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Original Research Article

The Relationship Between Waist/Height Ratio With Fasting Blood Glucose, Blood Pressure and Several Body Measurements in College Students

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Abstract

Visceral adipose tissue has been correlated to an increased risk of cardiovascular disease and waist circumference is a better predictor of cardiovascular disease. We analyzed the relationship between waist/height ration with Fasting Blood Glucose (FBG) systolic-diastolic blood pressure, Body Mass Index (BMI), hip circumference, waist circumference. The Relationship between Waist/Height Ratio with Fasting Blood Glucose (FBG), Blood Pressure and Several Body Measurements in 91 female, 85 male college students studying in AIBU was analyzed in this study. Waist/height ratios, waist/hip ratio, waist to weight ratio, BMI were calculated. Diabetes history in first degree relatives; smoking, alcohol consumption, exercise history were evaluated. In female volunteers, waist/height ratio was positively correlated with FBG, BMI, hip circumference, waist circumference; FBG was positively correlated with weight. In male volunteers waist/height ratio was positively correlated with weight, waist circumference, hip circumference; and it was negatively correlated with BMI; FBG was positively correlated with diastolic blood pressure. Significant relationships were found between waist circumference and FBG, systolic and diastolic blood pressures. No relationship was found between waits/height ratio and history of diabetes in the family, exercise habits and smoking. In our study population waist/height ratio was not found to be related with systolic and diastolic blood pressures but it was associated with FBG, weight, height, waist circumference, hip circumference and BMI. For relationship between waits/height ratio and FBG, p=0.01 r=0.243 was detected. In our study population in the 17-26 age group, waist circumference mostly affected waist/height ratio, FBG, systolic and diastolic blood pressures.

Keywords: Waist/height ratio, FBG, Blood pressure, Body measurements, Relationship

INTRODUCTION

Prevalence of obesity and overweight in each age group is increasing worldwide. Diagnostic criteria to determine obesity are the body mass index and the body weight that are not informative about fat distribution. Indeed, rather than obesity, metabolic complications are related to central fat distribution. Visceral adipose tissue has been correlated to an increased risk of cardiovascular disease and waist circumference is a better predictor of

cardiovascular disease than the body mass index (BMI), generally used to define then obesity (Ogden, 2004).

Body mass index is used to define severity of overweight and obesity across populations. But increasingly, measures of central adiposity, namely waist circumference (WC), waist-to-hip ratio (WHpR), a newly described index, waist-to-height ratio (WHtR) have been adopted as more accurate predictors of obesity-related cardiovascular risk and have replaced BMI in several definitions for clinical diagnosis of metabolic syndrome (Lee et al., 2008).

Waist circumference and waist-to-height ratio are used to screen the central obesity and identify metabolic syndrome. These parameters are dependent on sex, age and ethnicity, thus requiring specific values in each country (Rerksuppaphol and Rerksuppaphol, 2013). Waist/ hip ratio overestimates central obesity in the general population three fold than the waist circumference (69.23%compared to 23.08% stated by waist circumference). Genderwise, it can also be inferred that though waist/hip ratio as a predictor of central obesity is less reliable compared to waist circumference yet when used, it is a more reliable predictor in female than in males as it overestimated central obesity with respect to waist circumference only two fold in female (Ademolu et al., 2015).

A cross-sectional study was carried out to determine the relationship between glucose level, lipid profiles, and waist to height ratio among adults. For the subjects of this study, WHtR was found to be significantly related to lipid profile and blood glucose level (AbuSaad et al., 2015)

Siani et al. (2002) evaluated the relative role of central fat accumulation on the relationship between excess body weight, insulin resistance/hyperinsulinemia, and high BP in a sample of middle-aged men (25 to 75) that included normotensive and untreated hypertensive individuals.

In our study we analyzed the relationship between waist/height ration with FBG systolic-diastolic blood pressure, BMI, hip circumference, and waist circumference. In addition, we analyzed the relationship between history of diabetes in the family, smoking and alcohol use and exercise habits.

MATERIAL AND METHODS

Abant Izzet Baysal University (AIBU) Clinical Ethics Council was consulted and the study was approved. 17-23 age range (19±1.47)91 female and 85 male, in total 176 volunteer first class university students in AIBU were enrolled in our study. The following measurements were taken from the volunteer university students.

