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

Elsa AYO BIVIGOU

Université des Sciences de la Santé

Bridy MOUTOMBI DITOMBI

Université des Sciences de la Santé

Omella 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

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 a high school students from Libreville, the capital city of Gabon and to identify their predisposing 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 of family history of hypertension, eating habits, consumption of alcohol and/or tobacco, taking oral contraception, age, gender, body mass index and blood pressure were collected. The NHBP 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. The sex ratio was 2.3. The prevalence of hypertension was 19.4% and the predisposing factors were: obesity (OR: 2.62, [1.30-5.27]), overweight (OR: 2.52, [1.30-4.89]), male sex (OR: 2.13, [1.29-3.52]) and age over 18 (OR: 13.5, [6.6-27.4]). The prevalence of prehypertension was 23.0% and the predisposing factors were: obesity (OR: 4.38, [1.03-18.6]), overweight (OR: 2.16, [1.03-4.53]), the male sex (OR: 1.72, [1.10-2.78]) and the age below 18 years (OR: 1.21, [0, 57 to 2.56]).

Conclusions: Hypertension and prehypertension are frequent in school students from Libreville. Awareness on predisposing 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 among which cardiovascular diseases. These are responsible for a high mortality and morbidity with nearly 300 to 600 deaths per 100 000 inhabitants and they increasingly affect youth populations [1-2]. There are many factors linked with this morbidity-mortality which include the lack of knowledge on risk factors, delays in treatment, genetic and sociodemographic [2-3] 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 (PASCAR) and national scale [4]. The screening and the early management or correction of modifiable cardiovascular risk factors are also key components.

Hypertension is the main risk factor for cardiovascular diseases in sub-Saharan Africa, its prevalence varies from 33% to 70% in the adult population, depending on the regions [1-3,5]. Nearly 216 million individuals should be prone to hypertension by 2030 [5]. In addition to this high burden, hypertension of African natives is distinguished by early and severe complications which could be partly linked with the lack; 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 predisposing factors from adolescence, will allow reducing the risk of cardiovascular diseases and related adult mortality in sub-Saharan Africa [7-8].

Prehypertension or high blood pressure, is a known predisposing factor for a subsequent hypertension. Its correct management reduces the risk of progression into hypertension [9].

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

Methods

Study sites

This was a cross-sectional and analytical study carried out in two technical schools in Libreville from February to June 2019. It involved students from tenth to twelfth grade enrolled for the 2018-2019 school year. All the students 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 Elenga 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.

Parameters collection

The physical parameters which were collected included: age, gender, size, weight, body mass index (BMI) and blood pressure. 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 state of calm 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 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 statistical studies. 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. 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 superior to 5 mmHg above the 99th percentile.
- For students aged more than 18 years old, the diagnosis of hypertension was retained and stratified according to the the European Society of Cardiology (ESC) [12].
- Obesity was defined according to BMI by dividing the weight (in kilograms) by the square of the size (in meters). 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.
- 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 as well as the quantity of salt. 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

Data were recorded and processed using the Excel and Statview softwares.. The quantitative and qualitative variables were analyzed with the appropriate tests. In bivariate analysis, the comparison between the qualitative variables was performed with the chi-square test. The odd ratios (OR) were calculated for hypertension and prehypertension predisposing factors. A $p < 0.05$ value 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 minor participants gave their assents 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, respectively. 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

	Total 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 [19-22]	
BMI (kg/m2)	601	21.0 [19.6-22.9]	
Abdominal perimeter	601	72 [69-76]	
Systolic BP*	613	122.7 [113.7-131.5]	
Diastolic BP	613	70.2 [62.7-81.8]	

*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 sex, age, and family history

	Population		Sex			Age group (years)				Family history	
			M		F	14-17 18-24 >25			p		
	n	%	%	%	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	=
Systolodiastolic	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 systolodiastolic 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/m² in the case of hypertension. It was significantly higher in students with a systolic hypertension (23.3 [20-24.4] kg/m²) than those with a diastolic (21.1 [19.4-22.8] kg/m²) or systolodiastolic (21.9 [19.4-22.8] kg/m²) (p < 0.01) hypertension. Among obese students, 20% had a systolodiastolic hypertension whereas students with normal weight mainly had a diastolic hypertension (Table 3).

