Original Research Article

Prevalence of hypertension and its association with anthropometric indices among students of the University of Maroua (Far North Region, Cameroon)

ABSTRACT

Aims: Hypertension (HTN) is one of the major public health problems in the world, especially in developing countries. The objective of this study was to evaluate its prevalence and its association with anthropometric indices among students of the University of Maroua.
Study design: A cross-sectional, analytic, and descriptive study was designed.
Place and Duration of Study: Different campuses of the University of Maroua located in the Far-North Region of Cameroon, between January and February 2018.
Methodology: A total of 330 Cameroonian and Chadian students aged 17 to 35 years were recruited. Anthropometric parameters (weight, height, waist, and hip circumference) and blood pressure were measured. Hypertension (HTN) was diagnosed according to the International Diabetes Federation (IDF) and World Health Organization (WHO) criteria. Data were analyzed with Chi-square, Student t-tests, simple linear regression, and multivariate analysis.
Results: The prevalence of HTN was 8.2% according to WHO criteria and 21.8% according to IDF criteria. Men were more vulnerable (10%) than women (3.4%). Students aged 26-30 years old were the most affected (27%). Isolated diastolic hypertension (IDH) was the most common subtype in the general population, regardless of gender and nationality. Most participants with hypertension were in the pre-HTN stage (11.5%). Overweight (OR=3.73; 95% CI: 1.39-10.00) and waist-to-height ratio (WHtR) ≥0.5 (OR=3.64; 95% CI: 1.27-10.44) significantly increased the risk of developing HTN among students.
Conclusion: Regular blood pressure monitoring to prevent the silent development of HTN including early detection of HTN using Body Mass Index and WHtR will allow the decline of the disease in adulthood in these young people.

Keywords: Prevalence, hypertension, anthropometric indices, students, University of Maroua

1. INTRODUCTION

Hypertension is among the first five causes of mortality. Globally it contributes to more than 40% to cardiac-related deaths worldwide, with almost 70% of cardiovascular deaths in the low- and middle-income countries [1]. The disease is a silent threat to the health of people all over the world, with up to one-third of the world's population affected [2]. The WHO data predict a 1.56 billion (60%) increase in the global burden by the year 2025, while one in three adults living in low- and middle-income countries suffer from hypertension [3]. It is accountable for 20 to 50% of all deaths, especially in developing countries [4]. In Africa, HTN often affects the young population with later diagnosis of high blood pressure [5] and related complications in some organs [6] such as heart and kidney failure [7]. In Cameroon, the prevalence of HTN is estimated at 31% at the national level [8] and to 29.9% in Kaelé, a city in the Far North region of the country [9], and a prevalence of 12.7% was noted among 15–35-year-olds [10]. HTN risk factors are related to lifestyle habits such as smoking, high consumption of fatty and/or salty diets, and genetics [11].

With the high incidence of HTN worldwide, it is evident that young adults are not spared, despite the low screening rate in this population [12]. Several studies have shown that hypertension and pre-hypertension can start in the teenage years,

perhaps in the early stages of life, and continue into adulthood [13]. Young adults, characterized by the transition from adolescence to adulthood, become an important target of risk factors for several diseases; many experiences related to significant lifestyle changes, such as leaving home and going to university [14]. This important phase in the life cycle of young people makes them vulnerable to cardiovascular diseases in general [15] and hypertension in particular [16]. Importantly, during this phase of life, young adults begin to accumulate risk factors for diseases such as obesity or abdominal obesity which are risk factors for high blood pressure [17]. For this purpose, body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR), and waist-to-height ratio (WHR) are anthropometric indices used for the early diagnosis of obesity-related complications which may contribute to the development of hypertension [18]. However, many studies in different populations have shown differences in the ability of anthropometric indices to predict hypertension [19].

Most studies in Cameroon have examined the prevalence of hypertension in adults. Therefore, little is known about the case of university students. Furthermore, it is well known that hypertension is an asymptomatic disease that only reveals itself when complications arise. It is therefore very important to identify the populations that are at risk by early detection at an early age. Hence, the present study was initiated to assess the situation of hypertension in the student population of the University of Maroua. This will not only provide statistics on this pathology but will also identify associated risk factors for this part of the population.

