academicJournals

Vol. 6(1), pp. 8-13, January 2014
DOI: 10.5897/JPHE2013.0590
ISSN 2006-9723 ©2014 Academic Journals
http://www.academicjournals.org/JPHE

Journal of Public Health and Epidemiology

Full Length Research Paper

Correlation of obesity indicies and blood pressure among non obese adults in Zaria, Northern Nigeria

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Accepted 4 December, 2013

Epidemiological studies from different populations have reported significant association between different anthropometric indicators and hypertension in obese adults but few data are available for the non obese adults of this study population. This study assessed the association between adiposity measures and hypertension risk and analyzed various anthropometric indices (body mass index (BMI), waist-height ratio, waist-hip ratio, waist and hip circumferences) as predictors of hypertension among non obese adults of Samaru, a suburb of Zaria in Kaduna state, Nigeria. The study protocol was duly approved by the Ethical committee of Ahmadu Bello University Teaching Hospital, Shika, Zaria. This cross sectional study examined a total of 174 non obese adults, 35 to 70 years of age (male, 91; female, 83) who were randomly selected for the study. All subjects were normotensive, non obese and refrained from taking any medications known to influence energy regulation. Normal-weight BMI was defined as a range of 18.5 to 24.9 kg/m^2 and overweight BMI ≤ 27 kg/m^2 was considered in the study. Descriptive statistics, partial correlation and multiple regression analysis were used to determine the relationship between anthropometric measurements and blood pressure parameters, after controlling for age. Results showed significant ($p \leq 0.05$) relationships between the systolic blood pressure (BP), diastolic blood pressure (BP) as well as mean arterial blood pressure (BP) and the indices of adiposity in male (waist circumference, BMI and waist-height ratio) than in female (waist-height ratio) group. Waist-height ratio was the most important and consistent index of adiposity that associated with the hypertensive risk in both male and female non obese adult groups, particularly with systolic BP. It then means that a decrease in intra-abdominal fat could reduce blood pressure and should be a target in the management of hypertension.

Key words: Non obese adults, blood pressure, waist-height ratio, Zaria.

INTRODUCTION

Hypertension commonly remains undiagnosed until relatively late in its course, leading to a variety of other life-threatening conditions like kidney damage and heart failure. It is also a very prominent feature of the metabolic syndrome (MetS). Insulin resistance and central obesity, recognized as the main factors involved in the pathophysiology of the MetS, contribute to elevated blood pressure, which further promotes vascular damage in cardiac, renal and brain tissue (Sowers et al., 2004; Wang and Hoy, 2004).

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Several epidemiological studies from different populations have reported significant association between different anthropometric indicators (such as waist circumference, body mass index (BMI) and waist-height ratio) and blood pressure levels (Williams et al., 2000; Duvnjak et al., 2008; Kjeldsen et al., 2008). These associations between body fatness using different indices have been consistently observed but remain poorly understood and the mechanistic explanations for the phenomenon are still being debated and no biological model of the process has been established (Rufus et al., 2008). Studies have also revealed the existence of some populations with high %fat and central adiposity at a low BMI and they tend to develop chronic diseases compared to others (Wang et al., 1994; Tuan et al., 2009).

Obesity has been particularly recognized as a major independent risk factor for cardiovascular diseases (Despres, 2001). This is because increased body fat is accompanied by profound changes in the physiological and metabolic functions of the body, which are directly dependent on the degree of excess weight and on its distribution around the body (Sanya et al., 2009). The concept of the metabolically obese normal weight individual is based on the observation that these same characteristics may be found in normal weight individuals with disorders often associated with obesity (St-Onge et al., 2004; Tsai, 2009).

Although, waist circumference (Janssen et al., 2004), BMI (Sanya et al., 2009) and weight-height ratio (Cai et al., 2013) have been shown to be associated with hypertension in some age groups, to the best of our knowledge, no data is available for the non obese adults of Zaria, Northern Nigeria. In the present study we assessed the associations of adiposity measures to hypertension risk and analyzed various anthropometric indices as predictors of hypertension, among non obese adults of Zaria in Kaduna state, Northern Nigeria.

