

The National Ribat University

Faculty of Postgraduate Studies and Scientific Research

**Body mass index and blood pressure levels among adult Sudanese
population in Khartoum state in 2016**

**The research Submitted for the partial Fulfilment of the
Requirements of M.Sc. in Physiology**

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Acknowledgement:

My thanks to my family especially to my little family, my husband who always support me.

I am grateful to many persons, who shared their memories and experiences.

I must acknowledge as well my friends, colleges, teachers, and others who assisted, advised, and supported my research and writing efforts, thank them for their contribution and their good-natured support.

I need to express my gratitude and deep appreciation to professor Omer Abdulaziz my supervisor and also the biggest father of physiology who learn us how to be a good teacher and a good researcher, generously given his time and expertise to better our work.

Dedication:

I dedicate my work to my family specially for my mother and my father, my husband who is always being near ..

Special dedication to my teacher and supervisor professor Omer abudalaziz .

I also dedicate my work to my colleges, teachers, and others who support me to do this work.

Body mass index and blood pressure levels among adult Sudanese population in Khartoum state in 2016

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Abstract:

Background:

There is an increased prevalence of obesity and its comorbid diseases including hypertension. Several studies were conducted to establish the relation between body mass index and the blood pressure to reduce the incidence of obesity and hypertension.

Methods: An extensive internet PubMed search has been conducted for researches concerning the relation between the body mass index and the blood pressure, using key words (blood pressure, body mass index), covering the period from 2005 to 2014.

Results: More than 20 papers have been retrieved and 7 were reviewed. Most of the studies have shown that the prevalence of high blood pressure (BP) has significantly increased in relation to increased body weight among adults and adolescents in various countries of the world.

Conclusion:

The BMI is an important factor influencing the blood pressure, but there is no consideration of BMI in defining the normal blood pressure.

Body mass index and blood pressure levels among adult Sudanese population in Khartoum state in 2016

Introduction: Till now, there are no known studies conducted in the Sudanese population showing that if there is any relation between the body mass index and the blood pressure, and the reference for diagnosis of hypertension are referred to international ones that was obtained from western countries which are different in the climate, life style, ethnic groups, nutritional habits and body mass indices, compared to Sudan. The objective of this study is to establish the normal values of blood pressure in healthy adult Sudanese living in Khartoum State and the relation between the blood pressure and BMI. This review has targeted researches concerning the blood pressure levels in relation to body mass index.

Methods

An extensive internet search was conducted concerning the researches related to body mass index in relation to blood pressure.

Web site used: National Center for Biotechnology Information using the Google Scholar

Key words used for the research: Body mass index, blood pressure levels.

The research covered the past 11 years period from 2005 to 2014.

Results: twenty papers were retrieved and seven of them were reviewed, they have shown clear correlation between blood pressure and body mass index.⁽¹⁻⁷⁾ Study done in China by Isabel Cristina showed that each increment in BMI would increase systolic blood pressure by 1.198 mmHg.⁽⁴⁾

Author	Type of study/country	year	Sample size	Result and conclusion
Leah E. Robinson(1)	cross-sectional study/Alabama	2013	134 child boys and girls, age between(5-9) years.	134 participants (78% non-Hispanic Black), 10 (7.5%) were overweight and 25 (18.7%) were obese. Pre-hypertension and hypertension were detected in 9 (6.7%) and 20 (14.9%) children, respectively. Results indicate that mean systolic and diastolic blood pressure significantly increased with BMI, $P < 0.001$ and $P = 0.028$. Conclusion: Hypertension was strongly associated with an unhealthy BMI in these young children from a rural and low-socio-economic community.
f. tesfaye(2)	Cross sectional/ Ethiopia, Vietnam and Indonesia	2007	8014, adults males and females, age (25-64)	BMI was significantly and positively correlated with both SBP and DBP in all