2. MATERIAL AND METHODS

2.1 Description of the population and place of study

A cross-sectional, descriptive, and analytical study was carried out in January and February 2018 on different campuses of the University of Maroua located in the Far-North Region of Cameroon. The University of Maroua is the only Cameroonian University located in the Sahelian zone of the country and therefore presents particular geographical and climatic constraints. A total of 330 students aged 17 to 35, apparently healthy and untreated for high blood pressure, were recruited at the Faculty of Human and Social Sciences (FHSS); the Faculty of Science (FS); the Faculty of Economics and Management Science (FEMS); the Faculty of Law and Political Sciences (FLPS); the National Polytechnic High School (NPHS) and the Higher Teachers' Training College (HTTC) in the city of.

2.2. Ethical consideration and willingness to participate

The study received approval from the National Ethics Committee of Research for Human Health of Cameroon at No.2014/08/488/EC/CNERSH and each participant provided a written and signed consent form.

2.3. Structured interview questionnaire

A face-to-face interview was conducted with each volunteer by a well-trained enumerator using a questionnaire adapted from the STEP wise approach for metabolic disease surveillance instrument v2.1. Data were gathered on age, socio-demographic status, lifestyle, familial and personal history of hypertension, smoking status, and alcohol consumption.

2.4. Anthropometric measurements and nutritional status assessment

Weight (to the nearest gram), height, and waist circumference (to the nearest centimeter) were measured with participants in light clothing and footwear-free using standard methods. The body mass index (BMI) was computed and participants were classified according to WHO criteria [20] as normal weight (BMI between 18.5-24.9 kg/m2) and overweight (BMI ≥ 25 kg/m2). The IDF African-specific and WHO definitions were used to diagnose abdominal fat accumulation (a waist circumference (WC) ≥ 80 cm in women or ≥ 94 cm in men according to IDF; a waist to hip ratio (WHR) > 0.90 in women or > 0.85 in men according to WHO) [21]. WHtR was calculated as the ratio of waist circumference to height (cm). Standard cut-offs of 0.5 were used for WHtR, as described by Ashwell *et al*. [22], which did not take into account the difference in ethnicity. WHtR < 0.5 was considered normal and ≥ 0.5 was considered at risk.

2.5. Blood pressure measurement and definition of high blood pressure

Arterial blood pressure was performed by a nurse using a SmartheartTM (Automatic Digital Blood Pressure Arm Monitor) on the left arm in a quiet room after the students had rested for at least 10 minutes in a sitting position. An appropriate size of the cuff and standard measures were taken to ensure accuracy. Their left arms were kept at the same level as their heart during the measurement and two consecutive measurements were taken at an interval of at least five minutes.

The average of the two measurements was used to assess the presence or absence of high blood pressure in the participant. The IDF definition was used to assess high blood pressure (SBP ≥ 130 mmHg and/or DBP ≥ 85 mmHg) and the WHO definition for HTN (SBP ≥140 mmHg and/or DBP ≥ 90 mmHg) [21]. For the HTN subtypes, the following thresholds were used: isolated systolic HTN (SBP ≥ 130 and DBP < 85 mmHg); isolated diastolic HTN (SBP < 130 and DBP ≥ 85 mmHg), and systo-diastolic HTN (SBP ≥ 130 and a DBP ≥ 85 mmHg) [23]. The following thresholds were used to classify hypertensive patients according to the stage of the disease: pre-HTN (SBP = 130-139 mmHg and/or DBP = 85-89 mmHg); HTN grade 1 (SBP=140-159 mmHg and/or DBP= 90-99 mmHg); HTN grade 2 (SBP≥160 mmHg and/or DBP ≥ 100 mmHg) [24].

2.6. Data analysis

Data collected were analyzed using the Statistical Package for the Social Sciences (SPSS, version 20.0 for Windows). Descriptive statistics included frequency (%), and means ± Standard Deviation (SD). Chi-square and Student t-tests were performed to determine if the ratio of hypertensives between genders and nationalities was statistically significant. Univariate analysis and multivariate logistic regression were performed to determine the associations between gender, waist circumference, WHR, BMI, WHtR, and hypertension. The significance level was adjusted to 0.05.

