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Hypertension: Prevalence and Associated Factors in Gabonese Youth and Adolescents

Elsa Ayo Bivigou[1, *], Bridy Moutombi Ditombi[2], Ornella Mbang Nguema[2], Reinne Moutongo[2], Bedrich Pongui[2], Bernadette Ekomi[2], Patricia Mawili-Mboumba[2], Marielle Karine Bouyou-Akotet[2]

[1]Cardiology Department, Medical School, University of Health Sciences, Libreville, Gabon

[2]Department of Parasitology-mycology, University of Health Sciences, Libreville, Gabon

Email address:

bivayo@yahoo.fr (E. A. Bivigou)

[*]Corresponding author

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Abstract: *Background:* Early detection of hypertension is necessary to reduce the risk of cardiovascular events. The aim of our study was to determine the prevalence of hypertension in high school students from Libreville, 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 professional technical high schools in Libreville during the 2018-2019 school years. The collection of students was done randomly in the two establishments after parental consent and administrative authorizations. The sample size was calculated using the Daniel Sharwtz's formula. The parameters collected were anamnestic, socio-demographic and clinical. The National High Blood Pressure and European Cardiology Society 2017 classifications were used for the analysis of blood pressure in children and young adults respectively. *Results:* A total of 613 students with mean an 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: 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]). *Conclusions:* Hypertension is frequent in school students from this region. Awareness of associated factors and screening campaigns within school establishments are necessary to reduce complications in adulthood.

Keywords: Hypertension, Adolescents, Young Adults, Libreville

1. Introduction

In addition to infectious diseases, sub-Saharan Africa is marked by the rise of non-communicable diseases among which cardiovascular diseases are prominent [1]. These are responsible for a high rate of mortality and morbidity with nearly 300 to 600 deaths per 100 000 inhabitants and affect increasingly young population [1-2]. There are many factors linked with this morbidity-mortality which include delays in treatment, genetic and sociodemographic particularities [2-6]. It is therefore essential to implement adapted control programs for cardiovascular diseases with the development of treatment strategies as well as prevention plans both on the regional (Pan-African Society of Cardiology) and national scale [4]. Hypertension is the main cardiovascular risk factor in sub-Saharan Africa [3-5]. In a meta-analysis reported by Bosu, its prevalence varies from 22.3% to 90% from individual studies in the 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 [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 Gabon, very little data is available on the effective rate of hypertension prevalence in

Gabonese citizens, especially in adolescents and young adults. The aim of this study was to determine the prevalence rate of hypertension in a high school environment in Libreville and to identify the associated factors.

2. Methods

2.1. Study Sites

This was a cross-sectional and analytical study carried out in the two technical schools in Libreville, capital of Gabon, from February to June 2019. Gabon is a country in Central Africa and is ranked as a middle income country. This study was conducted in urban areas and the participants had westernized lifestyles that represent the way of life of many populations of large African cities today. 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 teams and investigators of the study. Data on the students was then gathered randomly in the two establishments upon spontaneous presentation of the student.

2.2. 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 [9]. Using Daniel Schwartz's formula (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.

2.3. Inquiry

All the students who agreed to participate in the study were received 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.

2.4. Parameters Collection

The physical parameters which were collected included: age, gender, size, weight and blood pressure. Body mass index (BMI) was calculated from the data collected. During the collection of these parameters, the students only kept their school uniforms on 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 level 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 Pan-African Society of Cardiology (PASCAR) guidelines [4, 10]. 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.

2.5. 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]. For students aged older then 18 years, the diagnosis of hypertension was conducted according to the European Cardiology Society (ESC) 2017 classification [11]. 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 [12]. Obesity was defined for a BMI above the 95^{th} percentile, and overweight between the 85^{th} and 95^{th} percentile, respectively. For students older than 18 years, the World Health Organization 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.

2.6. Statistical Analysis

The data were saved using Excel and statistical analysis by Statview. 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 associated factors. A $p<0.05$ value was considered significant.

2.7. 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 under 18 gave a consent form signed by their parents or legal guardians which had been handed to them a week before.

All students benefited from advice 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.

3. 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.

3.1. 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%). 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.

3.2. 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).

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.