				<p>the three populations, BMI in men varied between 19.41 (2.28) in Ethiopia to 21.17 (2.86) in Indonesia in (mean(st.d). A high prevalence of overweight/obesity was noted among Indonesian Women (25%) and men (10%), whereas low BMI was widely prevalent in Ethiopia and Vietnam, ranging from 33 to 43%. Mean systolic BP (SBP) among men varied between 117.15 (15.35) in Ethiopia to 127.33(17.80) in Indonesia. The prevalence of hypertension was highest among women (25%) and men (24%) in Indonesia.</p>
<i>Nadia Danon-Hersch(3).</i>	Cross sectional/ India	2007	<p>In 1989 (n = 1081) In 2004 (n = 1255) Males and females Age (25-64)</p>	<p>There is linear relationship between BMI and BP but markedly weaker in 2004 than in 1989. Among untreated persons, BMI increment of 1 kg/m² was associated with an elevation of 2.0/1.5 mm Hg of</p>

				systolic/diastolic BP in 1989 but only 1.3/1.0 mm Hg in 2004.
<i>Isabel Cristina BrittoGuimarães(4)</i>	Cross sectional/ China	2008	536 Aldolescents Age (11-18) years	The percentage of high SBP and DBP followed the increase in BMI (p=0.000), reaching 46.4% among boys and 39.3% among obese girls for SBP and 42.0% and 44.6% for DBP, respectively. High SBP and DBP were 3.9 and 3.4 times more frequent among boys and 2.2 to 2.0 times more frequent among girls withWC > 75th p, respectivelyeach increment in BMI would increase SBP by 1.198mmHg.
Suman. Dua(5)	Cross sectional/ India	2014	N=240 Males and females (18-50) years	Mean values of all the measurements were higher among males as compared with females, except skinfold thickness. Body mass index (BMI) and fat percentage was found to be higher among females as compared with males. There was asignificantpositive correlation between BMI, fat

				percentage, and blood pressure both SBP as well as DBP. Odds ratio showed that overweight/obese subjects were more likely to have hypertension than those with normal BMI.
*Salamatu Umar Aliyu(6).	Nigeria	2014	N=351, males and females; Students from College of Medical Sciences University of Maiduguri, Nigeria	The study revealed a significant correlation Between BMI and BP (SBP and DBP) among the participants (p<0.01). Significant correlation between BMI and BP (SBP and DBP) was recorded among male participants, while there was nosignificant correlation between BMI and BP (SBP and DBP) among female participants.
WB Drøyvold(7)	Norwage	2005	1984-86= (74 994) 1995-97= (66 140) Males and females age (20 and over)	An increase in BMI and a decrease in BMI were significantly associated with increased and decreased SBP and DBP,respectively, compared to a stable BMI in both genders and all age groups, although the strongest effect was found among those whowere 50 y and older.

Discussion:

All previous studies showed that there is positive correlation between the increase in BMI, waist circumference, and blood pressure (systolic and diastolic BP)⁽¹⁻³⁾, and the increase in the blood pressure also increased with age.⁽⁷⁾

Irrespective to other article showing that the association between BMI and BP has decreased over time.⁽³⁾ Further studies are needed to understand the reasons for the decline in this association.

The main function of the blood pressure is to perfuse the whole body, so if the body size increases, a higher blood pressure is needed to perfuse a larger size, If the blood pressure increases with increased body mass index, there should be different normal values according to BMI. A larger scale study is needed to derive an equation for finding the normal blood pressure according to BMI.

Conclusion:

Prevalence of prehypertension among overweight/obese subjects according to the existing guidelines without taking the effect of BMI on BP needs further studies.

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Body mass index and normal blood pressure levels among adult Sudanese in Khartoum State, 2016

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Abstract

Introduction: The reference values for the normal blood pressure and its relation to the body mass index are ill defined in Sudan and the current available values were obtained from international guidelines from western countries.

Objectives: to establish the normal values of blood pressure in Sudanese healthy adults living in Khartoum State and its relation to body mass index.

Methods: A cross-sectional study was conducted during 2016 in Khartoum state on adult males and females aged between 20-60 years who were not known to be hypertensive.