MATERIALS AND METHODS

A cross-sectional survey was conducted on non obese adults, aged 47.13 ± 8.10 years (male) and 44.96 ± 9.58 years (female) in March, 2013. Study participants were randomly selected from different wards in Samaru, a suburb of Zaria in Kaduna state, Northern Nigeria. The Samaru town is the fourth and the most recent addition to the Zaria suburban area. It evolves from a small colonial farming settlement to become a large community, a melting-pot, often referred to as 'the University village'. It is cosmopolitan in nature, drawing and fusing people of diverse national and international backgrounds. Data from 174 non obese adults (male, 91; female, 83) were collected. The reasons that participants dropped out were: obese, untreated cases of hypertension or diabetes, taking medicine on the day when measurements were taken or non compliance to anthropometric measurements. All candidates enrolled in this study underwent a physical examination to obtain anthropometric measures. Body weight was measured with light clothes and without shoes and was approximated to the nearest 0.1 kg on a mobile lever scale (SECA; Vogel and Halke; Germany) and height was measured to the nearest 0.1 cm using a stadiometer (SECA; Vogel and Halke; Germany). Waist circumference (WC) was measured by a non-elastic flexible tape in the standing position. The tape was applied horizontally midway between the lowest rib margin and the iliac crest. Hip circumference (HC) was measured at maximal protrusion of the buttocks. The mean of two measurements to the nearest 0.1 cm were documented.

Blood pressure (BP) was measured on the same occasion as the anthropometric measurements, while subjects were sitting and with the cubital fossa supported at heart level, after at least 5 min of rest. BP was measured using a mercury sphygmomanometer, with the appropriate cuff for the adults upper arm size. The cuffs used hand bladders long enough to circle at least half of the upper arm without overlapping, and widths that covered at least two-thirds of the upper arm. Systolic BP was defined by the onset of the first Korotkoff sound, and diastolic BP was indicated by the fifth Korotkoff sound (disappearance of Korotkoff sound). The mean arterial blood pressure (MABP) is the average arterial pressure throughout the cardiac cycle (Sabri, 2003) and is calculated as follows:

MABP = DBP + 1/3 Pulse Pressure (mm/Hg)

Pulse Pressure = Difference between systolic and diastolic Blood Pressure

Normal-weight BMI was defined as a range of 18.5 to 24.9 kg/m^2 according to National Institutes of Health/National Heart, Lung, and Blood Institute (NIH/NHLBI) (1998) criteria and overweight BMI ≤ 27 kg/m^2 was considered because BMI ≥ 28 kg/m^2 has been shown to be a significant prognostic factor for all-cause and cardiovascular mortality among adults (Asefeh et al., 2001; Ofei, 2005). Weight-height ratio was calculated as waist circumference divided by height. Waist-hip ratio was calculated as waist circumference divided by hip circumference. Study purpose was explained to all volunteers before seeking their written consent. The study protocol was duly approved by the Ethical committee of Ahmadu Bello University Teaching Hospital, Shika, Zaria.

Statistical analysis

Data was analyzed using statistical package for social sciences (SPSS Inc, version 16. 0; Chicago). Descriptive statistics of mean and standard deviation was computed by sex for age, weight, height, BMI, WC, WHtR, WHpR, systolic and diastolic BP for the purpose of data interpretation. Partial correlation analysis was used to examine the relationship between WC, WHtr, WHpr and BP after controlling for age. Correlations were considered significant at P ≤ 0.05 with critical values located at 0.2050 (male), 0.2172 (female) (Thomas and Nelson, 1996). A multiple regression analysis, adjusted for age was used to examine the influence of WC, WHtr, WHpr and BMI on the risk of hypertension in both sexes. Differences were considered significant at P ≤ 0.05.

RESULTS

Descriptive characteristics of the study population as presented in Table 1 consists of (91) male and (83) female with mean BMI of 23.13 kg/m^2 ± 2.73 (male) and 23.78 kg/m^2 ± 2.42 (female) which falls within the classified normal weight (World Health Organization (WHO), 2003). Statistical equality of means at P ≤ 0.05 showed that male participants were significantly taller and heavier with smaller HC than the female. No significant differences existed in SBP, DBP, mean arterial (MA)BP

Table 1. Descriptive characteristics of the study population

Measurements	Mean ±SD	
	Male (n=91)	Female (n=83)
Age (years)	47.13±8.10	44.96±9.58
Weight (kg)*	69.55±9.60	62.90±7.96
Height (cm)*	173.32±6.42	162.58±6.09
Waist circumference (cm)	87.90±8.17	86.87±7.70
Hip circumference (cm)*	93.37±6.12	99.27±6.48
Body mass index (kg/m^2)	23.13±2.73	23.78±2.42
Waist-hip ratio*	0.941±0.050	0.876±0.06
Waist-height ratio*	0.508±0.048	0.535±0.05
SBP (mmhg)	127.03±20.14	132.77±26.05
DBP (mmgh)	79.01±10.76	82.71±14.74
MABP (mmgh)	95.02±12.76	99.398±17.94

*Statistical significant difference of equality of means at (CI 95%, P ≤ .05; Critical value: 1.960; Df: 172).

