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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

OPEN ACCESS Pakistan Journal of Biological Sciences

ISSN 1028-8880
DOI: 10.3923/pjbs.2019.168.173

Research Article
Measurement of Visceral Fat, Abdominal Circumference and Waist-hip Ratio to Predict Health Risk in Males and Females

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Abstract

Background and Objective: Obesity is a risk factor for a broad range of diseases. This study aimed to estimate association between selected variables (visceral fat, abdominal circumference and waist-hip ratio) and health risk in between male and female. **Materials and Methods:** The university student based cross-sectional study was conducted among male and female students. The anthropometric measurements were taken through the auto-calibrated digital scale. Bioelectrical impedance analyzer device was used to determine visceral fat area, abdominal circumference and waist-hip ratio. Independent t-test and Pearson Chi-Square was used for statistical analysis. To see the association among the all three variables, scatter plots were also drawn. **Results:** The results showed that 28.3% male and 9.4% female at risk for visceral fat, for the abdominal circumference 16.9% male and 6% female at risk and for waist-hip ratio 27.5% male and 6% female fell under risk category. There was a significant relationship among all variable for male and female. **Conclusion:** Findings suggested that visceral fat area, abdominal circumference and waist-hip ratio were strong predictors of health risk. Male were more prone to health risk than female participants.

Key words: Visceral fat area, abdominal circumference, waist-hip ratio, health risk, bioelectrical impedance analyzer

Citation: Qassim Ibrahim Muaidi and Mohammad Ahsan, 2019. Measurement of visceral fat, abdominal circumference and waist-hip ratio to predict health risk in males and females. Pak. J. Biol. Sci., 22: 168-173.

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Obesity is a common condition now-a-days that is being increased worldwide especially in developed urban areas. Obesity is a complex and multifactorial chronic disease originating from a genetic and environmental or behavioral interchange, caused by an imbalance between energy intake and expenditure[1]. Obesity may increase the risk of many health problems such as blood pressure, diabetes, heart stroke[2], kidney, liver failure[3], osteoarthritis[4] and sleep apnea[5]. Obesity can be measured in several ways, each method has their pros and cons. The most basic methods are body mass index[6], skinfold thicknesses[7], visceral fat[8], waist circumference and waist-hip ratio[9,10].

In Harvard University, it was observed that about 10% of total fat is expected to be stored as visceral fat. Visceral fat includes excess intra-abdominal adipose tissue accumulation. The high amount of visceral fat can cause visceral obesity. Visceral obesity is a key hazard for insulin resistance, cardiovascular disease, systemic inflammation and hyperlipidemia[11]. Visceral obesity does not always occur with high BMI. It was documented in 1981 that normal weight, overweight and obese persons were due to the excess visceral fat[12]. This is identified that changes in body composition specifically reduction in visceral fat accumulates more important than the reduction overall body weight[13].

Abdominal circumference is an exact, simple and more reliable determinant of abdominal obesity or excess visceral fat. It is established that abdominal obesity, assessed by abdominal circumference, predicts obesity and health related risk[14]. A research finding indicated that abdominal circumference is a sound marker of a health risk than BMI; abdominal circumference is also a strong predictor of abdominal and non-abdominal fat[15,16]. Abdominal circumference is computed as a part of the initial measurement to monitor the efficiency of weight reduction therapy in obese and overweight individuals who have a BMI lesser[17] than 35 kg m^{-2}.