200 participants were assessed by a questionnaire covering age, gender, physical activity, daily salt intake and smoking history. Weight & height were measured by standard scales; BMI was calculated by the formula, weight (Kg)/height (m)². The blood pressure was measured by manual mercurial sphygmomanometer according to the standard procedure.

Results:

Of 200 participants, 116 males and 84 females, underweight participants were 6.55%, 40% of the participants were normal weight most of them were males, 34% were overweight participants, obese participants were 19.5% most of them were females. Both diastolic and systolic prehypertension were seen in 30% and 14% of the individuals respectively.

There is positive correlation between the increment of BMI and the diastolic blood pressure ($r = .145$, $p = 0.041$). However no statistically significant correlation between the BMI and systolic blood pressure ($r = -0.004$, $p = 0.965$).

Conclusion: There is positive correlation between the increment of the BMI and diastolic blood pressure with no correlation with systolic blood pressure. A big scale study is needed to establish the normal blood pressure in Sudanese and to assess its dependence on BMI.

ملخص الدراسة

مقدمه:

في السودان لا يوجد هنالك مرجع في تشخيص معدل ضغط الدم الطبيعي وعلاقته مع كتله الجسم, وان المراجع الموجودة هي مأخوذة من الدول الغربية.

الهدف من الدراسة:

معرفة معدل ضغط الدم الطبيعي في الشباب السودانيين وعلاقته مع كتله الجسم.

الطريقه:

تمت هذه الدراسة في عام 2016 في مدينه الخرطوم من الرجال والنساء باعمار تتراوح بين 20-60 سنه ويجب الا يكونوا مصابين بمرض ارتفاع ضغط الدم.

200 من من المتطوعين من الرجال والنساء تم سؤالهم بالاسئله الموجودة في الاستبيان, العمر, النوع, الرياضه, معدل الملح في الاكل والتدخين.

تم قياس كل من الطول والوزن وتم حساب كتله الجسم عن طريق المعادله , كتله الجسم= الوزن/ الطول² وايضا تم قياس ضغط الدم بمقياس جهاز ضغط الدم الزئبقي.

النتائج:

200 متطوع, 116 شاب و 84 شابه,

وجدت الدراسة انه يوجد هنالك علاقه بين ازيااد كتله الجسم وازدياد ضغط الدم الانبساطي, وانه لاتوجد علاقه بين ازدياد كتله الجسم مع ضغط الدم الانقباضي.

الخلاصه:

هنالك علاقه بين ازدياد كتلة الجسم وارتفاع ضغط الدم الانبساطي, ولا يوجد علاقه مع الانقباضي.

يجب اخذ عينه اكبر حجما لتحديد ضغط الدم الطبيعي وعلاقته مع الكتله.

Introduction:

Blood pressure (BP) is regulated by the activity of the autonomic nervous system. Obesity is associated with sympathetic activation and is found to be the leading risk factor for development of hypertension.⁽¹⁾ Very recent studies have suggested that age, body mass index, and physical activity can affect the prevalence of hypertension.^(2, 16) Over the past two decades, it has been observed that hypertension shows an increasing trend in children and adolescents. Various factors are contributing to this upward trend, and they primarily include changes in lifestyle and dietary habits.⁽³⁾

Overweight and obesity are serious and growing global public health problems among children and adolescents.⁽⁴⁾

A number of important contributory factors for hypertension (HTN) have been identified, including overweight/obesity, excessive dietary sodium intake, low physical activity, smoking, and high alcohol intake.⁽⁵⁾

Weight loss of as little as 10 lbs (4.5 kg) reduces BP and/or prevents hypertension in a large proportion of overweight persons, although the ideal is to maintain normal body weight.⁽⁶⁾ Several studies have confirmed the blood pressure-lowering effect of a modest weight loss in both hypertensive and nonhypertensive patients. A modest weight loss can normalize blood pressure levels even without reaching ideal weight; the pathophysiological mechanisms are not completely understood.⁽⁷⁾

The most commonly used measure of anthropometric variables in epidemiologic studies is the body mass index (BMI), defined as weight/ height² (kg/m²). One rationale for the use of this index is that it is supposed to be closely correlated with tissue density, which in turn is supposed to be closely correlated with percent of fat in body tissues (adiposity).⁽⁸⁾

