Obesity And Hypertension: Importance Of The Relationship Between Body Adiposity Index And Diastolic Blood Pressure In Women From Active Healthy Gabonese Adult's Population

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***Abstract*—Background: Obesity is defined as an excess of adipose tissue, and is associated with an increased chronic diseases as diabetes mellitus, hypertension, or cancer and associated as well as mortality rate.**

***Objectives:* The aim of this study was to assess the relationship between obesity and hypertension using body adiposity index (BAI) and diastolic blood pressure (DBP) in the adult population living in Libreville.**

***Results:* We conducted a cross-sectional study based on a sample of 957 working adults, men and women mean age, 37.47 ± 7.66 years in Libreville. The prevalence of hypertension, obesity and overweight was 35.63%, 17.03%, and 28.63%, respectively. The prevalence of abdominal obesity was 35.05% in women, and 08.18% for men according to WC index, and approximately 37.01% for women and 27.64% for men according to WHR_1 index. The prevalence of obesity was 33.09% and 16.51% depending on the BAI and BMI values, respectively. For both sexes, all variables were significantly higher with the upper thresholds.**

***Conclusions:* In our study, hypertension was strongly associated with BAI and WC in women. The increase in diastolic blood pressure associated to obesity indexes, mainly BAI or WC confirmed the fact that it's the fat that would be involved in the association between obesity and hypertension in more women. BAI index seems to be More Appropriate to estimate of obesity and his relationship with hypertension. The index currently remains WC specific index to assess abdominal obesity, in a situation of lack of more appropriate techniques such as DXA.**

Keywords—obesity, abdominal obesity, hypertension, active, women, diastolic blood pressure

Introduction

Obesity is a complex, multi-factorial chronic disease, which is defined as excess body fat. In recent years, the prevalence of obesity has increased dramatically in many countries. This increased prevalence of obesity-related is accompanied by an increase in the mortality rate (1-9). Thus, the body fat and in particular the fat distribution are used as indicators of risk for the health.

Several techniques such as body mass index (BMI), waist circumference (WC), waist-hip ratio (WHR), skin fold thickness, dual X-ray densitometry (DEXA) and hydrostatic densitometry are used to assess body fat. However, some of these techniques are too complex and expensive to be applied on a regular basis. In addition, some of these methods are clearly inaccurate because of their variability [10]. The increase in body fat is supposed to involve an increase in the total body weight in both sexes. Thus, the weight indices are commonly used for diagnosing obesity [3-6, 11, 12]. The BMI is the most widely used and accepted index to characterize obesity in individuals [13, 14]. However, BMI has important limitation because, subjects with a high percentage of fat may have a BMI in the normal range 22 and 24 kg/m^2.

Thus, given all the above, Bergman et al. have proposed a new index, the body fat index (BAI) based on measurements of the circumference of the hip and the waist. It was suggested that the hip circumference captures gender differences in body fat better than BMI [7]. Thus, it can be measured in locations where the accurate measurement of weight is difficult. This index showed a strong correlation with body fat measured by DXA. In their study, Bergman et al. also found that this correlation was higher than the correlation between BMI and body fat mass measured by DXA when men and women were combined. Thus, in this sense, the use of the hip circumference might assume an important conceptual advantage of BAI on BMI. Given this observation, it is expected that BAI would be a better predicting index of body fat in men and women separately.

For the descriptive and comparative logic, the aim of this study was to assess the relationship between obesity and hypertension using body adiposity index (BAI) and systolic blood pressure (SBP) in the adult population living in Libreville.

Materials and methods

Profile of the study population characteristics

We conducted a cross-sectional population-based study of 957 adult men and women (mean age 37.47 ± 7.66 years old, 19-66 years) in Libreville. The population was composed by teachers, students and support staff of the institutions. All active subjects were free of serious metabolic disorder at the time of inclusion.

