©Human Biology Review

Human Biology Review (ISSN 2277 4424) 1(4) 2012
Original scientific paper (Rana and Sidhu pp 342-351)
Revised and Accepted on 23.09.2012

Relationship of percent body fat (estimated by bioelectrical impedance analysis) with blood pressure among young adult females of Amritsar (Punjab)

Bindiya Rana* and Sharda Sidhu**

* Bindiya Rana, M.Sc. Student, Dept. of Human Genetics, Guru Nanak Dev University, Amritsar, 143005, Punjab, India, E-mail ID: bindiyarana18@yahoo.in

**Sharda Sidhu, Professor, Dept. of Human Genetics, Guru Nanak Dev University, Amritsar, 143005, Punjab, India, E-mail ID: shardasidhu@hotmail.com

Corresponding Author: Bindiya Rana, M.Sc. Student, Dept. of Human Genetics, Guru Nanak Dev University, Amritsar, 143005, Punjab, India, E-mail ID: bindiyarana18@yahoo.in

ABSTRACT

The present cross-sectional study was carried out to find the association of percent body fat (PBF) with blood pressure (BP) variables among apparently healthy young females studying in Guru Nanak Dev University, Amritsar. A total of 150 females ranging in age from 20-25 years were personally interviewed. Height and weight of each subject was taken using standard methodology. Their body composition parameters were taken by using body fat analyzer. Subjects were categorized as obese and non-obese according to PBF, in which those having >30% body fat was considered as obese. BP of each subject was measured by using the standard methodology. The prevalence of hypertension was calculated according to JNC VII criteria. In the pooled data, the percentage prevalence of obesity according to PBF was 36%. The percentage prevalence of pre-hypertension and hypertension in the pooled sample was 54% and 12%, respectively. However, it was observed that prevalence of hypertension was slightly more among obese females (7.3%) as compared to non-obese (4.7%) but the prevalence of pre-hypertension was significantly ($p<0.05$) more in non-obese females (39.3%) as compared to obese females (14.7%). The underline cause of this high prevalence of pre-hypertension in non-obese subjects was not known. It is clear from the correlation analysis that no association was observed between SBP and MAP with PBF in obese and non-obese subjects while DBP is positively and significantly ($p<0.05$) correlated with weight, fat mass and fat free mass in non-obese subjects only. Thus it is concluded from this study that PBF measured by BIA was not likely to be a good predictor of high BP. Therefore, further large prospective studies on the association of hypertension and whole body fat and abdominal fat should be carried out to confirm the role of fat on BP.

KEY WORDS: *Systolic Blood Pressure, Diastolic Blood Pressure, Hypertension, Pre-hypertension, Bioelectrical Impedance Analysis, Percent Body Fat.*

INTRODUCTION

Obesity has been widely recognized as one of the most important public health problems, both in developed and developing countries. The most common method for the assessment of obesity is body mass index (BMI) but the limitation of BMI is that it does not account for fat distribution, degree of muscularity or bone density, all of which are independent predictors of health risks (Shetty and Mantzoros, 2006; Bahadori *et al*., 2006). For this reason, it is necessary to assess an actual amount of fat and fat free mass in an individual's body. Several techniques have been used to assess body fat such as magnetic resonance imaging (MRI), dual-energy X-ray absorptiometry (DXA), computerized tomography (CT) and body density calculated from underwater weighing. However, these methods are difficult and expensive for a population study and not feasible to conduct in the field because they require large specialized equipment when compared to bioelectrical impedance analysis (BIA). The use of BIA for determining percent body fat (PBF) is widely accepted as safe, rapid, low cost and reliable technique (Tsui *et al*., 1998; Singh *et al*., 1999; Willett *et al*., 2006; Kobayashi *et al*., 2006).