Classification of blood pressure for adults aged 18 years and older as defined by the joint national committee on prevention, evaluation and treatment of high blood pressure.⁽⁷⁾

Category	Systolic (mm Hg)	Diastolic (mm Hg)
Optimal	<120	and <80
Normal	<130	and <85
Prehypertension	130–139	or 85–89
Hypertension	>139	≥ 90

Body mass index is positively and independently associated with morbidity and mortality from hypertension, cardiovascular disease, type II diabetes mellitus, and other chronic diseases.

⁽⁹⁾Increased prevalence of the diseases has been reported among overweight and obese persons as a consequence of unhealthy lifestyle.⁽¹⁰⁾

A higher BMI even within the “normal” range was associated with greater risk of HTN compared with the lowest fifth of BMI (18.5–20.0 kg/m²).⁽⁵⁾

BMI, the systolic blood pressure and diastolic blood pressure are normal in the normal weight subjects, whereas low in underweight and high in over height and obese subjects in both males and females.⁽¹⁰⁾

Recent cross sectional study done in china showed that the BMI and waist circumference (WC) are positively correlated with SBP and DBP, Both SBP and DBP were very significantly increased in overweight and obese groups.⁽¹¹⁾

It was noted that there was a strong correlation between the Body mass index and the blood pressure profiles in children.⁽¹²⁾

A comparative Study done in Ethiopia Indonesia, and Vietnam revealed that BMI is significantly and positively correlated with both SBP and DBP in all the three populations.⁽¹³⁾

Materials and Methods

This is an analytical cross sectional community based study conducted among the Sudanese population Khartoum state the capital of Sudan by visits to governmental institutions (communication companies and hospitals). . Sample size was 200 participants 116 males and 84 females aged between 20-60 years old who were not known to be hypertensive or suffer from other chronic disease, subjects who refused to consent were excluded. Samples were taken randomly. Following the consent from the participants, information about age, gender, living area, physical activity, dietary salt, smoking, hypertension and chronic diseases were obtained. Weight and height were measured by standard scales. The blood pressure was measured by manual mercurial sphygmomanometer, Germany, according to the standard procedure, and the BMI was calculated for every participant using the formula: $\text{weight (Kg)}/\text{height (m)}^2$. Data were collected and analyzed using SPSS (Statistical Package for Social Sciences) version 20, Pearson correlation was applied and P value < 0.05 was considered statistically significant. The ethical clearance was obtained from the National Ribat University, Khartoum, Sudan.

Results

The study included 200 participants; 116 males and 84 females in Khartoum state, aged between 20-60 years old, with mean of 1.99 ± 0.763 .

According to diastolic blood pressure the prevalence of prehypertension and hypertension was more in males than females.

Most of the normal weight participants (BMI= 18.4- 24.9) were prehypertensive most of them were males. (Table 1)

Overweight participants (BMI= 25-29.9) half of them were prehypertensive (50% males and females) while 26.4% were hypertensive. (Table 1)

Most of Obese participants BMI (>29.9) were prehypertensive males. (Table 1)

There is linear correlation between the increment of BMI and increment of diastolic blood pressure, which is statistically significant ($r= 0.145$, $p=0.041$). (Figure 1)

In relation to the systolic blood pressure, 54% of the subjects were prehypertensive and 14% were hypertensive.

Concerning the systolic blood pressure 69.2% of the underweight were prehypertensive, 7.6% were smokers, and 6.7% were hypertensive, 15.3% of them were smokers. Underweight hypertensive females were not encountered in this study. (Table 2)

Also most of normal weight was prehypertensive males and females. (Table 2)

Concerning obese participants the prevalence of prehypertension and hypertension were more in males than females. (Table 2)

No statistically significant correlation between the increment of BMI and the systolic blood pressure ($r= - 0.004$ $p=0.956$). (Figure 2)

Table (1)

BMI in relation to diastolic blood pressure and gender differences.