Anthropometry measurements

The measurements were taken only in the morning from 8.30 AM to 14h PM. Body weight was measured using a manual scale and prior to take subject height using a measuring rod, shoes had to be taken off. Waist circumference was measured between the 10th rib and the iliac crest in mid-breath as recommended by the Third meeting of survival on National Health and Nutrition Examination. The hip circumference was measured with a tape to the widest point on the greater trochanter. BMI was calculated as weight in kilograms divided by the square of height in meters (kg / m^2), and the index of body fatness (BAI) was calculated as ([hip / $(height)^{1.5}$)] - 18) [7]. Other parameters such as round waist-hip (WHR_1), waist-hip circumference (WHR_2) and were also calculated [15-17]. WC categories are: (i) normal WC <80 cm for women and <90 cm for men; (ii) moderate abdominal obesity, 80-88 cm for women and 90-102 cm for men; and (iii) severe abdominal obesity, ≥88 cm for women and ≥102 cm for men. WHR1 categories are: (i) normal WHR <0.85 for women and <0.90 for men; and (ii) abdominal obesity, ≥0.85 for women and for men ≥0.90. BAI categories are: (i) normal BAI <25; (ii) moderate BAI, 25-30; and (iii) serious BAI> 30.

Para-clinical and biological measures

Hypertension was defined as systolic blood pressure >140 mm Hg, diastolic blood pressure > 90 mm Hg. Blood pressures (systolic and diastolic) and heart rate were measured once on the non-dominant arm sitting after five minutes of recovery, using an automatic recording device (OMRON M_3 automatic blood pressure). Fasting blood glucose was measured in the morning by the portable system, ACCU CHEK Performa.

Statistical Analysis

Data were statistically analyzed using the software Statview Version 5. The results are shown in the form of mean ± standard deviation (SD) for quantitative variables and in percentage (%) for the qualitative values. Since the points of anthropometric measurements differed by gender, analyzes were performed separately for women and men. The significance of differences between the means of two groups were determined using unpaired t Student test or by analysis of one-way variance (ANOVA) with post-hoc comparison of two Fisher two. Bivariate correlations were assessed with Pearson's coefficient between the variables in the comparison groups. P values less than 0.05 ($p < 0.05$) were considered statistically significant.

Results

Results presented in Table 1 show a prevalence of hypertension of 35.63%, obesity of 17.03%, and 28.63% of overweight. Among hypertensive patients, 26.69% were obese whereas 55.82% of obese subjects were found hypertensive. So there is two times more hypertension among the obese than among obese hypertensive. Moreover, among the overweight subjects, 44.60% were hypertensive, whereas 36.07% of hypertensive were found to be overweight. Compared with the BMI threshold values, the prevalence of hypertension was the highest in the BAI range >25<30 (39.30%), and 58.00% for BAI>30.

Systolic and diastolic blood pressures increased with obesity and overweight. Indeed, larger values of systolic and diastolic blood pressures correspond to higher classes. Note that among the greatest pressure values of these categories, only those corresponding to the higher waist circumference (>102 cm) in men above the threshold for hypertension (150.75 ± 20.80 and 89.95 ± 13.60 mm Hg). The value of the corresponding systolic mean waist circumference (>90<102cm) was (136.50 ± 15.26 mm Hg) above 135 mm Hg (Table 1) (15).

The data presented in table 2 showed the average values of different indicators of obesity and the presence or absence of hypertension in overweight or obese subjects. Previous observations on these associations persisted in the sense that the values of the following indicators, BMI, WC, and BAI were significantly higher as the occurrence of these risk factors (obesity, hypertension, overweight). We also noticed that only waist circumference in women beyond the critical threshold (> 88cm) Table 2.

The correlation between systolic and diastolic blood pressure and indicators of obesity as BMI, WC and BAI was highly significant ($p < 0.0001$). The correlation coefficients were greater between the WC and the diastolic pressure. It was better with men ($r = 0.36$, $p < 0.0001$) (Table 2 and Figures 2 and 3). The figure 1 showed the evolution of both obesity indicators, BMI and BAI according to systolic and diastolic pressures and growing larger in women.

Discussion

Based on our findings, there are twice as many obese hypertensives in our population. At the same time, the prevalence of overweight was approaching 29%. Moreover, the tendency for hypertension was alarming even though our data did not show whether this was the persistent hypertension or not, since this aspect was not being explored. We believe it is the first phase of hypertension based on systolic pressure greater than or equal to 150 mm Hg. Additionally, people with hypertension, at the time of the study, were taking no treatment against hypertension.

