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Association of Body Fat Percentage with Caridometabolic Risk Factors: a Hospital Based Observational Study

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Abstract
Background: *Obesity is considered as an important global health problem worldwide and is on a very high rise in the past one decade. Its association with numerous comorbidities such as cardiovascular diseases, type 2 diabetes, hypertension, certain cancers etc. make it a matter of major concern for the clinicians. Present study thus aimed to evaluate the association of Body Fat Percentage with a wide variety of cardiometabolic risk factors.*
Material and Method: *115 subjects were enrolled in the study. Body fat Percentage was calculated using Bioelectrical impedance analysis method. The subjects were divided into two groups depending upon their BF%. Anthropometric parameters, systolic blood pressure, diastolic blood pressure, fasting lipid profile, and blood glucose were collected.*
Results: *Percentage body fat was significantly and directly associated with total cholesterol, triglycerides, low-density lipoprotein cholesterol, fasting blood glucose and Systolic Blood Pressure (p<0.001).*
Conclusions: *Obesity is a major determinant of high blood pressure, raised cholesterol and impaired glucose levels and increased BF% is associated with a higher risk of developing Cardiometabolic risk factors.*
Keywords: *Obesity, Body fat percentage, Cardiometabolic risk factors.*

Introduction

Obesity is acknowledged as one of the most alarming global health problems reducing the life expectancy and quality of life.[1] The epidemic of obesity is said to occur on genetic backgrounds that have not changed till date, but there are many other socio-economic and demographic factors also that influence the obesity epidemic, including age, gender, cultural, behavioural and environmental factors, urbanization, imbalance between food intake and lack of physical activity.[2,3]

Over the past two decades there has been a dramatic rise in the prevalence of obesity throughout the world.[4] As per the WHO World Health Statistics Report 2012, globally one in six adults is obese and nearly 2.8 million individuals die each year due to overweight or obesity.[5] In

India the prevalence of obesity is 12.6% in women and 9.3% in men. In other words, more than a 100 million individuals are obese in India.[6,7]

Prospective epidemiological studies have also documented a significant relationship between overweight/obesity and cardiovascular morbidity and mortality. Also obesity has been found to be strongly related to the major cardiovascular risk factors such as raised blood pressure, glucose intolerance, type-2-diabetes and dyslipidaemia.[8,9]

There are several obesity indices to estimate the Cardiovascular Disease (CVD) risk. Body Mass Index (BMI) being one of the most traditionally used indicator of obesity for population samples, but there are certain limitations to BMI interpretation as it depicts only the relationship between body weight and height. Waist circumference (W.C.), waist-hip ratio (WHR) and the waist-height ratio (WHtR) are other simple parameters which can assess both intra-abdominal fat mass and overall obesity.[10,11] On the contrary there are some diseases and pathological condit-ions which are accompanied by changes in the composition of the different body compartments such as fat-free mass, fat mass and total body water.[12] Hence the need for an alternative approach to setting obesity standards thus aroused so as to study the association of a more direct measure of adiposity with CVD risk factors to determine the level of association between the two. The assessment of body composition thus is considered of great value in metabolic, nutritional and energy balance studies.[13] There are no direct methods for measuring the adiposity and the most frequently used indirect methods are Magnetic Resonance Imaging (MRI), Computerized tomo-graphy (CT), Dual Energy X-ray absorptiometry (DXA), body density calculated from underwater weighing and Bioelectrical impedance analysis (BIA).[14] The determination of Body Fat Percentage (BF%) by BIA has certain advantages over the other techniques for the study of body composition, such as ease of use, cost, and safety.[15] By sending a small electrical current through the body, we can calculate the resistance opposed to its flow by the tissues (impedance), and thus calculate body composition.[16]

Recently, BF% has emerged as an important risk factor of morbidity and mortality related to cardiovascular diseases, independent of BMI,[17] and is found to be more useful in identifying early stage accumulation of cardiovascular disease risk.[18]Various studies have provided substantial evidence in support of BMI and BF% not being analogous entities[19] and that a high BF% is far more useful in detecting normal-weight obesity.[20] There is paucity of accurate data and statistics related to this in our region (Shimla). Thus we conducted this study with an aim to evaluate the association between the BF% and the CVD risk factors.

Material and Methods

Setting and study design; Tertiary care hospital based prospective case control observational study.