		Normo	Prehypertension		Hypertension		Total	
			NO	% of groups	NO	% of groups	NO	% of total
Males								
	Underweight	1	4	36.4%	6	54.5%	11	9.4%
BMI	Normal weight	9	31	60.7%	11	21.5%	51	44%
	Overweight	8	20	50%	12	30%	40	34.5%
	Obesity	3	5	35.7%	6	42.8%	14	12.1%
	Total	21	60	51.7%	35	30.1%	116	100%
Females								
	Underweight	0	1	50%	1	50%	2	2.4%
BMI	Normal weight	12	12	42.3%	5	17.2%	29	34.5%
	Overweight	8	14	50%	6	21.4%	28	33.3%
	Obesity	3	9	36%	13	52%	25	29.8%
	Total	2	36	42.8%	25	29.7%	84	100%
Total	Underweight	1	5	38.4%	7	53.8%	13	6.5%
BMI	Normal weight	21	43	53.7%	16	20%	80	40%
	Overweight	16	34	50%	18	26.4%	68	34%
	Obesity	6	14	35.8%	19	48.7%	39	19.5%
	Total	44	96	48%	60	30%	200	100%

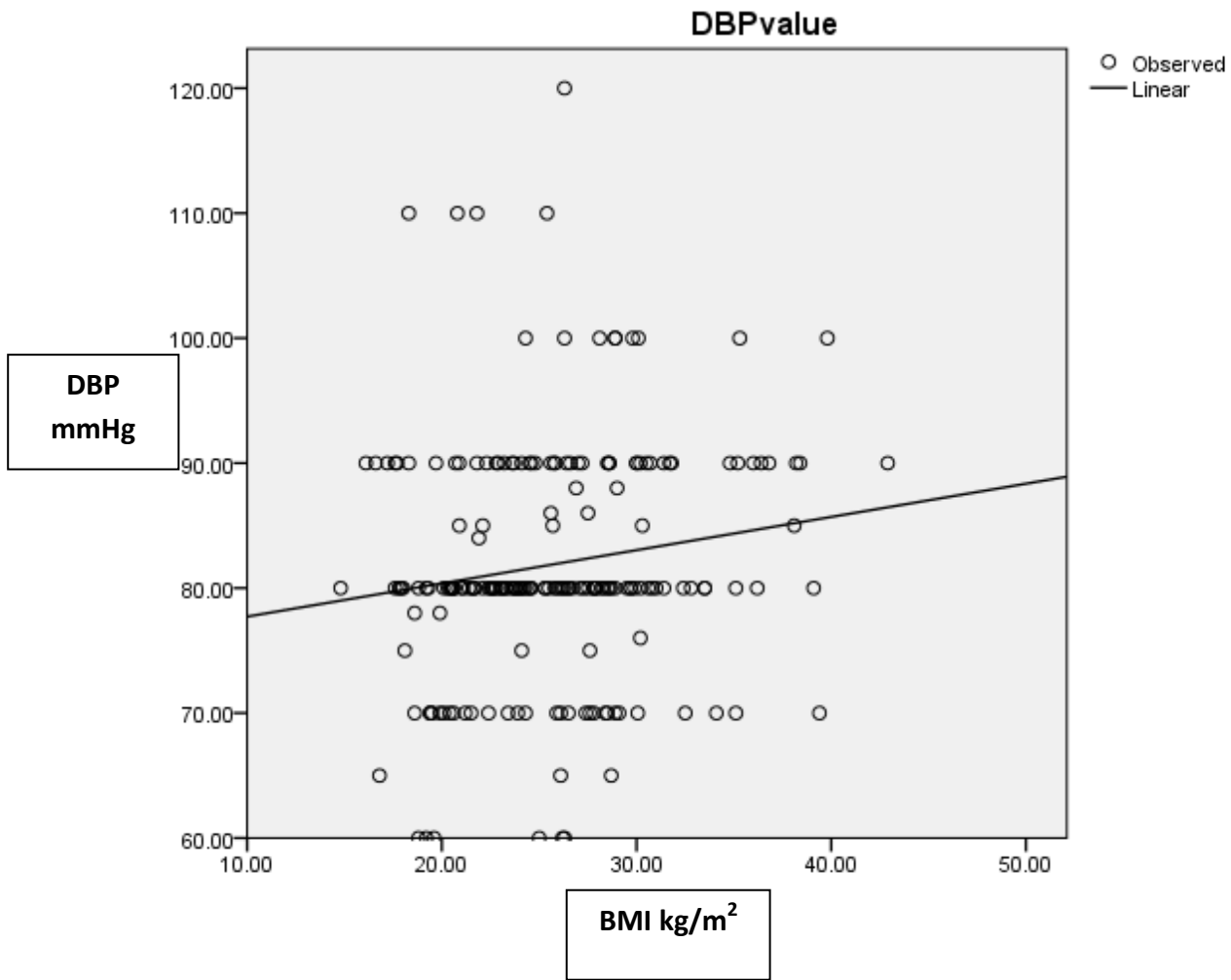


Figure 1

Correlation between BMI and diastolic blood pressure