3. RESULTS

3.1. General characteristics of the study population

Out of the 330 students who took part to this survey, 120 (36.4%) were Chadians and 210 (63.6%) were Cameroonians. Among them, 73% (241) were men, and 27% (89) were women. In terms of age, the majority of participants were aged between 17-25 years old. As concerns their marital status, 89.7% of them were single while 10.3% were married. In addition, 81.5% of the student surveyed were undergraduates (Table 1).

Table 1. General characteristics of the study population

		Frequency n=330	Percentage (%)
Nationality	Cameroonian	210	63.6
	Chadian	120	36.4
Gender	Men	241	73.0
	Women	89	27.0
Age (years)	17-25	241	73.0
	26-30	63	19.1
	31-35	26	7.9
Marital status	Single	296	89.7
	Married	34	10.3
Level of education	undergraduate	269	81.5
	graduate	61	18.5

3.2. Clinical characteristics of the study population

Table 2 presents the anthropometric and hemodynamic characteristics of the study population. The mean age was significantly higher among Cameroonians (p=0.003) and men (p=0.027) as compared to Chadians and women respectively. Regarding anthropometry, the Chadian student had a high waist circumference (77.65±6.15 cm vs

75.20±8.09 cm for Cameronian); the female student exhibited a higher BMI (23.06±3.60 kg/m^2 vs 21.87±2.33 kg/m^2) and a higher WHtR (0.45±0.05 vs 0.43±0.03) while male students had a higher WHR (0.83±0.05 vs 0.80±0.08). The mean SBP was significantly higher among males (112.24±11.68 mmHg; p<0.05) compared to female students.

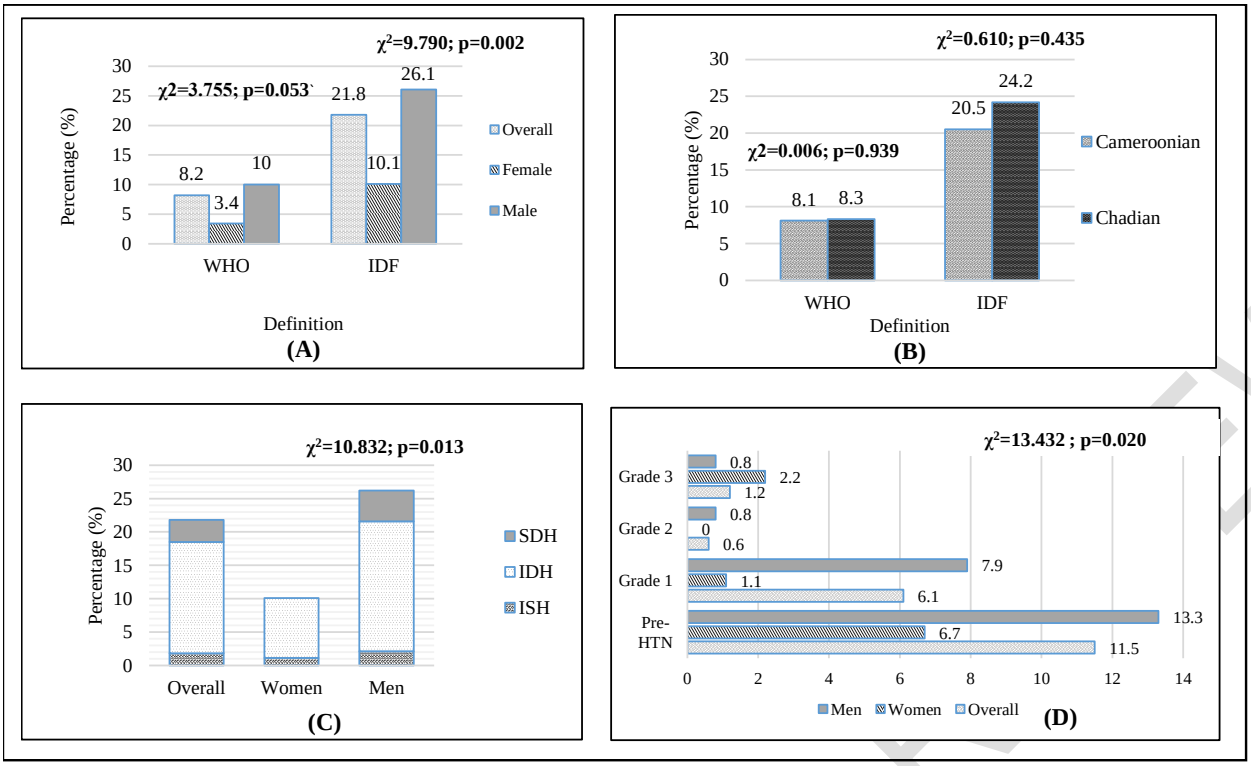
Table 2. Anthropometric and hemodynamic characteristics of the study population