An association between obesity and high blood pressure has been shown in both men and women. Various studies (Gerber *et al*., 1995; Singh *et al*., 1999; Shuger *et al*., 2006; Shetty and Mantzoros, 2006; Bassuk and Manson, 2006) indicate that who suffer from obesity have an increased risk of cardiovascular diseases such as elevated blood pressure and coronary artery diseases.

Bell *et al*. (2002) and Shuger *et al*. (2008) conducted studies on the association between blood pressure and obesity assessed by BMI. According to these studies, both systolic and diastolic blood pressure increases with BMI and obese individuals are at higher risk of developing hypertension than lean subjects. Sidhu and Kumari (2002), Sidhu and Prabhjot (2007) studied the association of blood pressure with body fat and fat free mass estimated by skinfolds in Punjabi population. Talwar *et al.* (2010) studied Rajput girls of 11-17 years of age belonging to Theog Tehsil, Shimla (Himachal Pradesh) and reported that BMI, PBF and fat mass were significantly correlated only with diastolic blood pressure. However, no study has examined the association of percent body fat (estimated by BIA) with blood pressure among young adult females ranging in age 20-25 years. Therefore in the present study, an attempt has

been made to examine the association of percent body fat with hypertension in young apparently healthy females of Amritsar (Punjab).

MATERIALS AND METHODS

The present study was conducted on 150 healthy young females ranging in age from 20-25 years and belonging to middle socio-economic status. All the subjects were studying in the Guru Nanak Dev University, Amritsar (Punjab). Institutional Ethics Committee approved the study protocol and written consent was obtained from each subject. Questionnaire was designed to extract the relevant information about age, socio-economic status and physical activity. Two anthropometric measurements like height and weight were taken on each subject using standard methodology (Weiner and Lourie, 1981). Percent body fat (PBF) was assessed with the help of body fat analyzer (BODYSTAT – 1500, UK model) by bioelectrical impedance method. Bioelectrical impedance analysis (BIA) is a non-invasive, simple, quick and inexpensive method for measuring body composition. The readings were recorded after entering the data about sex, age, height, weight and physical activity of the subject. The prevalence of obesity was determined from PBF using Singh *et al*. (2000) criteria in which if the value of PBF is more than 30% in females then subject is considered to be obese.

Blood pressure was measured using standard mercury sphygmomanometer (Pagoda, New Delhi) with an appropriately size cuff and stethoscope by following recommendations of American Heart Association (Atamen *et al*., 1996). Three readings were taken at 5 minutes interval and their mean values were used in the subsequent analysis. Mean arterial pressure [MAP=DBP+ 1/3 (SBP-DBP)] and pulse pressure (PP=SBP-DBP) were calculated using standard method of Perusse *et al*. (1989). The hypertension status of the studied sample was determined by using JNC VII (2003) criteria, as given below:

CLASSIFICATION	SBP (mmHg)	DBP (mmHg)
Normotensive	<120	<80
Pre-hypertensive	120-139	80-89
Hypertensive	≥140	≥90

Mean, standard deviation (SD) and standard error (SE) was calculated. The data was analyzed using Statistical Package for Social Sciences for Windows version 16.0 (SPSS inc, and Chicago, IL). Pearson's correlation, Chi-square test and Student 't' test were performed to

compute the degree of relationship between variables and statistical significance was defined as a value of $p<0.05$.

RESULTS

Table-1 shows the general characteristics of the studied subjects. For studying relationship between blood pressure and obesity, all the subjects were categorized into two groups on the basis of percent body fat (PBF). Subjects having PBF ≤30% were classified as non-obese and those having >30% were considered as obese. A statistically significant ($p<0.01$) difference between the mean values of obese and non-obese females was observed in weight, height, PBF and fat mass. It is interesting to note that the young females of Amritsar have very high percentage of body fat (28.57%) which was determined by bioelectrical impedance analysis (BIA) method. According to PBF criteria of Singh *et al*. (2000), 36% females were obese as shown in **Table-2**.

Table 1: Characteristics of the study participants.

