; several genetic, socioeconomic, racial and ethnical factors might influence the risk of cardiovascular diseases in regular consumers [27, 36, 37]. A moderate reduction in alcohol consumption has been shown to decrease the level of blood pressure [38]. The high rate of regular consumers (49.1%) requires a monitoring of their cardiovascular risk. Awareness campaigns on the dangers of alcoholism must be realized at the national level and should target children and adolescents as well.

Isolated diastolic hypertension was found to be the most frequent form of hypertension (9.6%) as reported elsewhere in sub-Saharan Africa [15,26]. This type of hypertension is associated with an increased risk of cardiovascular events [39]. Greater attention must be paid to even slight increase of diastolic pressure in young adults, especially in the 8.9% of students aged 18 to 24 years old and the 14.3% of those aged more than 24 years old. . An early start in drug treatment is sometimes necessary [39].

Isolated systolic hypertension, found in 5.4% of students, also deserves to be noted. Its mechanism is complex in young subjects and many hypotheses such as sympathetic hyperactivity and the increase in arterial rigidity were formulated [40]. This form is often neglected and linked to a “white coat effect” [25]. Even though its negative prognostic is controversial in young subjects, its management is necessary, especially through early lifestyle and dietary measures [11, 40, 41]. It is however sometimes associated with an under-diagnosis and a lack of appropriate treatment [25]. Systolic hypertension was frequent among study participants who had regularly a fat diet. It has been reported to correlate with BMI and waist size [19]. Frequent awareness campaigns must be implemented in school establishments in order to fight against therapeutic inertia and begin early care for these students.

Prehypertension was found in 23% of students (Table 2). It was significantly more frequent in male students. A comparable prevalence was reported in Congo (20.7%) while lower rates were noted in South-Africa (12.3%), Nigeria (2.5 à 5%) and Algeria (12.4%) [10, 18-19, 26]. Nevertheless, different study designs, particularly regarding the definition of prehypertension and the number of blood pressure measurements (one to three) could be the cause. In this study, diagnostic was established after three measurements separated each by one month measurements as recommended by the NHBP, taking into account the important variation in blood pressure during childhood and adolescence [11, 9]. However, data on prehypertension prevalence in African populations are also controversial. A possible increase in the risk of hypertension in teenagers was mentioned in the USA but in other studies [30, 31, 43, 44].

Obesity and overweight were found associated with the risk of prehypertension. This association is well known and seems more important in female adolescents and young ladies [10, 18-19, 31, 32, 45] . Waist size, which was not assessed, is also linked to the prehypertension risk, even in the absence of excess weight [31-42]. Weight loss is recommended by the NHBP to reduce the risk of hypertension.

Even though family history of hypertension and a regular consumption of tobacco and/or alcohol did not increase the risk of prehypertension among the study participants, other studies report a positive correlation between these different factors [32, 39, 45]. Thus, the public health policy makers should emphasize the fight against tobacco and alcohol consumption, which remains a priority in the youth population.

Approximately 0.5 to 1.1% prehypertensive adolescents per year develop hypertension, while prehypertension management reduces the probability of this evolution [9, 31]. The treatment of prehypertension consists in modifying the lifestyle habits of overweight subjects to induce weight loss, adopt a diet poor in salt and engage in regular physical activities [11, 44]. Collected data regarding eating habits, tobacco and alcohol consumption and excess weight of these students, warrant their monitoring and the implementation of awareness campaigns within schools. Moreover, many studies report the role of chronic inflammation in the pathogenesis of prehypertension and its complications [46]. Chronic parasitism, usually asymptomatic in sub-Saharan Africa, is responsible for chronic inflammation which could have been involved in this study’s prehypertension data. This hypothesis warrants the collaborative nature of this study with the parasitology department of the Faculty of Medicine of Libreville.

This study had some limits. First, it was performed in professional technical schools which are not representative of the whole youth and adolescent population. However, over 60% of Libreville youth have the same living conditions as the participants in this survey. Other risk factors such as low birth weight, hips-size ratio, socioeconomic level, and physical activity could not be recorded. Similarly, salt consumption could not be accurately quantified. An additional study including these data and other mixed school establishments of Libreville should be performed. However, the results obtained on cardiovascular disease risk factors and lifestyle give insight on the expected increase of cardiovascular diseases but also other non-communicable diseases (cancer, chronic respiratory diseases, and diabetes) in Libreville in the absence of a true prevention policy. National control programs adapted to all cardiovascular disease risk factors are essential. New communication techniques, which are widely used by the target population of children and adolescents, could be an excellent awareness tool.

Conclusion

Hypertension and its precursor prehypertension are a reality in the school environment in Libreville, Gabon. The associated and modifiable risk factors are essentially obesity, overweight and poor eating habits. High prevalence in tobacco and alcohol consumption are also cause for concern. Implementing awareness programs in this young population is a priority to overcome the expected cardiovascular mortality and morbidity in the near future..

Abbreviations

BMI: body mass index, BP: blood pressure, CI: confidence interval, OR: odds ratio N: number of data, NHBP: National High Blood Pressure, N: number of data, NW = normal weight, OW= overweight, O = obesity, OR = odds ratio WI: weight insufficiency,

Declarations

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Availability of data and materials

The datasets generated during and/or analyzed during this study are available upon reasonable request to the corresponding author.

Author's contribution

MKB-A was the principal investigator and conceived the study. BMD, OMN, RM, BP and BE collected all data in the field. Analysis of blood pressure figures were performed by EAB. EAB wrote the paper. DPM-M and MKB-A reviewed and edited the paper. The statistical analyses were carried out by MKB-A and EAB took part in the interpretation of data. EAB, OMN, RM, BP and BE were the physician of the study. All authors read and approved the final manuscript.

Ethics approval and consent to participate

This is detailed in "Methods" section.

Consent for publication

Not applicable

Competing interest

The authors declare that they have no competing interest.

Author's details

1- Department of Cardiology service of the University Hospital Center of Libreville, Gabon

2-Department of Parasitology-Mycology, University of Health Sciences, PO Box: 4009 Libreville, Gabon

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