Parameters	Overall	Nationality			Gender		
		Cameroonian	Chadian	P value	Female	Male	P value
Age (years)	23.95±3.67	24.40±3.82*	23.16±3.24	0.003	23.06±3.60	21.87±2.33*	0.027
BMI (kg/m²)	22.19±2.78	22.20±2.87	22.18±2.62	0.953	23.06±3.60	21.87±2.33*	0.001
WC (cm)	76.09±7.53	75.20±8.09*	77.65±6.15	0.004	74.81±9.62	76.57±6.55	0.060
WHR	0.82±0.06	0.82±0.07	0.83±0.04	0.193	0.80±0.08	0.83±0.05*	0.0001
WHtR	0.44±0.04	0.43±0.04	0.43±0.03	0.982	0.45±0.05	0.43±0.03*	0.001
SBP (mmHg)	111.42±11.08	111.72±11.28	110.90±10.75	0.519	109.19±8.95	112.24±11.68*	0.026
DBP (mmHg)	76.98±10.05	77.28±10.08	76.46±10.01	0.478	75.70±1.00	77.45±10.05	0.159
HR(pulse/min)	83.00±18.36	81.66±15.56	85.36±22.33	0.078	83.43±11.73	82.85±20.29	0.799

*= Mean significantly different at P < 0.05, BMI = Body Mass Index, WC= Waist circumference, WHR= waist-to-hip ratio, WHtR = Waist to height ratio, SBP= Systolic Blood Pressure, DBP=Diastolic Blood Pressure, HR= Heart Rate.

3.3. Prevalence of hypertension in the study population

HTN was diagnosed according to the IDF and WHO definitions. Results in Figure 1A show that among the overall population, the prevalence of hypertension was 8.2% (WHO definition) and 21.8% (IDF definition). Chadian students (24.2%) were slightly more affected by high blood pressure than Cameroonian students (20.5%) meanwhile male participants were the most vulnerable compared to females, according to the IDF definition (p=0.002) (Fig 1A and 1B). In addition, 11.5% of participants were pre-Hypertensive. However, the proportion of those in stages 1 and 2 was not negligible for a young population (6.1 and 0.6% respectively) (Fig 1 D). IDH was the most prevalent subtype of HTN in the overall population and regardless of gender followed by the combined systolic/diastolic subtype. In addition, there was no case of the combined subtype (SDH) among female students (Fig 1 C).



HTN : hypertension; ISH : isolated systolic hypertension; IDH : isolated diastolic hypertension; SDH : systo-diastolic hypertension

Figure 1. Prevalence and feature of HTN according to gender (A), nationality (B), subtype (C) and grade of HTN (D)

3.4. Distribution of hypertension by age strata in the study population

Table 3 shows that the 26-30 age group was the most affected by hypertension with 17 cases out of 63 participants (27%). Male and female students had a prevalence of 29.2% and 20.0%, respectively for the 26-30 age group.

Table 3. Prevalence of hypertension by age strata according to the IDF criteria

	Age (years)			P value
	17-25	26-30	31-35	
	n=241	n= 63	n= 26	
Overall	20.7 (50)	27 (17)	19.2 (5)	
Women	8.7 (6)	20.0 (3)	0 (0)	0.535
Men	25.6 (44)	29.2(14)	23.8(5)	

Results are expressed as percentage % (n).