VARIABLES	POOLED SAMPLE		PERCENT BODY FAT (PBF)				't' VALUE
			NON-OBESE (≤30) (N=96)		OBESE (>30) (N=54)		
	MEAN	SD	MEAN	SD	MEAN	SD	
Weight (kg)	53.03	8.81	49.87	7.56	56.67	8.09	6.55**
Height (cm)	158.20	5.75	159.33	5.65	156.14	5.39	3.42**
PBF	28.57	5.15	25.70	3.64	36.66	3.10	14.15**
FM (kg)	15.37	4.83	12.89	3.01	19.79	4.28	10.48**
FFM (kg)	37.62	5.06	37.06	5.47	38.60	4.09	1.95
SBP (mmHg)	117.43	7.97	117.40	6.97	117.48	9.57	0.06
DBP (mmHg)	78.46	7.52	77.84	6.25	79.56	9.33	1.21
MAP (mmHg)	91.20	7.17	90.75	5.96	92.01	8.94	0.93
PP (mmHg)	38.23	7.64	38.72	7.59	37.37	7.72	1.03

**: significant difference at $p<0.01$.

Table 2: Distribution of subjects according to Percent Body Fat (PBF).

Total sample	Percentage Prevalence of PBF	
	Non-obese (≤30)	Obese (>30)
150	64.0 (96)	36.0 (54)

Figures in the parenthesis are the number of subjects.

The mean values of systolic blood pressure (SBP) and diastolic blood pressure (DBP) in the pooled sample were 117.43±7.97 mmHg and 78.46±7.52 mmHg, respectively. Based on JNC VII classification 12% subjects were hypertensive, 54% were pre-hypertensive and 34% females were normotensive (**Table-3)**. The prevalence of hypertension was significantly (χ^2 = 7.869; df = 2; $p<0.05$) more in obese females (7.3%) as compared to non-obese females (4.7%) while on the other hand the prevalence of pre-hypertension was more in the non-obese females (39.3%) as compared to obese females (14.7%) as shown in **Table-4**.

Table 3: Percentage Prevalence of Normotensive, Pre-hypertensive and Hypertensive in the pooled sample.

STATUS OF HYPERTENSION	PERCENTAGE PREVALENCE (POOLED SAMPLE)
Normotensive	34 (51)
Pre-hypertensive	54 (81)
Hypertensive	12(18)

Figures in the parenthesis are the number of subjects.

Table 4: Percentage Prevalence of Hypertension according to Percent Body Fat (PBF).

PBF	STATUS OF HYPERTENSION			CHI-SQUARE VALUE
	NORMOTENSIVE	PRE-HYPERTENSIVE	HYPERTENSIVE	
≤30(96)	20.0 (30)	39.3 (59)	4.7(7)	7.869* $p<0.05$
>30(54)	14.0 (21)	14.7 (22)	7.3 (11)	

Figure in the parenthesis are the number of the subjects.

Pearson's correlation coefficient between blood pressure and body composition variables was calculated. In the present study (**Table-5**), there was a significant ($p< 0.05$) positive relationship of diastolic blood pressure (DBP) with weight, fat mass (FM) and fat free mass (FFM) while on the other hand pulse pressure (PP) had significant ($p<0.05$) negative association with weight and FFM only in non-obese females. Systolic blood pressure (SBP) and mean arterial blood pressure (MAP) were not significantly correlated with above mentioned parameters.

Table 5: Pearson's correlation co-efficient of Blood Pressure variables with various Anthropometric and Body Composition measurements among non-obese and obese females according to Percent Body Fat (PBF).