The waist-hip ratio is a quick, easy method to determine body composition. It is a common measure that shows the degree of a person's abdominal fat. Srikanthan *et al.*[18] confirmed that waist-hip ratio is a superior clinical measurement for predicting all causes of CVD mortality. While Vazquez *et al.*[19] proved that waist-hip ratio is a consistent predictor for type 2 diabetes mellitus. Moreover, Wellborn and Dhaliwal[20] concluded that the hip circumference suggests a lower risk for body fat accumulation. Earlier researches indicate that waist hip ratio higher than 1.0 for men and 0.8 for women are associated with higher risk of diabetes and hypertension. Storing excessive fat in the abdominal region is associated with an increased risk for life style and weight-related diseases. Ross *et al.*[21] indicated that visceral fat, abdominal circumference and waist circumference are uniformly helpful to recognize diabetes risk, cardiovascular disease and all cause of mortality. Although, many research works have been done worldwide on various aspects of anthropometric measurement to predict the risk of obesity and non-communicable diseases. The primary objective of this investigation was to determine the association among visceral fat, abdominal circumference and waist-hip ratio for the prediction of health risk diseases among male and female.

MATERIALS AND METHODS

Study setting: University students based cross-sectional analytical study was conducted in college of applied medical sciences among male and female students during the academic session 2017-2018.

Ethical consideration: Ethical approval was obtained from the institutional review board (IRB) from deanship of research, Imam Abdulrahman Bin Faisal University, Dammam with approval number (IRB-2017-03-165).

Inclusion and exclusion criteria: The participants voluntarily took part in this study. Participants suffering from physical or mental disabilities, cardiac problems or any chronic illness and pregnancy were excluded from the study.

Procedure: Before conducting data collection, consent forms were received from the participants. All participants were explained about all important instructions to follow while participating in data collection as per manual of Bioelectrical Impedance Analyzer (BIA). The anthropometric measurements were taken with the auto-calibrated digital scale (Detecto-model 750, USA). The visceral fat, abdominal circumference and waist-hip ratio were assessed using auto-calibrated BIA device (i0i 253, Jawon Medical, S. Koria). The bioelectrical impedance used method shows high correlation (R = 0.88) with dual X-ray absorptiometry[22]. To measure all variables, participants asked to stand barefoot over the electrodes of the device. The essential personal details: gender, age and height entered into the device. Participant asked to grip hand-held electrodes and press the button. The device took 2-3 min to complete the test. The visceral fat area considered normal as range 50-100 for male and 40-80 for female. The abdominal circumference less than 102 cm for male and less than 88 cm for female was considered as normal. For the waist hip ratio (WHR), the normal range was 0.75-0.90 for male participants and 0.70-0.85 for female participants.

Statistical analysis: The identified parameters were statistically analyzed for the proper evaluation of characteristic related to both genders. Data were represented using percentages, mean and standard deviation. Independent t-test was done to see the difference in means, Pearson Chi-Square was also used. To see the association between the measure's parameters, graphs were drawn as well. A p-value $\leq$0.05 was taken as statistically significant. The Statistical Package for Social Sciences Version 23 for Windows (SPSS Inc., Chicago, IL, USA) was used to analyze the data.

RESULTS

Table 1 showed that there was no significant difference for the age in between male and female whereas, there were significant differences for the height, weight, BMI, VCA, AC and WHR in between male and female participants. Male also had greater values for all parameters than female.

Table 2 showed that among the participants for the prevalence of body mass index, 13.3% were underweight, 51.7% were normal, 14.6% were overweight and 20.4% were obese. For the gender classification female were more underweight (66.67%) as compare with male (10%). More females (58.33%) were in normal weight than male (45%) participants. The prevalence of the overweight and obesity was determined by BMI that is 15.42 and 29.58% for male and 13.75 and 11.50% for female, respectively. The males were more overweight and obese than female participants.

Table 3 showed that among the male and female participants, according to their VFA measurement, 21.7% male fell under normal category and 28.3% fell at risk category, Whereas, 40.6% female fell under normal category and only 9.4% at risk category. According to their WHR measurement, 27.5% male fell under normal category and 22.5% fell at risk category, Whereas, 44% female fell under normal category and only 6% at risk category. Over all male were at more risk than the female participant and there was also significant relationship among male and female participants for all parameters.

Figure 1 showed a strong linear association among VFA-AC, WHR-AC and WHR-VFA as 0.928, 0.916 and 0.922, respectively for male participants.