3.5. Contribution of anthropometric indices to the risk of developing hypertension in the study population

Among these participants, 40 (12.1%) and 28 (8.5%) presented abdominal fat accumulation according to IDF and WHO definitions respectively; 43 (13%) were overweight and 39 (11.8%) had an at-risk waist-to-height ratio. Also, being overweight (OR=3.73; 95% CI: 1.39-10.00) or having an at-risk waist-to-height ratio (OR=3.64; 95% CI: 1.27-10.44) significantly increased the risk of developing hypertension among these students (Table 4).

Table 4: Evaluation of some anthropometric indices as risk factors for hypertension in the study population

Anthropometric indices		Frequency % (n)	P value	Odd ratio	P value	Odd ratio (gender control)	P value
high WC (IDF criteria)	No	87.9 (290)	0.0001	1		1	
	Yes	12.1 (40)		0.26 (0.03-1.97)	0.193	0.49 (0.05-4.49)	0.531
high WHR (WHO criteria)	No	91.5 (302)	0.0001	1		1	
	Yes	8.5 (28)		0.85 (0.19-3.80)	0.834	1.01 (0.22-4.54)	0.999
BMI≥25kg/m^2 (Overweight)	No	87 (287)	0.0001	1		1	
	Yes	13 (43)		2.59 (1.02-6.56)	0.044	3.73 (1.39-10.00)	0.009
WHtR ≥ 0.5 (At risk)	No	88.2 (291)	0.0001	1		1	
	Yes	11.8 (39)		2.33 (0.88-6.20)	0.088	3.64 (1.27-10.44)	0.016

WC= Waist circumference, WHR= waist to hip ratio, BMI = Body Mass Index, WHtR = Waist to height ratio.

4. Discussion

The prevalence of hypertension observed among students of the University of Maroua respectively of 8.2% (WHO definition) and 21.8% (IDF definition) were similar to those reported by Losimba *et al*. [6] among students at Kisangani University in the Democratic Republic of Congo (8%), but was lower than the 12.7% (WHO definition) obtained by Epacka *et al*. [10] among students at Douala University. These results were also contrary to those of Maha *et al*. [25] who reported a prevalence of 26.5% at the University of Damietta in Egypt. In addition, all these studies also noted a significant gender difference. A low prevalence in women (3.4% according to the WHO definition) and (10.1% according to the IDF definition) was noted (Figure 1A) as well as a higher prevalence of pre-HTN among men (13.2%) compared to women (6.7%) (figure 1D). Similar observations were made by Peltzer *et al*. [26] in a study of students in the Association of Southeast Asian Nations (ASEAN) countries, where they found that 28.7% of male students and 13.9% of female students were pre-hypertensives. This difference could be attributed to female hormones, particularly estrogens, which have a protective effect on the cardiovascular system. These hormones have a vasodilatory effect on vascular endothelial cells [27, 28].

A slight difference was observed between the frequency of elevated blood pressure among Cameroonian versus Chadian students (20.5% versus 24.2%) (Figure 1B). This difference may be related to socio-economic, demographic, dietary, and geographical characteristics [29,30]. Regarding the HTN subtypes, the results (Figure 1C), were different from those reported by Abiodun *et al*. [31] where the combined form (SDH) was highest (77.6%) among 18 years of age and older in South-West Nigeria. The prevalence of pre-HTN (11.5%) observed among Maroua students (Figure 1D) was similar to those reported in studies conducted by Peltzer *et al*. [26] among Indonesian and Malaysian students. These authors noted an increased pre-HTN prevalence of 11.3% and 11.5% respectively. However, these results were different from Chitrapu and Thakkallapalli [32] who observed 37.45% pre-HTN in 275 medical students in India. The observed difference can be attributed to socio-economic conditions of communities and lifestyles differences [33, 34]. In general, the dissimilarities observed between the two nationalities listed in terms of the prevalence of pre-hypertension can be attributed to the different stages of the epidemiological transition of the populations participating in the study and also to the effects of dynamic interactions between genetic, demographic, socio-cultural and economic factors [26]. Also, most Chadian students lived far away from their parents or without guardians in the city of Maroua. As a result, they were at a higher risk of pre-HTN compared to Cameroonian students, with many of them still living with their parents or guardians. Previous studies have shown that students living away from their parents may be more influenced by lifestyle changes that increase the risk of development of pre-HTN and even HTN [13, 35].