Table 1. *Characteristics of the study population.*

	Total population		
	N	**n**	**%**
Age group (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 (years)	613	20	[19-22]
BMI (kg/m^2)	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]

* data are not recorded for all patients, **Blood Pressure

Table 2. *Prevalence of hypertension according to sex, age, and family history.*

	Population		**Sex**			**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	=
Systolo-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	=

Table 3. *Prevalence of hypertension 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*		*0.97*		*0.71*
Systolic	4.1	=	4.3	=	5.6	=	0.0	5.2	11.1	0.0	=	5.7	=	5.7	=
Diastolic	7.6	=	10.5	=	10.5	=	11.5	9.4	11.1	0.0	=	9.0	=	5.6	=
Systolo-diastolic	4.5	=	3.3	=	3.7	=	0.0	4.0	8.9	20.0	=	4.5	=	4.5	=
Hypertension degree		*<0.01*		*0.05*		*0.07*					*<0.01*		*0.68*		*0.86*
Grade 1	16.2	=	16.8	=	18.7	=	11.5	17.6	11.0	10.0	=	17.7	=	14.7	=
Grade 2	0.0	=	1.1	=	0.8	=	0.0	0.7	20.1	10.0	=	1.3	=	1.1	=
Grade 3	0.0	=	0.2	=	0.2	=	0.0	0.3	0.0	0.0	=	0.0	=	0.0	=

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

Table 4. *Factors associated with hypertension (bivariate analysis).*

	OR	CI 95%	p
Age < 18 years	0.07	0.04-0.15	< 0.01
Age > 18 years	13.5	6.60-27.4	< 0.01
Male sex	2.13	1.29-3.52	< 0.01
Obesity	2.62	1.30-5.27	<0.01
Overweight	2.52	1.30-4.89	<0.01
Hypertension family history	0.72	0.47-1.09	0.14
Salty diet	0.71	0.47-10.9	0.14
Salty additives	0.80	0.51-1.27	0.40
Fat consumption	1.50	0.78-2.86	0.14
Alcohol consumption	0.94	0.63-1.40	0.80

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 systolo-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 systolo-diastolic (21.9 [19.4-22.8] kg/m^2) ($p < 0.01$) hypertension. Among obese students, 20% had a systolo-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.

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 ($p=0.02$).

Bivariate analysis revealed that associated factors for hypertension were: obesity, overweight, male sex and an age above 18 years (Table 4).

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

4. Discussion

4.1. 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 in which it varied between 11 and 18 years [9, 13-15]. The fact that the selected school were professional technical 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 [9, 13-17].

4.2. 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% [9, 13, 17-20]. 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). The automatic measurement of blood pressure was chosen for this work as in other studies for this advantages among which ease of use and the minimization of the "white coat effect" especially in

young students [15, 17].

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%) [18, 19]. It is however close to data reported in Central Africa, especially in Congo (10.1%) and Cameroon (17.9%) [9, 14]. 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) [9, 13, 16]. Hypertension in adolescents is associated with an increase of cardiovascular mortality in adulthood, especially by cerebrovascular strokes with a risk multiplied by 3.12 according to Leiba et al. [8]. 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, often overlooked in our region, should become a reflex among doctors. This study also reports a high prevalence of hypertension 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 [16]. 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 apparition of early cardiovascular complications [17]. 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.

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 [9]. The link 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 in developed countries as well as sub-Saharan Africa [9, 16-17, 21-22]. Obesity is responsible for a hypersensitivity to salt which increases the risk of hypertension [22]. 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 [23]. Reducing the risk and the frequency of excess weight must be one of the targets in hypertension prevention and control in children and adolescents [22-24].

Alcohol consumption was not associated with the risk of hypertension, even though it slightly predominated in a study in Cameroon [15]. 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 [25-26]. An even moderate reduction in alcohol consumption has been shown to diminish the level of blood pressure [26]. 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 [13]. This type of hypertension is associated with an increased risk of cardiovascular events [27]. 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 [27].

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 [28]. In a study performed by Johnson, it was often neglected and linked to a "white coat effect" [17]. Even though its negative prognostic is controversial in young subjects, its management is necessary, especially through early lifestyle and dietary measures [10, 28]. It is however sometimes associated with a low diagnostic and treatment rate [17]. 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 [17]. Frequent awareness campaigns must be implemented in school establishments in order to fight against therapeutic inertia and begin early care for these students.

5. Limits and Perspectives

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. An additional study including these data and other mixed school establishments of Libreville should be performed. However, the results obtained on cardiovascular disease risk factor sand 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.

6. Conclusion

Hypertension is 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.

Additional Files

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,

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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. MKB-A and PMM reviewed and edited the paper. The statistical analyses were carried out by MKB-A and PMM 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

Competing Interest

The authors declare that they have no competing interest.

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