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

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

	Salty diet		Salty additives		Fat additives		BMI					Alcohol		Tobacco	
							LW	NW	OW	O					
	%	p	%	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	0.78	14.7	0.26
Type of hypertension	0.09		0.02		0.02		<0.01							0.71	
Systolic	4.1	=	4.3	=	5.6	=	0.0	5.2	11.1	0.0	=	5.7	0.97	5.7	=
Diastolic	7.6	=	10.5	=	10.5	=	11.5	9.4	11.1	0.0	=	9.0	0.97	5.6	=
Systolodiastolic	4.5	=	3.3	=	3.7	=	0.0	4.0	8.9	20.0	=	4.5	0.97	4.5	=
Hypertension degree	<0.01		0.05		0.07		<0.01							0.86	
Grade 1	16.2	=	16.8	=	18.7	=	11.5	17.6	11.0	10.0	=	17.7	0.68	14.7	=
Grade 2	0.0	=	1.1	=	0.8	=	0.0	0.7	20.1	10.0	=	1.3	0.68	1.1	=
Grade 3	0.0	=	0.2	=	0.2	=	0.0		0.0	0.0	=	0.0	0.68	0.0	=
							0.3								
Prehypertension	20.3	0.01	21.1	<0.01	-	0.02	2.9	83.5	10.1	3.6	0.01	22.7	0.76	26.1	0.86

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

Among students which added salty additives in meals, 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).

Bivaried analysis revealed that predisposing factors for hypertension were : obesity (OR:2.62, [1.30-5.27]), overweight (OR:2.52, [1.30-4.89]), male sex (OR:2.13, [1.29-3.52]) and an age above 18 years (OR:13,5, [6.6-27.4]). The female gender (OR: 0.52, [0.32-0.87]) and an age below 18 years (OR : 0.07, [0.04-0.15]) were protective (Table 4).

Salt consumption and family history of hypertension did not significantly increase the risk of hypertension (Table 4).

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

	Hypertension			Prehypertension		
	OR	CI 95%	p	OR	CI 95%	p
Age < 18 years	0.07	0.04-0.15	< 0.01	1.21	0.7-2.6	0.69
Age > 18 years	13.5	6.60-27.4	< 0.01	0.19	0.01-0.40	< 0.01
Female sex	0.52	0.32-0.87	0.01	0.58	0.37-0.90	0.02
Male sex	2.13	1.29-3.52	< 0.01	1.72	1.10-2.78	0.02
Obesity	2.62	1.30-5.27	<0.01	4.38	1.03-18.6	0.04
Overweight	2.52	1.30-4.89	<0.01	2.16	1.03-4.53	0.03
Hypertension family history	0.72	0.47-1.09	0.14	0.71	0.48-1.06	0.10
Salty diet	0.71	0.47-10.9	0.14	0.65	0.43-0.97	0.04
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	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

Prehypertension

Prehypertension was found in 23% of students and it predominated in boys or men ($p < 0.01$) (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).

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 addition of salt additives into meals and the regular consumption of fat additives were more frequent in patients with prehypertension ($p < 0.01$) (Table 3).

Bivaried analysis revealed that predisposing factors for prehypertension were: obesity (OR: 4.38, [1.03-18.6]), overweight (OR: 2.16, [1.03-4.53]), male sex (OR: 1.72, [1.10-2.78]) and an age below 18 years (OR: 1.21, [0.57-2.56]) (Table 4).

Discussion

This study is the first to report data on hypertension and its predisposing factors in a school environment in Gabon.

General data

The mean age of participants (20.3 years) was higher than the age of participants from other studies carried out in schools in sub-Saharan Africa; there, it varied between 11 and 18 years [10,14-16]. The fact that the selected school were professional and technical schools explains this difference. However, this study offers preliminary data in two target populations for hypertension prevention: adolescents and young adults which 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 the female sex predominates [10, 14, 16-18,].

Hypertension

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, 14, 16-19]. Indeed, methodological differences can explain this disparity, especially the type of measurement (oscillometric or auscultatory), the number of measures, the norms admitted, but also the mean age 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, 16, 18, 20]. 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 United-States of America and N’goran in Ivory Coast (1.2%) [14, 21]. It is however close to data reported in Central Africa, especially in Congo (10.1%) and Cameroon (17.9%) [16, 22]. The choice of the study population can partly explain these differences. Indeed, lowest prevalence (1.2 à 3.5 %) are reported in series which include younger students (mean age, 11.8 to 14.4 years) [10, 14, 17]. Hypertension in adolescents is 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 service [23]. Patients are often young and the main etiology (52%) is neglected or unknown hypertension [23]. 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 the child and adolescent should become a reflex among doctors. This study also reports hypertension prevalence in the 18-24 year age group. It is 18.3% and the hypertension risk is 13.5 after the age of 18. These data corroborate the link between age and the increased risk of hypertension previously described [17]. This young adult population should definitely be considered as a target for the control of the burden of 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 apparition of early cardiovascular complications [24]. Implementing early treatments and therapeutic education for these young adults is 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 (32.2%) is a good indication of the extent of this public health problem in Gabon.