Figure 2 exhibited a strong linear association among VFA-AC, WHR-AC and WHR-VFA as 0.945, 0.892 and 0.886, respectively for female participants.

Table 1: Descriptive statistical comparison for anthropometric measurements of male and female participants

Parameters	Both (Mean±SD)	Male (Mean±SD)	Female (Mean±SD)	t-test
Age	19.07±1.99	19.17±2.54	18.96±1.18	1.43
Height	162.40±8.71	167.58±8.38	157.22±5.27	262.30*
Weight	66.70±23.81	76.888±27.89	56.52±12.26	107.21*
BMI	24.98±7.32	27.108±8.68	22.86±4.81	43.92*
VCA	79.84±60.89	103.738±72.26	55.95±32.63	87.17*
AC	85.09±19.05	93.89±22.17	76.29±8.97	129.95*
WHR	0.87±.098	0.85±.11	0.78±.06	82.08*

*Significant at 0.05 level

Table 2: Prevalence of body mass index of the studied participants [(Male = 240+Female = 240) Total = 480]

BMI status	Both (%)	Male (%)	Female (%)
Under weight	64 (13.3)	24 (10.00)	40 (66.67)
Normal	248 (51.7)	108 (45.00)	140 (58.33)
Overweight	70 (14.6)	37 (15.42)	33 (13.75)
Obese	98 (20.4)	71 (29.58)	27 (11.50)

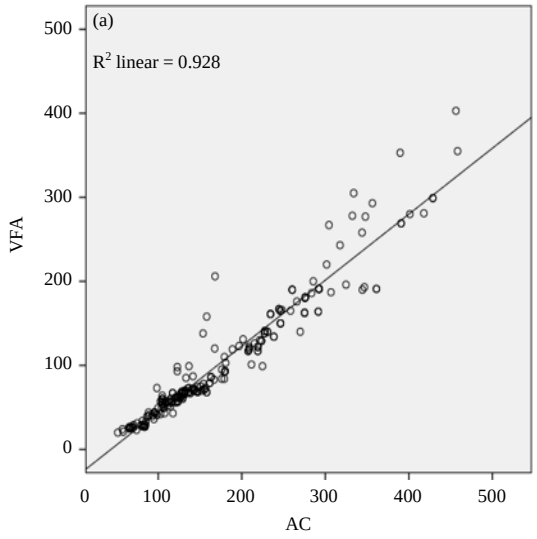
DISCUSSION

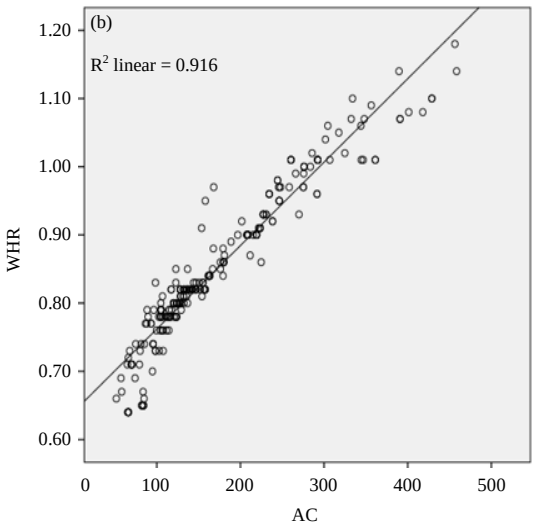
The finding showed that male participants (103.74) had more VFA than female (55.95), it means that male participants were at more risk than female. Research findings predicted the health risk in between male and female on the basis of earlier finding as Hayashi *et al.*[23] found that specific age-related cutoff level for VFA prediction of metabolic disorder in men 96.1 cm^2 (age >57 years) and 88.6 cm^2 (age $\leq$56 years) and in women were 86.3 cm^2 (age >57 years) and 51.5 cm^2 (age $\leq$56 years). The VFA calculated through magnetic resonance imaging (MRI) above 80 cm^2 was associated with high risk factor of metabolic syndrome[24]. A high level of visceral adipose tissue is linked with type 2 diabetes and impaired fasting plasma glucose[25]. Nicklas *et al.*[26] studied that VFA of 106 cm^2 was related with a considerable risk of cardiovascular diseases above the 45 years old women. In normal-weight individuals, it was observed that high level of visceral adipose tissues was related with cardiovascular risk factors in women, but not in