Regarding the age distribution of hypertension, it is noted that although previous studies have reported that the prevalence of hypertension increases with age [36], our results showed a decrease in the prevalence of hypertension in the 31-35 years age group (19.2%) (Table 3). This observation is consistent with the work of Tanu *et al*. [37] who found that the prevalence of hypertension was high in younger age groups, particularly in developing countries. This high incidence of hypertension in our study population, which is mainly in the 26-30 years age group (27%), could be related to stress due to study pressure and lifestyle habits (unhealthy diet and lack of physical activity). This finding is per Spruill's [38] observations who demonstrated that the high incidence of hypertension in the population may be partly due to career and life stress.

When considering the contribution of anthropometric indices to the occurrence of hypertension, our results are in agreement with those reported by other studies which have shown that a 5% weight gain is associated with a 20-30% increase in the risk of developing hypertension [39]. Indeed, being overweight is a major risk factor closely associated with hypertension. This occurs by activating the renin-angiotensin-aldosterone system, which has been considered to have an important function in the pathogenesis of obesity-related hypertension by causing vasoconstriction that leads to an

increase in blood pressure [40]. Furthermore, this study found that a waist-to-height ratio ≥0.5 was associated with a 3.64-fold increased risk of developing hypertension in students (Table 4). This result is consistent with the work of Lu *et al*. [41] who showed that the waist-to-height ratio was positively associated with hypertension in young adults in the Southern part of China. Indeed, it has been reported that WHtR is a better marker of adiposity for detecting hypertension than BMI, waist circumference, and WHR [42, 19].

4. CONCLUSION

Hypertension was indeed present among students at the University of Maroua and Chadian students were slightly more affected compared to Cameroonian students. Isolated diastolic hypertension was the most prevalent subtype in the overall population, regardless of gender and nationality. However, being overweight, and having a high waist-to-height ratio increased the risk of HTN among this population, requiring more attention in terms of hypertension management, morbidity prevention, and cardiovascular mortality.

CONSENT

All authors declare that written informed consents were obtained from the students.

ETHICAL APPROVAL

"All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki."

REFERENCES

1. Nahimana MR, Nyandwi A, Muhimpundu M A, Olu O, Condo J U, Rusanganwa A, Ota MO. A population-based national estimate of the prevalence and risk factors associated with hypertension in Rwanda: implications for prevention and control. BMC Public Health. 2017; 18(1) :1-9.

2. Mamdouh H, Alnakhi KW, Hussain YH, Ibrahim, Hussein A, Mahmoud I, Alawadi F, Hassanein M, Abdullatif M, AlAbady K, Farooq S, Sulaiman N. Prevalence and associated risk factors of hypertension and pre-hypertension among the adult population: findings from the Dubai Household Survey, 2019. BMC Cardiovascular Disorders. 2022; 22:1-9.

3. Lim, S. S., Vos, T., Flaxman, A. D., Danaei, G., Shibuya, K., Adair-Rohani, H., Andrews, K. G. (2012). A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. The Lancet, 380(9859), 2224-2260.

4. Saka MH, Shabu SA, Shabila NP. Prevalence of hypertension and associated risk factors in a population sample of older adults in Kurdistan, Iraq. East Mediterr Health J. 2019;25:1-15.

5. Traore DHO Ba, Dougnon O, Coulibaly S, Diall IB, Sidibe N, Sangare I, Camara Y, Sanogo KM. HTA in young subjects aged 18 to 35 years in the Cardiology Department of the University Hospital. 2014; (10) 13070/rs.fr.1.1254c.

6. Losimba LJ, Munyapara SA, Yemba A, Batina AS. Frequency of hypertension and risk factors among students in the Department of Public Health at the University of Kisangani, DRC. Kisangani Medical. 2014; 5(1): 2-8.