Male students were 2.5 times more at risk of being hypertensive. These results corroborate those of other studies [14, 21]. The female gender seems protective (OR 0.52) but these data are not reported elsewhere [25].

Even though family history did not increase the risk of hypertension (OR 0.72), the link between them is well established [26]. The development of hypertension in children and adolescents depends on genetic and environmental factors [26-28]. Many studies report a higher frequency of hypertension in African and Hispanic children, as is the case for adults [21, 26]. In a study performed in Côte d’Ivoire, nearly two thirds (64%) of students reported a family history of hypertension [14]. Early lifestyle and dietary changes and the monitoring of students would diminish their risk of developing ulterior hypertension [28].

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 [10]. The link between excess weight and hypertension is already well established. Hypertension frequency increases with BMI, in both children and adults as observed in many studies in developed countries as well as sub-Saharan Africa [10,17-19, 21,28-31]. Obesity is responsible for a hypersensitivity to salt which increases the risk of hypertension [32]. 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 increases with obesity. Indeed, according to a WHO 2016 report, the prevalence of obesity has increased by nearly 50% in Africa since 2000 [33]. Reducing the risk and the frequency of excess weight must be one of the targets in hypertension prevention and control in children and adolescents [34].

Alcohol consumption was not associated with the risk of hypertension, even though it slightly predominated in a study population from Cameroon [16]. The association 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 [26, 35, 36]. An even moderate reduction in alcohol consumption has been shown to diminish the level of blood pressure [37]. 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 as reported elsewhere in sub-Saharan Africa [14,25]. This type of hypertension is associated with an increased risk of cardiovascular events [38]. 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 [38].

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 [39]. In a study performed by Johnson, it was often neglected and linked to the “white coat effect” [24]. Even though its negative prognostic is controversial in young subjects, diastolic hypertension management is necessary, especially through early lifestyle and dietary measures [11, 39, 40]. It is however sometimes associated with a low diagnostic and treatment rate [24]. Systolic hypertension was more frequent in our study participants who regularly consumed fat additives. It has been reported to correlate with BMI and waist size [18]. Frequent awareness campaigns must be implemented in school establishments in order to fight against therapeutic inertia and begin early care for these students.

Prehypertension

Prehypertension was found in almost one quarter (23%) of the study participants, especially in adolescents (24.4%). A comparable prevalence was reported in Congo (20.7%) while diverse rates were noted in South-Africa (12.3%), Nigeria (2.5 à 5%) and Algeria (12.4%) [10, 17, 18, 25]. However, 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 determined following three measurements separated each by one month as recommended by the NHBP and taking into account the important variation in blood pressure during childhood and adolescence [11, 9]. However, data on prehypertension prevalence in African populations are contradictory. A possible increase in the risk of hypertension in teenagers was mentioned in the United-States, but these results were not found in other studies [29, 30, 42, 43].

Obesity and overweight were found associated with the risk of prehypertension in this study. This association is well known and seems more important in the girls and young women [10, 17-18, 30, 31, 44]. Waist size, which could not be studied in this work, is also linked to the prehypertension risk, even in the absence of excess weight [30-41]. 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 in this work, other studies report a positive correlation between these different factors [31, 38, 44]. This association should motivate the public health system to emphasize the fight against tobacco and alcohol consumption, which remains a priority in the youth population.

Approximately 0.5 to 1.1% prehypertensive adolescents develop hypertension each year, while prehypertension management reduces the probability of this evolution [9, 30]. 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, 43]. 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 [45]. 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 Libreville Faculty of Medicine.

Limits and perspectives:

This study had some limits. First, it was performed in professional technical schools which are not representative of the type of schools in Libreville. 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. An additional study including these information 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, 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 Wl: weight insufficiency,

Declarations

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Availability of data and materials

The datasets generated during and/or analysed 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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