Regarding the interactions between hypertension and obesity, it has been widely demonstrated that there was a strong association between these two "diseases" [16]. Our results have clearly confirmed it and even better with abdominal obesity. Indeed, it was shown that in obese subjects there were many hypertensive than the reverse, which could be explained by the fact that obesity is a multi-factorial condition. It can therefore be considered as a cause, because obesity is associated with increased blood pressure, often via sympathetic activation [17]. Note that the men at Fort waist were the only ones presented pressure values above the threshold limits. This showed that not only blood pressure increased very significantly with abdominal obesity, but also that it was gender dependent. It also showed that the correlation coefficients of diastolic blood pressure were better than the systolic blood pressure. This suggests that in these patients the cardiac recovery (diastole) after phase systolic ejection was not done properly. Thus, the fact that the residual pressure was maintained beyond 85 mm Hg was undoubtedly a potential cause of the occurrence of acute myocardial dysfunction (heart failure), but more in people of a certain age. This observation was made only in men with waist circumference, adapted to define abdominal obesity and not with BMI and BAI that define overall obesity.

As for the values of the BAI indicator, they are relatively modest compared to the pressure values. However, in women, it remained largely higher. This means that women generally have a fairly large amount of fat, and this would explain their state of predisposition to obesity. This situation can be exacerbated with old age. Conversely, in our context, men were more susceptible to hypertension than would women (data not shown).

Finally, the BAI index seemed to be better adapted to identify obese subjects compared to BMI, which underestimated body fat composition. It is relatively inaccurate in subjects with a significant lean mass, such as athletes, and it cannot be generalized between different ethnic groups [6,18]. These limitations may be more suitable for the treatment of metabolic conditions associated with the distribution of body fat. For example, someone may have with a normal BMI may be an excess of fat. Our study demonstrates that the prevalence of obesity depends on two indices gave different results. Other previous studies indicate that BMI is commonly used to estimate body fat and classify overweight and obesity, but has clearly shown its limits [19]. In addition, BMI does not take into account the differences between men and women. These, and many others, are the reasons that lead us to suggest the use of new indices, the BAI. BAI measurement is very simple and very useful in underdeveloped countries where accurate measurement of weight can be difficult, and where the scales are not available [7]. This could mean a significant benefit to the BAI on BMI. Keys et al. show a strong correlation between BMI and adiposity [13].

In another study, body fat as measured by DXA, was used as a criterion of body fat (BFI), and the correlation with BAI body fat is higher compared to BMI. Our previous study [20] indicated that BFI, a new index of the overall study of adiposity is highly correlated with BMI. BFI has also been correlated with WC and BAI (data not shown). The major problem with this index and its use requires complex equipment (DXA) and would be inaccessible in remote areas of modest means. The BAI has been considered a good predictor of body fat composition (BF) among Mexican-American subjects, and this result was confirmed in another study among African-Americans [7]. The BAI had a better match and a significantly higher correlation with BF with BMI, although the BAI is less suitable for low levels of adiposity in European-American adults [21]. Prior to this study, this parameter BAI had not yet been the subject of extensive investigations in an African context. Interestingly, the BAI has an advantage over BMI to define adiposity, but it overestimates BAI also the BF for men compared to women [21]. We recommend that the BAI is used to determine the prevalence of obesity (taking into account only the fat). We note that with the BAI about 36% of obese subjects, when we were only 16% for BMI (our study). The WC was considered the best predictor of abdominal obesity.

All these observations were used to associate obesity with hypertension by gender, age and background. How then to explain the physiological basis for this association and these observed differences? This issue continues to be the subject of multiple investigations in different contexts and several hypotheses have been advanced [22]. Indeed, everyone agrees on the fact that obesity is strongly associated with inflammatory processes. The keystone is the fatty tissue that is a real source of proinflammatory adipokines production. One hypothesis suggests that the overloading of adipocytes with fat massively increases macrophage infiltration. These methods can cause the subsequent activation and differentiation of cytotoxic T cells, which initiate and propagate the inflammatory cascades [18]. Second hypothesis suggests that large adipose tissues become relatively hypoxic. Hypoxia in adipose tissue can activate inflammatory pathways [20, 23]. The last assumption is that overloaded adipocytes can directly activate pathogenic immune sensors that cause chronic [24] inflammation. This inflammation is also the source of endothelial dysfunction, which in turn will be linked to activation of the renin angiotensin system and associating increased sympathetic system. The latter system systematically induced a rise in blood pressure. So it is a cascade of reactions that keep coming until the appearance of genuine illness (metabolic syndrome and obstructive sleep apnea) even characterized disorders (diabetes, renal failure, hepatic steatosis, heart problems and cerebral brovasculaires, etc.). This association is nevertheless oriented in one direction, obesity - hypertension. Indeed, the state of obesity is a favorite part of onset of hypertension among others and in all contexts. One out of two is obese hypertensive.