Table 2

BMI in relation to systolic blood pressure and gender differences.

Gender			Normo		Prehypertension		Hypertesion		Total	
			NO	% of groups	NO	% of groups	NO	% of groups	NO	% of groups
Male	BMI	Underweight	1	9	81.8%	1	9%	11	9.5%	
		Normal weight	13	25	49%	13	25.4%	51	44%	
		Overweight	13	21	52.5%	6	15%	40	34.5%	
		Obesity	2	11	78.5%	1	7,1%	14	12%	
		Total	29	66	56.8%	21	18.1%	116	100%	
Female	BMI	Underweight	2	0	0	0	0	2	2.4%	
		Normal weight	14	14	48.2%	1	3.4%	29	34.5%	
		Overweight	14	12	42.8%	2	7.1%	28	33.3%	
		Obesity	5	16	64%	4	16%	25	29.7%	
		Total	35	42	50%	7	8.3%	84	100%	
Total	BMI	Underweight	3	9	69.2%	1	7.6%	13	6.5%	
		Normal weight	27	39	48.7%	14	17.5%	80	40%	
		Overweight	27	33	48.5%	8	11.7%	68	34%	
		Obesity	7	27	69.2%	5	12.8%	39	19.5%	
		Total	64	108	54%	28	14%	200	100%	