Study Design

The study was conducted in volunteerfirst grade university students. Sample selection was not done and full population was taken for the study.

Height and weight: measurements were done by standard scale and measurement band. Body Mass Index (BMI) was calculated by dividing the weight in kilograms with the square of height in meters (Saygin et al., 2011).

Body Mass Index (BMI): (kg/m^2) According to the BMI classification; BMI < 18.5 was accepted as underweight, 18.5–24.9 as normal, 25.0–29.9 as overweight and ≥30 obese. Waist circumference >102 cm was as abdominal obesity. Waist-to-hip ratio (WHpR) was calculated by dividing the WC to HC. WHpR exceeding 1.0 was defined as abdominal obesity. WHtR was calculated by dividing the WC to height. In order to evaluate WHtR values, 0.5cut-off point was used. The WHtR values ≥0.5 were defined as abdominal obesity (Sahin et al., 2011).

Waist circumference (WC): Measure the waist circumference at the end of several consecutive natural breaths, at a level parallel to the floor, midpoint between the top of the iliac crest and the lower margin of the last palpable rib in the mid axillary line.

Hip circumference (HC): Measure the hip circumference at a level parallel to the floor, at the largest circumference of the buttocks (WHO Report).

Waist to height ratio: (waist cm/height cm) The Ashwell® Shape Chart based on waist-to-height ratio. Waist to height ≥ 0.5 abdominal obesity (Ashwell, 2011).

Waist to hip ratio: (waist cm/hip cm) › 1.0 abdominal obesity, ≤1 normal (Sahin et al., 2011).

Fasting blood glucose (FBG): was measured after 12 hours of fasting at 9 am from the tip of the finger. Blood sample from the tip of the finger was obtained by Accu-Chek Sofclix lancet after cleansing with 70% ethanol and drying. It was measured by. Accu-Chek Performa Nano (Roche Diagnostics GmbH, Mannheim, Germany) glucometer with Accu-Chek performa (Ref06454011) strips. The test principle used in the test strips is transformation of the glucose found in the sample to gluconolactone by the mutant version of glucose dehydrogenase from Acinetobacter-calcoacticus recombined in E.coli (Bilen et al., 2005).

Blood pressure: was measure in the morning after a night of fasting, in the seated position with a standard sphygmomanometer.

Presence of diabetes in first degree relatives, exercise habits, smoking, alcohol and drug use were questioned. The questionnaire included the measurements and the questions. SPSS program was used to evaluate the data obtained from the questionnaires.

Table 1. The Mean Values of Female Volunteers

	N	Min.	Max.	Mean	Std. Deviation
Age	91	17.00	26.00	19.3956	1.47482
Height	91	1.47	1.80	1.6323	.04969
Weight	91	18.00	95.00	55.4286	10.39139
Waist circum.	91	43.00	104.00	70.7582	9.56305
Hip circum.	91	69.00	118.00	93.4176	7.83023
Waist to height	91	.27	.65	.4335	.05767
Waist to weight	91	.88	3.28	1.3057	.25887
Waist to hip	91	.88	3.28	1.3059	.25880
BMI	91	6.61	37.11	20.7753	3.55693
FBG	91	76.00	114.00	88.8791	6.78697
Systolic BP	91	80.00	140.00	108.0879	11.05205
Diastolic BP	91	30.00	90.00	70.1209	10.82265

Table 2. The Mean Values of Male Volunteers

	N	Min.	Max.	Mean	Std. Deviation
Age	85	17.00	25.00	19.7882	2.11623
Height	85	1.53	1.96	1.7753	.07306
Weight	85	51.00	107.00	71.5824	11.12506
Waist circum.	85	55.00	108.00	82.0082	9.09833
Hip circum.	85	78.00	112.00	95.4376	7.48471
Waist to height	85	.29	.57	.4625	.05218
Waist to weight	85	.68	1.48	1.1601	.13679
Waist to hip	85	.68	1.48	1.1598	.13663
BMI	85	16.95	16.95	22.7037	3.22195
FBG	85	65.00	65.00	90.9762	7.71320
Systolic BP	85	80.00	80.00	114.9412	12.29736
Diastolic BP	85	40.00	40.00	73.8706	11.18118

Statistical analysis

Data input and statistical analysis were done by SPSS 17.0 for windows package program. Statistical analysis methods: Kolmogorov-Smirnov test was used for % distribution, Man-Whitney U test was used when the distribution between the male and female volunteers was not normal, Spearman test was used for correlation. Multiple regression analysis and Chi square tests were performed.