VARIABLES	BLOOD PRESSURE MEASYREMENTS							
	PBF ≤30				PBF >30			
	SBP	DBP	MAP	PP	SBP	DBP	MAP	PP
Weight (kg)	-0.020	0.248*	0.170	-0.211*	0.071	0.074	0.083	0.020
Height (cm)	-0.055	0.166	0.096	-0.185	-0.064	-0.010	-0.020	-0.033
PBF	0.033	0.051	0.066	0.030	-0.062	0.024	0.004	-0.071
Fat mass (kg)	0.016	0.241*	0.155	-0.114	0.053	0.089	0.089	-0.014
Fat free mass (kg)	-0.030	0.241*	0.156	-0.226*	0.157	0.124	0.144	0.053

*: significant difference at $p < 0.05$

DISCUSSION

It is apparent from this study (**Table-1**) that young adult females of Amritsar have very high mean value of PBF (28.57%) and it was observed that 36% females were obese (**Table-2**). The percentage prevalence of pre-hypertension and hypertension in the pooled data was 54% and 12%, respectively as presented in **Table-3**. This shows that a large proportion of young adult females were in the pre-hypertensive category. Shanthirani *et al*. (2003) reported the prevalence of pre-hypertension among urban females of Chennai as 47.10%. According to Deshmukh *et al*. (2006), 45.10% of women of rural Wardha are pre-hypertensive where as Yadav *et al*. (2008) noticed 28.10% prevalence of pre-hypertension in North Indian affluent females. It is observed from this comparison that prevalence of pre-hypertension is quite high in young adult females of Amritsar. Gupta, (1997) reported that if we apply JNC VII criterion strictly in Indian scenario it is feared that almost 50% of Indian population may be pre-hypertensive. Greenlund *et al*. (2004)

and Liszka *et al*. (2005) reported that persons with pre-hypertension have a greater risk of developing hypertension than to those with lower blood pressure levels. In addition, pre-hypertension is associated with increased risk of major cardiovascular events, independent of other cardiovascular risk factors. So, it may be concluded from the present results that females with pre-hypertension may be at increased risk of hypertension than those with lower values of BP and require health promoting life styles modifications to prevent cardiovascular diseases (CVD). Thus, longitudinal studies involving regular check up of BP should be carried out in future to study the casual relationship between pre-hypertensive levels of BP and subsequent development of hypertension and there is urgent need to implement at the community level, cost-effective strategies, targeting individuals and health care providers to prevent pre-hypertension or hypertension and improve its awareness, treatment and control in the young adults.

To study the relationship between hypertension and PBF, all the subjects were categorized into two groups i.e. obese (PBF>30) and non-obese (PBF ≤30). **Table-4** presents that the prevalence of hypertension was more among obese females (7.3%) as compared to non-obese (4.7 %) but the prevalence of pre-hypertension was significantly ($p<0.05$) higher in non-obese females (39.3%) as compared to obese (14.7%) females. It was apparent from the present data that subjects having ≤30 PBF had very high percentage prevalence of pre-hypertension as compared to subjects having >30 PBF. This was also confirmed by correlation analysis in which no association has been observed between SBP and MAP with PBF in obese and non-obese subjects (**Table-5**). However, it is also apparent from this table that DBP is positively and significantly correlated only in non-obese subjects with weight (r= 0.248), fat mass (r=0.241) and fat free mass (r=0.241). The underline cause of this high prevalence of pre-hypertension in non-obese subjects was not known. Kobayashi *et al.* (2006) studied Japanese population and also reported that PBF (estimated by BIA) does not provide any association with BP. Thus PBF measured by BIA was not likely to be a good predictor of high blood pressure among young females of Amritsar. In literature, (Bassuk and Manson, 2006; Ahmad *et al*., 2011) the importance of excess fat in abdominal region, as a risk factor for BP in adults is well documented. Bassuk and Manson (2006) further reported that abdominal and upper body obesity is a powerful risk factor for hypertension than the general obesity. Therefore, further large prospective studies on the association of hypertension and whole body fat and abdominal fat should be carried out to confirm the role of fat on BP.

ACKNOWLEDGEMENT

All the subjects who co-operated and participated in the fulfillment of this study are duly acknowledged. The present study was carried out from partial grants received from the departmental SAP and PURSE programmes.

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