Table: 3: Statistical analysis to compare risk level in between male and female

	VFA			AC			WHR		
Parameters	Male (%)	Female (%)	Pearson chi-square	Male (%)	Female (%)	Pearson chi-square	Male (%)	Female (%)	Pearson chi-square
Normal	104 (21.7)	195 (40.6)	73.447[a]*	159 (33.1)	211 (44.0)	31.890[a]*	132 (27.5)	211(44.0)	63.750[a]*
At risk	136 (28.3)	45 (9.4)		81 (16.9)	29 (6.0)		108 (22.5)	29 (6.0)	

[a]0 cells (0.0%) have expected count less than 5. The minimum expected count is 90.50. *Asymp. Significance (2-sided)





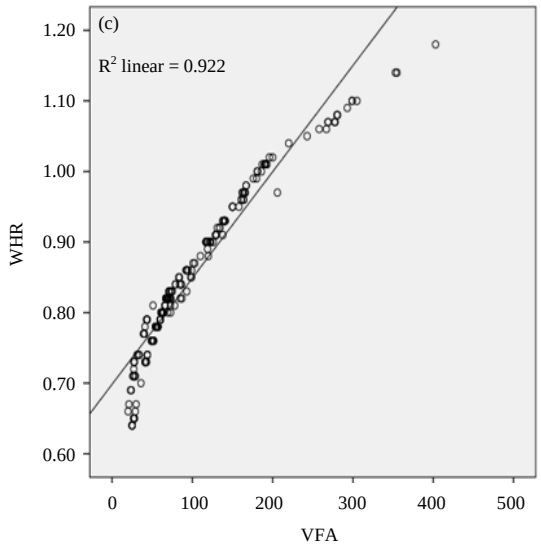
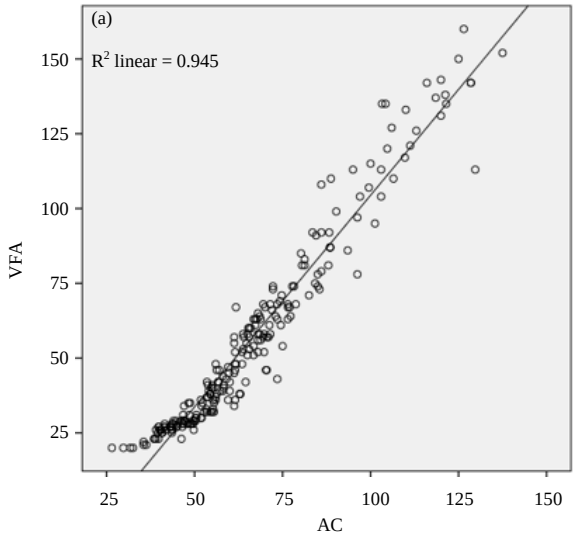
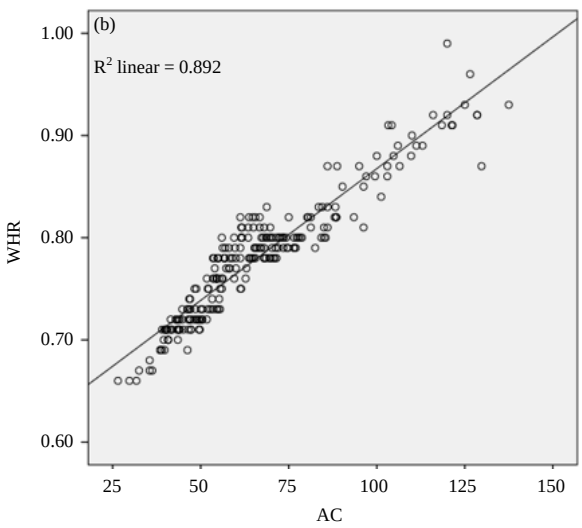