RESULTS

The mean age of the female volunteers was 19.39±1.47, the mean age of the male volunteers was 19.72±2.11. The mean values of other data are stated in Table 1 and Table 2.

Statistically meaningful results

Female Volunteers

FBG: positive correlation with weight, waist/height ratio
Waist/height ratio: positive correlation with BMI, hip circumference, waist circumference, FBG.
Systolic Blood Pressure: positive correlation with weight, waist circumference, hip circumference.
Waist/hip ratio: Negative correlation with BMI.

Male Volunteers

FBG: positive correlation with diastolic blood pressure
Waist/Height Ratio: positive correlation with height, weight, waist circumference, hip circumference, BMI.
Waist/Hip Ratio: negative correlation with systolic

Table 3. Significant Correlations in Female Volunteers

FBG	Weight	r=0.22	p=0.35
	Waist to height	r=0.23	P=0.01
Waist to height	Weight	r=0.63	P=0.00
	Hip circum.	r=0.59	P=0.00
	Waist circ.	r=0.94	P=0.00
	BMI	r=0.73	P=0.00
Systolic BP	Weight	r=0.24	P=0.22
	Waist circ.	r=0.23	P=0.25
	Hip circum.	r=0.24	P=0.21
Waist to hip	BMI	r=-0.51	P=0.00

Table 4. Significant Correlations in Male Volunteers

FBG	Diastolic BP	r=0.26	P=0.01
Waist to height	Weight	r=0.50	P=0.00
	Height	r=-0.24	P=0.02
	Waist circ.	r=0.92	P=0.00
	Hip circum.	r=0.48	P=0.00
	BMI	r=0.69	P=0.00
Systolic BP	Weight	r=0.27	P=0.01
	Height	r=0.29	P=0.00
	Hip circum.	r=0.37	P=0.00
	Waist to height	r=-0.32	P=0.00
	Diabetes in family	r=-0.27	P=0.01
	Cigarette	r=-0.27	P=0.01
Waist to hip	Systolic	r=-0.32	P=0.00
	BMI	r=-0.51	P=0.00

blood pressure and BMI

Systolic blood pressure: positive correlation with height, weight and hip circumference

Total: FBG: Height, waist circumference, waist/height ratio BMI was positively correlated with FBG, and negatively correlated with waist/weight ratio.

Waist/Height Ratio was positively correlated with weight, waist circumference, hip circumference, FBG and BMI.

Systolic blood pressure was positively correlated with height, weight, waist circumference and hip circumference. It was negatively correlated with waist/weight ratio

Diastolic blood pressure was positively correlated with height, weight, waist circumference, hip circumference.

Waist/hip ratio was negatively correlated with FBG, systolic blood pressure, waist circumference, exercise habits. Statistically Significant Correlations are demonstrated in Table 3 and 4.

5.47% of female volunteers and 37.64% of male volunteers were smoking. 2.35% of male volunteers was using alcohol. % 29.67 of the female volunteers and 27.05% of the male volunteers had a relative with history of diabetes. 31.86% of the female and 50.58% of the male volunteers regularly exercised.

BMI: 22% of the female volunteers and 6% of the male volunteers had BMIs lower than 18.5. 67% of the female volunteers and 70.2% of the male volunteers had BMIs between 18.5-24.9. 9.9% of the female volunteers and 21.4% of the male volunteers had BMIs between 25.0-29.9. 1.1% of the female volunteers and 2.4% of the male volunteers had BMIs higher than 30.

Waist to height: 90% of the female volunteers and 80% of the male volunteers had lower than 0.5 waist to height ratio. While, 9.9% of the female volunteers and 20% of the male volunteers had higher than 0.5% waist to height ratio (Table 5).

According to Ashwell scale, 8.79% of the girls were

Table 5. Distribution of Waist to Height Values

	Waist To Height		
Gender	<0.5	>=0.5	Total
Female %	90.1	9.9	100.0
Male %	80	20	100.0

Table 6. Distribution of Waist to Hip Ratios

	Waist To Hip		
Gender	<=1	>1	Total
Female %	96.7	3.3	100.0
Male %	98.8	1.2	100.0

found to be in the greenzone, which indicates the group that is considered to put exercise into their life, that of 1.09% were in the redzone, which is the group that is supposed to lose weight. 22.35% of the boys were found in the greenzone whereas there was no one in the red zone.