7. Kayima A, Nankabirwa J, Sinabulya I, Nakibuuka J, Zhu X, Rahman M, Longenecker TC, Katamba A, Mayanja-Kizza H, Kamya RM. Determinants of hypertension in a youngadult Ugandan population in epidemiologicaltransition—the MEPI-CVD survey. BMC Public Health.2015; 15(830): 1-9.

8. Kingue S, Ndongngoe C, Menanga A, Fesuh B, Nooueddoui C, Muna WFT. Prevalence and risk factors of hypertension in urban areas of Cameroon: a nationwide population-based crosssectional study. The journa of Clinical Hypertension. 2015; 17(10): 819-824.

9. Ntentie RF, Tchuente TRB, Nguedjo WM, Dama G, Mboindi MO, Azantsa KGB, Ngondi LJ, Oben EJ. A silent killer in the Far North Region of Cameroon: Increasing prevalence of hypertension among Kaele dwellers. International Research Journal of Medicine and Biomedical Sciences. 2015; 4(2): 13-22.

10. Epacka E, Mandengue HS, Priso EB, Moumbe TS, Ahmadou, Bita AF. Screening of cardiovascular diseases among students at the University of Douala and influence of physical and sports activities. Pan Afr Med J. 2012; 11: 77.

11. Kwon YJ, Kim JO, Park JM, Choi JE, Park DH, Song Y, Hong, KW. Identification of Genetic Factors Underlying the Association between Sodium Intake Habits and Hypertension Risk. Nutrients. 2020; 12(9): 1-13.

12. Gooding HC, McGinty S, Richmond TK, Gillman MW, Field AE. Hypertension Awareness and Control Among Young Adults in the National Longitudinal Study of Adolescent Health. Journal of General Internal Medicine. 2014; 29(8) :1098-1104.

13. Al-Majed HT, Sadek AA. Pre-hypertension and hypertension in college students in Kuwait: a neglected issue. J Family Community Med. 2012;19 (2): 105-112

14. Lanoye A, Brown KL, LaRose JG. The Transition into Young Adulthood: a Critical Period for Weight Control. Current Diabetes Reports. 2017; 17(11): 1-14.

15. Diaz-Valencia PA, Bougnères P, Valleron AJ. Global epidemiology of type 1 diabetes in young adults and adults: a systematic review. BMC Public Health. 2015; 15:255.

16. Poobalan A, Aucott L. Obesity Among Young Adults in Developing Countries: A Systematic Overview. Curr Obes Rep. 2016; 5:2-13.

17. Takeoka A, Tayama J, Yamasaki H, Kobayashi M, Ogawa S, Saigo T, Shirabe S. Intra-abdominal fat accumulation is a hypertension risk factor in young adulthood. Medicine. 2016; 95(45): e5361.

18. Yazdi M, Assadi F, Qorbani M, Daniali SS, Heshmat R, Esmaeil Motlagh M, Kelishadi R. Validity of anthropometric indices in predicting high blood pressure risk factors in Iranian children and adolescentss. J Clin Hypertens. 2020; 22(6): 1009-1017.

19. Dereje R, Hassen K, Gizaw G. Evaluation of Anthropometric Indices for Screening Hypertension Among Employees of Mizan Tepi University, Southwestern Ethiopia. Integrated Blood Pressure Control. 2021;14: 99-111.

20. World Health Organization (WHO). Obesity: Preventing and Managing the Global Epidemic. WHO technical report series 894. 2000; 252.

21. Alberti KGM, Zimmet P, Shaw J. The metabolic syndrome—a new worldwide definition. The Lancet. 2005; 366(9491): 1059-1062.

22. Ashwell M, Gunn P, Gibson S. Waist-to-height ratio is a better screening tool than waist circumference and BMI for adult cardiometabolic risk factors: systematic review and meta-analysis. Obes Rev. 2012; 13: 275-286.

23. Franklin SS, Pio JR, Wong ND, Larson MG, Leip EP, Vasan RS, Levy D. Predictors of new onset diastolic and systolic hypertension: the Fra-mingham Heart Study. Circulation. 2005; 111: 1121-1127.

24. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JJ, et al. The seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report JAMA. 2003; 289: 2560-2572.

25. Maha MMM, Reda IE, Hanan HE. Prevalence of hypertension and associated risk factorsamong university students: Comparative study. Journal of Nursing Education and Practice. 2021; 6(5): 19-27.