Fig. 1(a-c): Graphical representation of linear association of VFA, AC and WHR among male participants





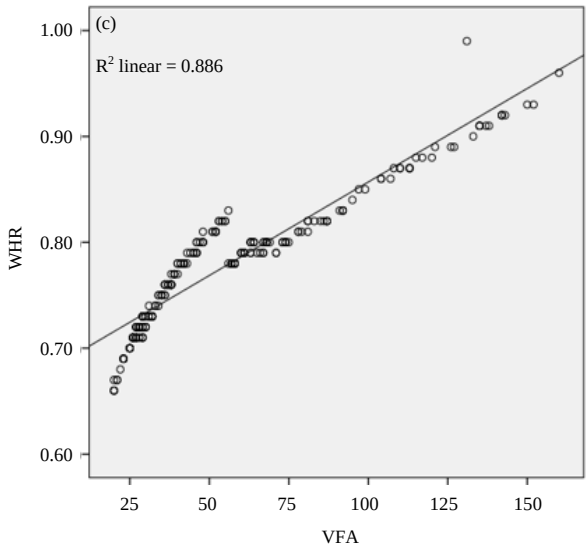


Fig. 2(a-c): Graphical representation of linear association of VFA, AC and WHR among female participants

men[27]. The results showed that mean AC for the female (76.29±8.97) was lesser than male (93.89±22.17), the mean difference was significant (t=129.95). Male participants were at more risk than female for bigger abdominal circumference. Dong *et al.*[28] found that the high level of AC was associated with greater enhance in hypertensive risk in overweight (74%) children than that of children with normal (74%) AC. Another investigation showed that the ideal AC cutoff values were 73.5 cm for women and 82.5 cm for men regarding insulin resistance. This is recommended that AC has solid relationship with metabolic risk level of individuals[29]. Gill *et al.*[30] found that participants with large WC had 2.4 times risk of developing inability to walk 400 m when compare with healthy participants. A Tehran study found that WC was the best examining method to determine CVD risk-factor when compared with WHR and BMI[31].

The result of the study also showed that male (0.85±0.11) had more WHR than female (0.78±0.06), the mean difference was significant (t = 82.08). So, males were at more risk than female participant for WHR. The research findings predicted the health risk on the basis of earlier finding as Elsaye *et al.*[32], who investigated that WHR were strongly related with increased risk cardiac events in patients with chronic kidney disease. A meta-analysis conducted with 12 case-control studies in 14 eligible trails and revealed that higher WHR value were more strongly predictive of MI in women than men[33]. A cross sectional investigation found that WHR have parallel predictive power in the risk of diabetes type II for both genders[34]. Tice *et al.*[35] also found a monotonic relationship between WHR and mortality in women. Srikanthan *et al.*[18] noticed higher WHR and WC in women. Moreover, according to them morality risk get enhanced with high WHR and WC. A study of Streng *et al.*[36] found a significant association between WHR and sex with mortality. There was a strong significant relationship with high WHR and higher mortality risk in women, while there was insignificant relationship for men. Hence, it is recommended that sound prevention strategies must intervene to reduce health risk and to promote a better healthy life style.

CONCLUSION

This study concluded that visceral fat area, abdominal circumference and waist-hip ratio have strong association with the health risk. Males were found to be at more health risk than females in all categories. These findings could provide good predictive ability to determine health risk. Researchers recommend that sound prevention strategies must intervene to reduce health risk and promote a better healthy life style.

SIGNIFICANCE STATEMENT

This study discovered the level of visceral fat area, abdominal circumference and waist-hip ratio among male and female participants that can be beneficial to predict the health risk among them. This study will help the researchers to uncover these critical areas of obesity that many researchers were not able to explore. Thus, this study provided a new insight to prevent the causes of health risks that occur due to selected components of obesity.

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