Waist to hip: 96.7% of the female volunteers and 98.8% of the male volunteers had lower than or equal to one waist to hip ratio, while 3.3% of the female volunteers and 1.2% of the male volunteers had higher than 1 waist to hip ratio (Table 6).

BMI and waist/height ratio were found to significantly different between female and male volunteers while no significant difference was found in waist/hip ratio.

1.1% of the female volunteers aged 17-26 had BMIs higher than 30. 2.4% of the male volunteers aged 17-26 had BMIs higher than 30. 9.9% of the female volunteers and 20% of the male volunteers had ≥0.5 waist/height ratio. 3.3% of the female volunteers and 1.2% of the male volunteers had higher than 1 waist to hip ratio. These volunteers belonged to the obesity group and they had increase in abdominal fat.

DISCUSSION

Waist-to-height ratio (WHtR) is an easy and inexpensive adiposity index that reflects central obesity. Increased baseline WHtR and WC correlated with the development of diabetes after 4 years. WHtR might be a useful screening measurement to identify individuals at high risk for diabetes (Lee et al., 2016). HbA1c levels or the risk factor morbidity index was significantly associated with waist/height ratio, waist/hip ratio was not significantly associated with most of the variables (Hsieh and Yoshinaga, 1995). The sensitivity of waist-to-height ratio (WHtR) as a marker for high blood pressure in children aged nine to 15 years (n = 1 131), from schools in the North West province, South Africa (Motswagole et al., 2011). WHtR was found to be significantly related to lipid profile and blood glucose level among adults (Abu Saad et al, 2015).

In our study waist/height ratio and fasting blood glucose levels were associated in female volunteers (p=0.01 r=0.243). Very poor association was found between waist to height ratio and blood pressure in our study.FBG was loosely associated with diastolic blood pressure in both male (r=0.26) and female (r=0.22) volunteers.

In the 17-26-year-old college students study group waist/height ratio was correlated very weak with FBG and was not correlated systolic and diastolic blood pressures. In 9.9% of the female volunteers waist/height ratio was ≥0.5, thus they had abdominal obesity. 20% of the male volunteers had waist/height ratio more than 0.5. Male volunteers had twice more abdominal obesity than female volunteers.

Blood pressure parameters increased significantly with BMI with higher values in males than in females among university students in South East Nigeria (Nwachukwu et al, 2014). In our study, no significant relationship was found between BMI and systolic and diastolic blood pressure in college students.

Obesity and cardiovascular risks are closely associated. Hypertension is the most common and early complication of obesity. Tambe et al have found that in hypertensive middle aged Indian males diastolic blood pressure showed a better correlation with Waist to Hip Ratio rather than with Body Mass Index (Tambe et al, 2010).In our study waist/hip ratio and systolic blood pressure was loosely related with BMI in male college students (r=0.32, r=0.51).

BMI and WC were closely associated with fat mass (FM), percent of body fat, respectively in adolescents aged. However, the degree of these associations depends on gender and weight status. BMI may provide

a better proxy estimate of overall adiposity than WC; nevertheless, both of them would appear to be a reasonable surrogate for FM and PBF as screening tools to identify adolescents at risk of developing excess body fat and high level of FBG (Mehdad et al, 2012).

The mean waist circumference of the female volunteers was 70.75±9.56 cm. It was 82.00±9.09 in the male volunteers. In total only the waist circumference significantly affected waist/height ratio, systolic and diastolic blood pressures.

Male volunteers had twice as much abdominal obesity than female volunteers. 3.3% of the female and 1.2% of the male volunteers had higher than 1 waist/hip ratio (abdominal obesity defined as ›1). Nonetheless, no statistically significant difference was found between waist/hip ratios.

CONCLUSION

The waist circumference was most significantly associated with waist/height ratio, FBG, systolic and diastolic blood pressures. According to our findings, prevention of increasing the waist circumference and weight gain is important starting from average 19 years of age.

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Conflict of Interest

Authors declare no conflict of interest.

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