Conclusions

In our study, the relationship between obesity indices and SBP in women was very strong. The increase in systolic blood pressure associated to obesity indexes, mainly body adiposity index or waist circumference confirmed the fact that it was the fat that would be involved in the association between obesity and hypertension in more women. BMI underestimated the prevalence of obesity and was an inappropriate judgment to estimate body fat. However, the BAI index overestimated body fat and seemed to be more appropriate to estimate obesity and its relationship with hypertension. Generally, the WC index remains a specific index to assess abdominal obesity, in a situation of lack of more appropriate techniques such as DXA. The limitations of this study are based on the insufficiency of all participants of certain biological and clinical data. More comprehensive and longitudinal further investigation is needed.

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Tables

Table 1: General anthropometric, clinical and biological data

Obesity	Total *n (%)*	HTA *n (%)*	Obesity *n (%)*	Overweight *n (%)*	SBP *(mm Hg)*	*P-value*	DBP *(mm Hg)*	*P-value*
Yes	163 (17.03)	91 (26.69)	163 (100)	0	133.93 ± 18.53	*<0.0001*	83.50 ± 12.68	*<0.0001*
Non	803 (82.97)	250 (73.31)	0	0	124.93 ± 16.45		76.90 ± 10.39	
HTA								
Yes	341 (35.63)	100	91 (55.82)	128 (44.60)	144.16 ± 13.75	*0.0002*	87.28 ± 10.34	*<0.0001*
Non	616 (64.37)	0	72 (44.17)	159 (55.40)	116.64 ± 9.05		72.93 ± 7,66	
Overweight								
Yes	274 (28.63)	123 (36.07)	0	274 (100)	129.68 ± 17.69	*<0.0001*	80.23 ± 10.80	*<0.0001*
Non	683 (71.37)	218 (63.93)	0	0	125.18 ± 16.77		77.15 ± 11.09	
BMI (kg/m^2)								
<18	20 (2.09)	4 (1.17)	0	0	115.90 ± 13.71	*ac****	75.25 ± 10.65	*ad***
>18<25	475 (49.63)	114 (33.43)	0	0	122.38 ± 15.28	*bc, bd****	75.09 ± 9.61	*bc****
>25<30	304 (31.77)	134 (39.30)	0	274 (100)	129.54 ± 17.29	*cd**	79.86 ± 10.95	*cd***
>30	158 (16.51)	89 (26.10)	163 (100)	0	133.89 ± 18.49	*ad****	83.50 ± 12.53	*bd****
BAI tertiles								
<25	313 (32.78)	87 (25.59)	2 (1.23)	29 (10.62)	123.77 ± 14.59	a_1b_1**	75.32 ± 9.55	a_1b_1***
>25<30	326 (34.14)	119 (35.00)	21 (12.88)	124 (45.42)	127.11 ± 17.40	a_1c_1***	78.24 ± 11.30	a_1c_1***
>30	316 (33.09)	134 (39.41)	140 (85.89)	120 (43.96)	128.46 ± 18.86	*ns*	80.45 ± 11.70	b_1c_1*
Men								
WC (cm)								
<90	343 (70.14)	140 (58.33)	2 (3.28)	82 (51.57)	128.76 ± 15.37	a_2b_2***	76.97 ± 10.41	a_2b_2***
>90<102	106 (21.68)	66 (27.50)	25 (40.98)	71 (44.65)	136.50 ± 15.26	a_2c_2***	84.04 ± 11.56	a_2c_2***
>102	40 (8.18)	34 (14.17)	34 (55.74)	6 (3.77)	150.75 ± 20.80	b_2c_2***	89.95 ± 13.60	b_2c_2**
Women								
WC (cm)								
<80	215 (46.24)	26 (26.00)	1 (0.98)	14 (12.28)	116.58 ± 12.92	a_3b_3*	74.04 ± 9.38	a_3b_3*
>80<88	87 (18.71)	16 (16.00)	6 (5.88)	50 (43.86)	120.43 ± 14.22	a_3c_3***	76.54 ± 9.14	a_3c_3***
>88	163 (35.05)	58 (58.00)	95 (93.14)	50 (43.86)	125.39 ± 16.62	b_3c_3*	79.43 ± 10.84	b_3c_3*