Table 2. Correlation between measures of adiposity and blood pressure.

Parameter	Male			Female		
	SBP	DBP	MABP	SBP	DBP	MABP
WC	0.232 (0.03)*	0.266 (0.01)*	0.271 (0.01)*	0.127 (0.254)	0.114 (0.309)	0.123 (0.269)
BMI	0.271 (0.01)*	0.255 (0.02)*	0.285 (0.006)**	0.192 (0.084)	0.203 (0.067)	0.204 (0.066)
WHpR	0.229 (0.03)*	0.121 (0.255)	0.188 (0.077)	0.010 (0.927)	-0.087 (0.437)	0.045 (0.690)
WHtR	0.284 (0.007)**	0.211 (0.046)*	0.267 (0.011)*	0.223 (0.044)*	0.202 (0.069)	0.218 (0.049)*
HC	0.142 (0.180)	0.273 (0.009)**	0.229 (0.030)*	0.153 (0.171)	0.236 (0.033)*	0.205 (0.065)

**Correlation is significant at the 0.01 level (2-tailed) *Correlation is significant at the 0.05 level (2-tailed) Critical value: 0.2050. P: ≤ 0.05.

Table 3. Regression analysis examining the independent contribution of obesity measures to blood pressure.

Sex	Dependent variables	Model	β	R^2	p-value
Male	SBP	Waist-Height ratio	0.312	0.098	0.003*
	DBP	Waist Circumference	0.271	0.073	0.009*
	MABP	Waist Circumference	0. 288	0.083	0.006*
Female	SBP	Waist-Height ratio	0.819	0.071	0.002*
	DBP	Waist-Height ratio	0.442	0.055	0.002*
	MABP	Waist-Height ratio	0.789	0.066	0.003*

*Significant (CI 95%, P ≤ 0.05)

and age between male and female participants (P ≤ 0.05). The mean values of WHtR (male: 0.508 ± 0.048; female: 0.535 ± 0.05) and WHpR (male: 0.941 ± 0.05; female: 0.876 ± 0.06) were slightly above the classified risk values (Kuba et al., 2013). Table 2 shows significant positive relationships between the indices of adiposity and blood pressure in both sexes. WHtR significantly correlated with SBP (Male: 0.007**, Female: 0.044*), DBP (Male: 0.046*, Female: 0.069) and MABP (Male: 0.011*, Female: 0.049*). Also, in male only, WC significantly correlated with SBP (0.03*), DBP (0.01*) and MABP (0.01*). BMI also showed significant correlation with SBP (0.01*), DBP (0.02*) and MABP (0.006**) in male not female. Regression analysis in Table 3 shows