26. Peltzer K, Supa P, Vanphanom S, Ferrer AJG, Wah YL, Thang NH, Hla Hla WER, Niruwan T. Prehypertension and psychosocial risk factors among university students in ASEAN countries. BMC Cardiovascular Disorders. 2017; 17(230): 1-9

27. Alhalaiqa F, Abu-shbeeb I, Batiha AM, Masa'Deh R, Am-arneh B. The Relation of Demographic Characteristics with Fatigue Levels among Coronary Heart Disease Patients: A Jordani-an Study. Advanced Studies in Biology. 2015; 7 (7): 301-322.

28. Papathanasiou G, Zerva E, Zacharis I, Papandreou M, Papageorgiou E , Tzima C , Georgakopoulos D, Evangelou A. Association of High Blood Pressure with Body Mass Index, Smoking and Physical Activity in Healthy Young Adults. Open CardiovascMedJ. 2015; 9: 5-17.

29. Saeed AA, Al-Hamdan NA, Bahnassy AA, Abdalla AM, Abbas MAF, Abuzaid LZ. Prevalence, Awareness, Treatment, and Control of Hypertension among Saudi Adult Population: A National Survey. International Journal of Hypertension. Int J Hypertens. 2011; 2011: e174135.

30. Abed Y, Abu-Haddaf S. Risk factors of hypertension at UNRWA primary health care centers in Gaza governorates. ISRN Epidemiology. 2013; 1-9.

31. Abiodun M, Adewole A, Bamidele OT, Babatunde LS, Adesola O, Cooper RS. Hypertension Subtypes among Hypertensive Patients in Ibadan. International Journal of Hypertension. 2014; 15 (6): 29-91.

32. Chitrapu RV, Thakkallapalli ZM. Prehypertension among Medical Students and its Association with Cardiovascular Risk Factors. J NTR Univ Health Sci. 2015; 4: 8-12.

33. Batiha AM, Obead KA, Alhalaiqa FN, Kawafha MM, El-Razek AA, Albahtawy M, Saifan A, Ruz MEA, Al Ew-aidat H. Quality of life and Fatigue among Jordanian Cancer Patients. Iranian journal of public Health. 2015; 44(8):17-34

34. Albashtawy M, Batiha A, Tawalbeh L, Tubaishat A, AlAzzam M. Self-medication among school students. Journal of School. 2015; 31(2): 110-116

35. Nkeh-Chungag BN, Mxhosa TH, Mgoduka PN. Association of waist and hip circumferences with the presence of hypertension and pre-hypertension in young South African adults. Afr Health Sci. 2015; 15(3): 908-916.

36. Shukuri A, Tsegaye Tewelde T, Shaweno T. Prevalence of old age hypertension and associated factors among older adults in rural Ethiopia. Integr Blood Press Control. 2019; 12: 23-31.

37. Tanu M, Arati L, Bhola N, Ranjeeta K, Umeshwar P. Prevalence of isolated diastolic hypertension and associated risk factors among adults in Kanpur. India. International journal. 2012; 64: 374-379.

38. Spruill TM. Chronic Psychosocial Stress and Hypertension. Current Hypertension Reports. 2010; 12(1): 10-16.

39. Kotchen TA. Obesity-Related Hypertension: Epidemiology, Pathophysiology, and Clinical Management. American Journal of Hypertension. 2010; 23(11): 1170-1178.

40. Shariq OA, McKenzie TJ. Obesity-related hypertension: a review of pathophysiology, management, and the role of metabolic surgery. Gland Surgery. 2020; 9(1): 80-93.

41. Lu P, Zhu L, Hu L, Bao H, Huang X, Zhou W, Wang T, Liu X, Li J, Li P, Wu Y, Wu Q, Wang Z, Gao R, Li M, Cheng X. Association of waist-to-height ratio with hypertension and its subtypes in southern China. Journal of Human Hypertension. 2021; 1-6.

42. Choi JR, Koh SB, Choi E. Waist-to-height ratio index for predicting incidences of hypertension: the ARIRANG study. BMC Public Health. 2018; 18 (767): 1-6.