Data are mean ± Standard Deviation or Number (percentages). *SBP: systolic blood pressure; DBP: diastolic blood pressure, WC: waist circumference; BAI: body adiposity index; BMI: body mass index. BMI cutoff: a:<18, b:>8<25, c:>25<30, d:>30; BAI tertiles:* a_1*:<25,* b_1*: >25<30,* c_1*: >30; WC cutoff for men:* a_2*: <90,* b_2*: >90<102,* c_2*:>102; WC cutoff for women:* a_3*: <80,* b_3*: >80<88,* c_2*: >88.*

Table 2. Correlation coefficients between obesity indicators and both systolic-diastolic blood pressure according to gender.

		BAI %		WC (cm)		BMI (kg/m^2)	
		r	*P-value*	r	*P-value*	r	*P-value*
SBP		0.03	<0.0001	0.24	<0.0001	0.08	<0.0001
	Women	0.10	<0.0001	0.25	<0.0001	0.12	<0.0001
	Men	0.07	<0.0001	0.25	<0.0001	0.09	<0.0001
DBP		0.09	<0.0001	0.35	<0.0001	0.13	<0.0001
	Women	1.13	<0.0001	0.31	<0.0001	0.15	<0.0001
	Men	1.12	<0.0001	0.36	<0.0001	0.13	<0.0001

SBP: systolic blood pressure; DBP: diastolic blood pressure; BAI: body adiposity index; BMI: body mass index; WC: waist circumference.