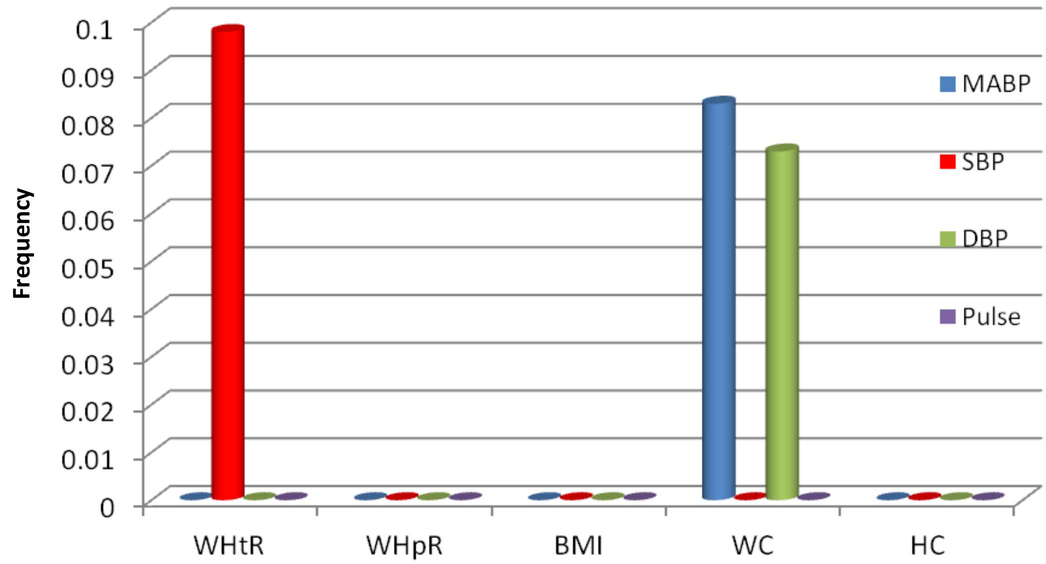


Figure 1. Predictability of measures of adiposity for blood pressure (male).

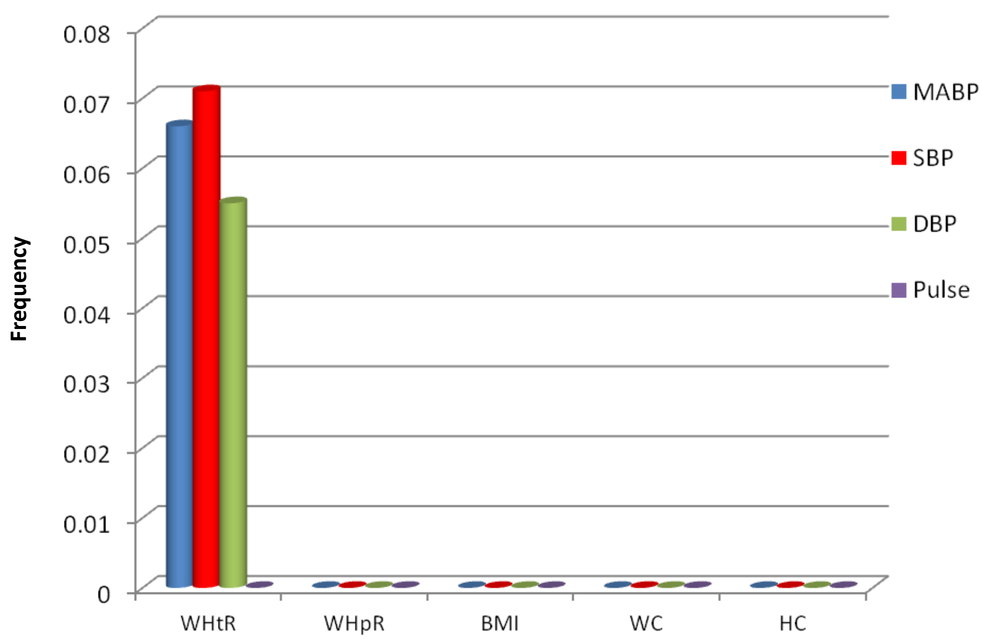
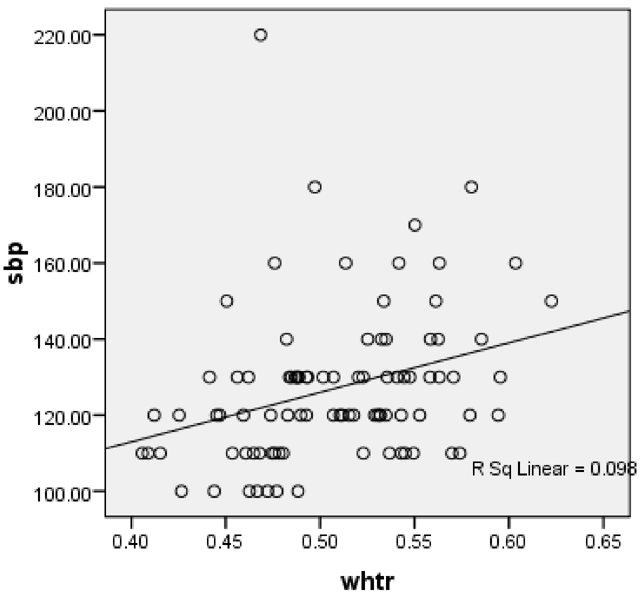


Figure 2. Predictability of measures of adiposity for blood pressure (female).

the clinical implication of large WC in male as it predicts high diastolic BP (0.009*) and mean arterial BP (0.006*), but WHtR was the most important and consistent index of adiposity that associated with the hypertensive risk in both sexes, particularly with SBP (male: r = 0.003*; female: r = 0.002*) as these were also shown in Figures 1 and 2. Using the R^2 values, Figure 3 shows the strength of the linear relationships between systolic blood pressure and waist-height ratio in male and female groups.