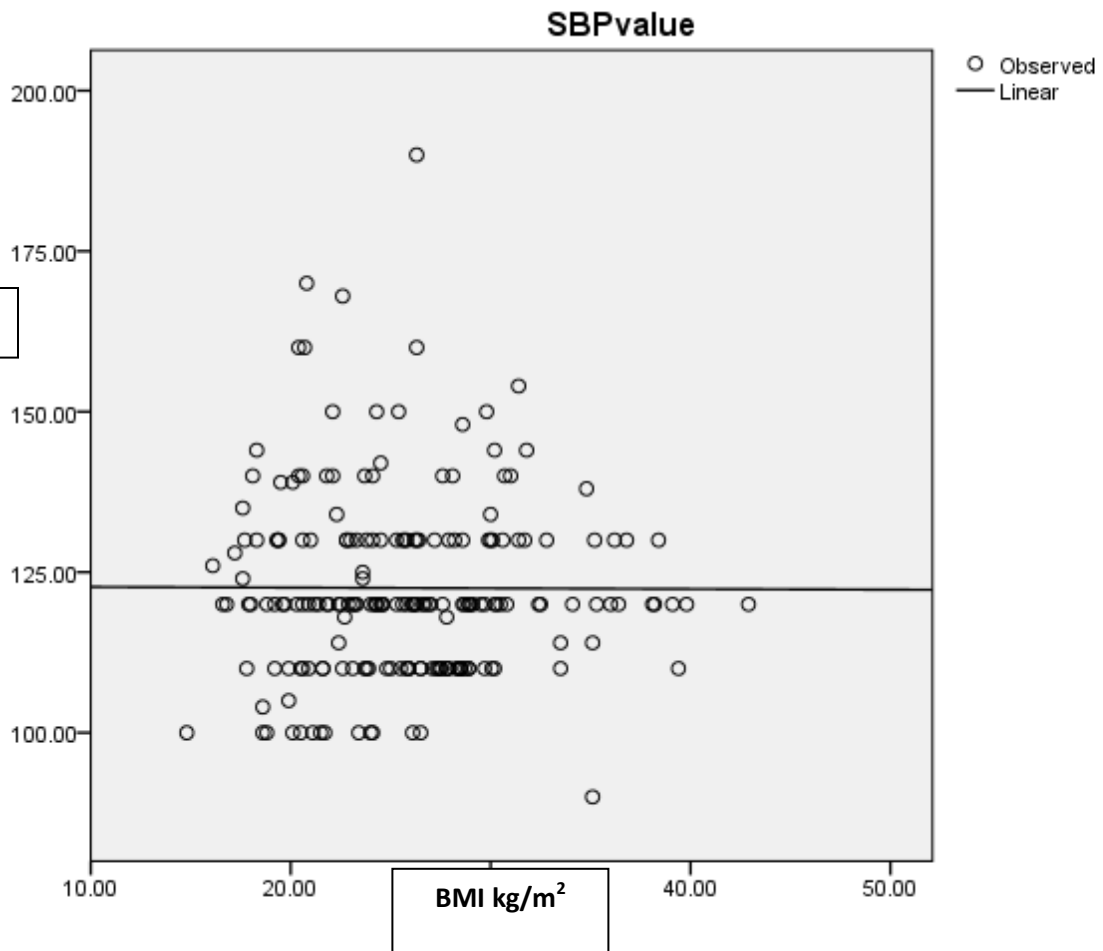


Figure 2
Correlation of BMI and systolic blood pressure.

Discussion:

Both the prevalence and consequences of elevated blood pressure has been extensively documented.⁽¹⁻³⁾ Obesity measured in terms of body mass index has been used as the predictor for hypertension, Although the BMI is the most commonly used to classify the obesity, it may not accurately assess obesity in different populations as it can be affected by muscle and bone density.

This study attempted to capture the true relationship of blood pressure and BMI in Sudanese adults. Two linear models were used to assess the relationship between systolic blood pressure, and diastolic blood pressure as the outcome measures and BMI as an explanatory variable. The linear correlation between the increment of BMI and the diastolic BP is consistent with previous similar studies.⁽¹²⁾⁽¹³⁾.

On the other hand the correlation of BMI with systolic BP does not follow a linear increment, hence there is no correlation.

A similar recent article by Carolin Alder who observed that the association of BMI and systolic blood pressure has decreased between 1998 and 2008-2011.⁽¹⁴⁾

Also, a similar article done by Nadia Danon Hersch, showed the same results.⁽¹⁵⁾

The correlation is evident in DBP, diastolic blood pressure mainly depend on total peripheral resistance, which in turn mainly depend on diameter of arterioles, increased body weight (non lean tissue) affects blood vessels and expected to affect the DBP. SBP mainly depend on cardiac output.⁽¹⁷⁾

The prevalence of diastolic hypertension is more in the males of underweight participants compared to overweight and obese their numbers are only two of two, while in females, it less in normal weight compared to obese, this require further investigation.

One limitation of this study is that the sample size was not sufficient for an accurate prediction; a larger sample is needed for more documentation. Secondly, blood pressure measurements were done only in single visit; high readings were referred to the hospitals for follow up, other risk factors of hypertension were not included within the scope of the questionnaire. Further studies are needed to explore the reasons of this association.

Conclusion:

From the observation of this study, the positive correlation between the diastolic blood pressure and BMI was observed in the participants with higher BMI compared with those with low and normal BMI, weight reduction could be mandatory to decrease the incidence of hypertension.

The nature of the relationship between the variables could be expressed in a mathematical formula, if the causal correlation is to be established.

Systolic blood pressure decreased with increased BMI further studies are recommended to investigate the cause of this decrement of the association.

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