Figures

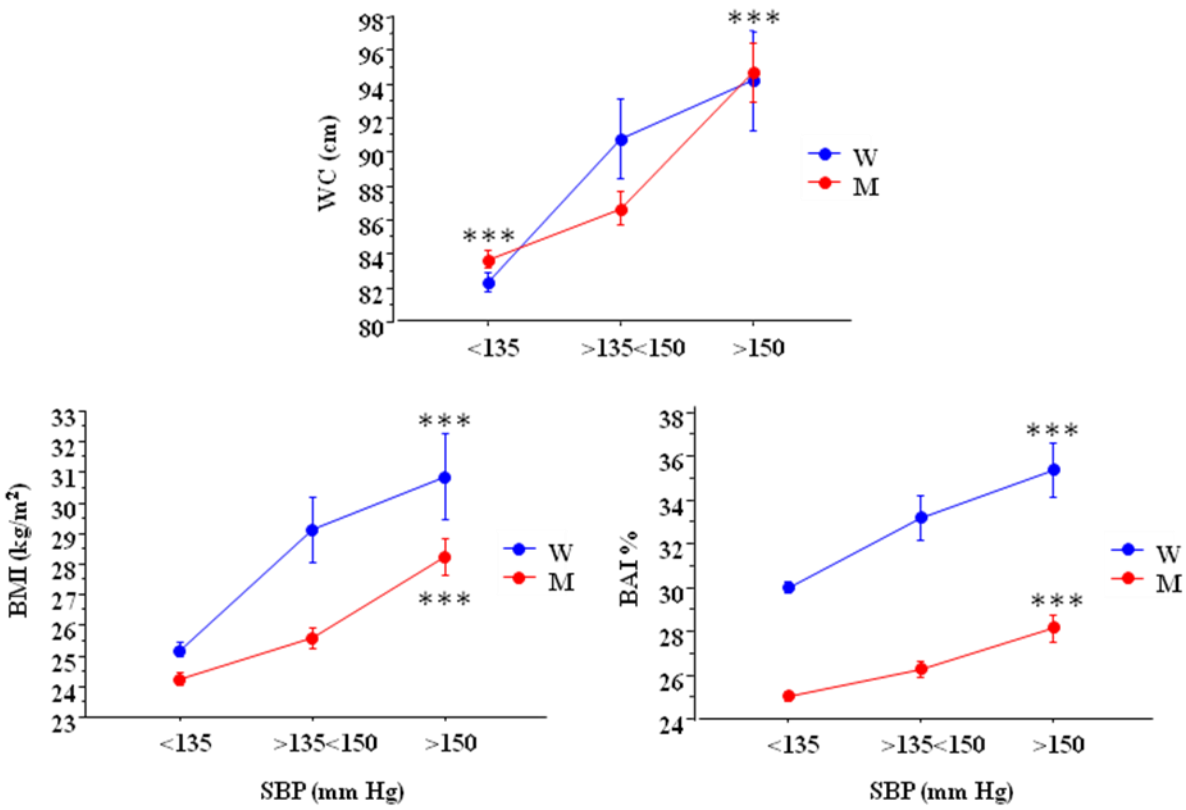

Figure 1: Obesity indicators according to systolic blood pressure cutoff. W: women; M: men; WC: waist circumference; BMI: body mass index; BAI: body adiposity index; SBP: systolic blood pressure. ***p<0.0001 (lower SBP cutoff vs higher cutuff).

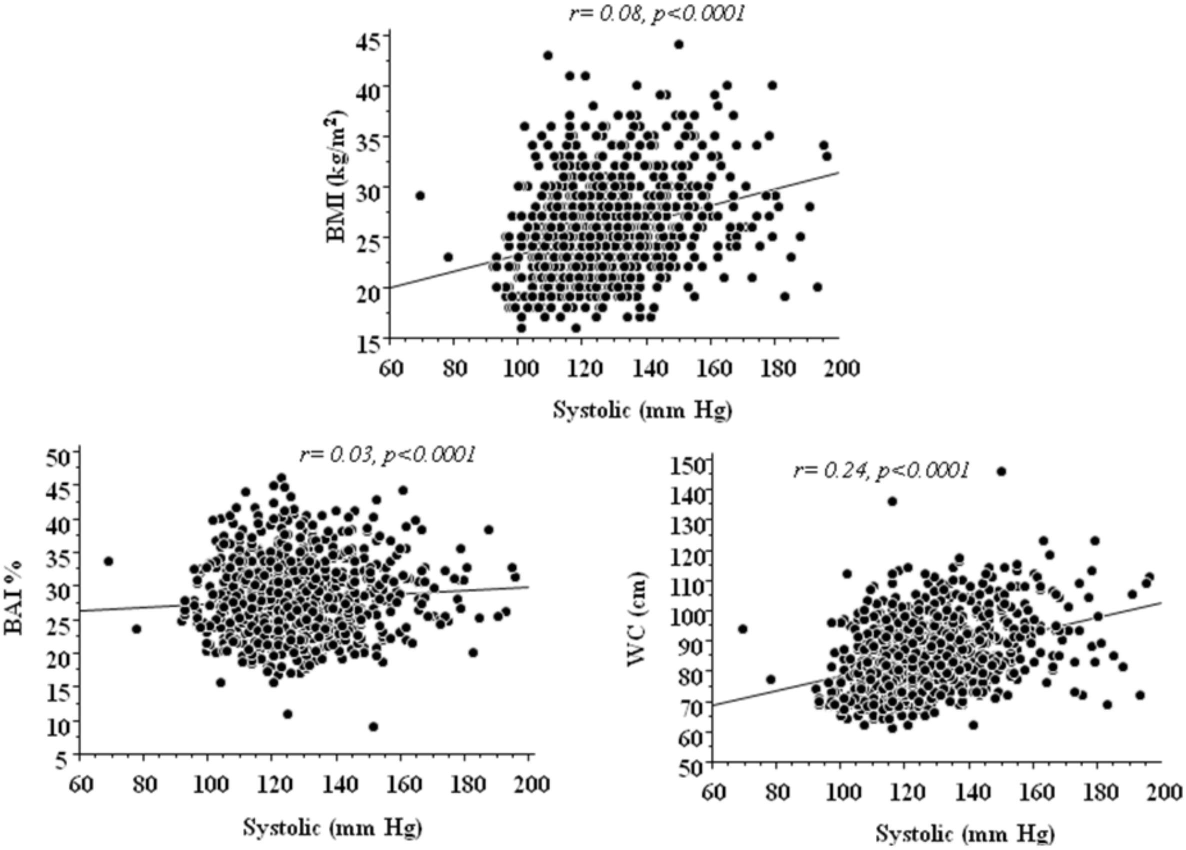

Figure 2: Regression plot of obesity indicators according to systolic blood pressure