DISCUSSION

More suitable indices of body fat distribution have been suggested and waist-height ratio and waist-hip ratio have



(a)

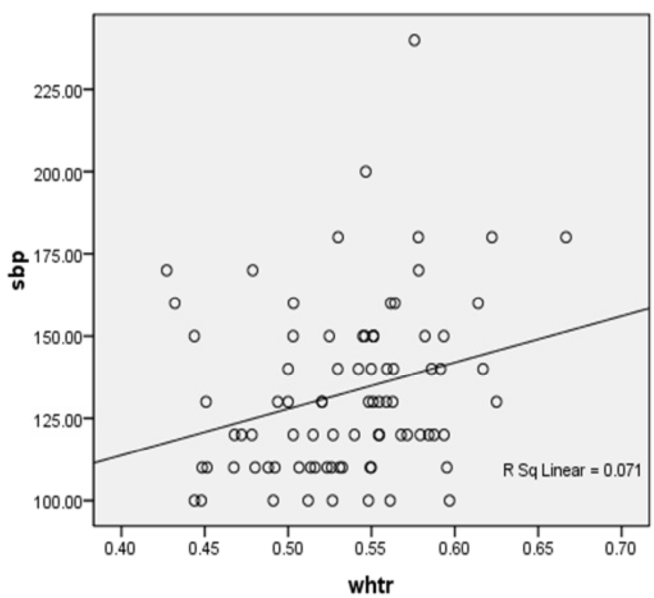


Figure 3. Relationship between Systolic blood pressure and Waist-Height ratio (Male) (Female)

been recommended. Studies have shown strong association between these indices and metabolic complications of obesity and cardiovascular risks in adults, children and different ethnic groups (Sanya et al., 2009; Falaschetti et al., 2010; Palacio et al., 2011). Most of the studied groups were obese adults; this study demonstrated that waist-height ratio was statistically superior to BMI, waist circumference and waist-hip ratio for indentifying hypertension among non obese adults. The discriminating power of waist-height ratio was lager in men than women and this is consistent with previous descriptions of non obese adults (Knowels et al., 2011; Vasan et al., 2011). This study also showed that waist circumference, BMI and waist-hip ratio correlated with blood pressure, although using regression analysis, significant influence of waist circumference, BMI and waist-hip ratio was not found, particularly in female.

Waist-height ratio takes into account the distribution of body fat in the abdominal region which has been shown to be more associated with cardiovascular risks than body weight, It adds significantly to cardiometabolic risk prediction over BMI and waist circumference in men, and it is an important index of central obesity, which is free from any bias due to hip width changes along with waist circumference of short and tall subjects (Dhall et al., 2011). The significant correlation exhibited by waist-height ratio in this study could then mean that it carries the burden of hypertension risks among non obese adults; so much so that the recommended optimal cut-off point of 0.5 for men and women (Browning et al., 2010) is higher in this study (0.508 in men and 0.535 in women). This is in agreement with the findings of Park et al. (2009) and Nambiar et al. (2010) who showed waist-height ratio to be a better predictor of cardiovascular diseases than other anthropometric measurements, including BMI, waist circumference, waist-hip ratio and skinfold thickness. These observations was also reflected in recent studies on non obese adults by Knowels et al. (2011) and Vasan et al. (2011) who proved that BMI was the least accurate predictor of hypertension.

Conclusion

In this study, waist-height ratio showed strong and consistent correlation with systolic BP > diastolic BP > mean arterial BP in both male and female groups, followed by waist circumference. This fact could then mean that waist-height ratio and waist circumference carry same information of visceral obesity. This also suggests that a decrease in intra-abdominal fat could reduce blood pressure and shows consistence with previous studies. Waist-height ratio can be calculated by individuals themselves and bias toward underestimation is minimal.

ABBREVIATIONS

WHtR, Waist-height ratio; **WHpR,** waist-hip ratio; **WC,** waist circumference; **HC,** hip circumference; **BMI,** body mass index; **SBP,** systolic blood pressure; **DBP,** diastolic blood pressure; **BP,** blood pressure; **MABP,** mean arterial blood pressure.

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