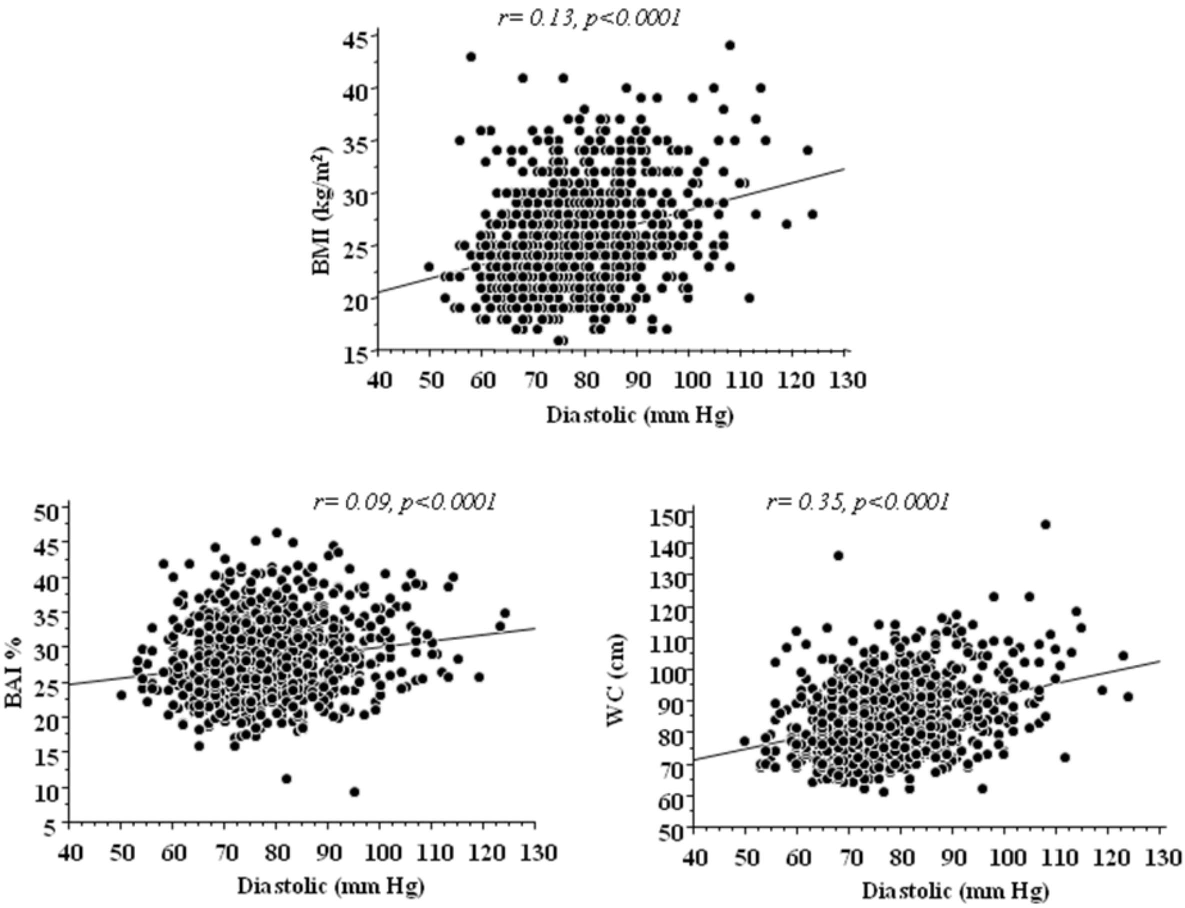

Figure 3: Regression plot of obesity indicators according to diastolic blood pressure