Study subjects and selection method; Patients were selected from the Cardiology OPD of IGMC who came for evaluation of their symptoms rela-ted to chest pain, breathlessness etc. Individuals with incidence of CVD (myocardial infarction, coronary insufficiency, angina, ischemic stroke, haemorrhagic stroke, transient ischemic attack, peripheral artery disease, or heart failure), chronic kidney disease, history of bariatric surgery, previous medical treatment for dyslipidemia, hypertension, diabetes, or other chronic diseases, and patients with any nutritional intervention, intensive exercise training or muscle strength training which could modulate body composition were excluded from the study. After obtaining informed consent 115 patients were enrolled in the study. The study was approved by the ethical committee of the institution.

Data Collection; Data related to demographics, behavioural risk factors, clinical characteristics, anthropometry and BP were recorded using standard and validated tools and following standard guidelines. BP was recorded with mercury based sphygmomanometer using

appropriate size BP cuff and observing all precautions after 5-10minutes of rest. Two readings were recorded at an interval of 3-5 minutes in sitting position. Averages of two readings were taken as the BP value. Weight was measured using flat surfaced weighing machine in light clothes with shoes off. Before recording weight zero error was corrected if found. Weighing machine was calibrated against standard weight periodically to ensure valid recording of weight. Height was measured using wall mounted calibration scale with off shoes and cap if any, subject standing erect with heels touching wall. Waist circumference was measured using non stretchable measuring tape in erect posture at the end of exhalation during normal breathing at point mid way between anterior superior iliac spine and lowest rib with the measuring tape parallel to the ground. Hip circumference was measured at the point of maximal protrusion of the gluteal muscles also to the nearest 0.1 cm.

Assessment of Body composition; Body fat percentage was determined by Bioelectrical Impedance Analysis (BIA) method using Body Stat, Quad scan 4000 analyser machine. Measurements were taken after at least 5h fasting and with an empty bladder. Any jewellery and metal accessories were removed and children were asked to lie supine for 5min before starting the measurements. One electrode was attached at the level of the ulnar head at the wrist and the other just behind the knuckles. On the foot, the two electrodes were attached at the level of the medial and lateral malleoli and just behind the toes, respectively. Impedance (Ω) at 50 kHz and BF% measurements was recorded. The subjects were classified for BF% according to BF criteria for South Asian population as according to the BF% scale: Males — normal weight (BF%: 12-22%), overweight (BF%: 22.1-27 %), and obese (BF%: =27.1); Females — normal weight (BF% 17-27%), overweight (BF% 27.1-32%), and obese (BF% > or=32.1).[21]We finally divided the study population into two groups – Group I having Normal BF% and Group II having increased BF%

(which included the overweight and the obese category both).

The classification of physical activity; included occupational, commuting, and leisure time physical activity which was questionnaire based.[22]

- **Sedentary-** Defined as subjects who reported light levels of occupational {sitting office work (eg. secretary)}, commuting (walking or bicycling <30 minutes), and leisure time physical activity (eg. reading, watching TV).

- **Moderate-** Defined as doing some physical activity >4 hours a week (walking or bicycling ≥30 minutes, light gardening, fishing, hunting).

- **Vigorous-** Defined as performing vigorous physical activity >3 hours a week (eg.running, jogging, skiing, swimming, ballgames, regular exercise) or heavy manual labor (eg. store assistant, industrial work, or farm work).

Blood Biochemistry; 5 cc of venous blood sample was drawn in fasting state for estimation of blood sugar and lipid profile. Blood sugar and lipid profile was done using standard kits in fully automatic auto analyzer Model Konelab (Backmancoulter) of central biochemistry lab of IGMC.

Statistics; Data was entered in Microsoft Excel spread sheet and Epi Info version 3;4,3 statistical software was used for statistical analysis. The clinical characteristics of the study population were reported as percentages and Mean±sd for categorical and continuous variables respectively. Comparison of significance of differences in the distribution of categorical variables and study population means of continuous variables between group with and without increased BF% was analyzed by X^2 test and unpaired t test or Mann Whitney test as appropriate respectively. The distribution of clinical characteristics among group with Normal and Increased BF% was done using X^2 and unpaired t test for categorical and continuous variables respectively. 2 tailed

significance at <0.05 was taken as statistical significance.

Results

Clinical and General Characteristics; of the study population are described in detail in Table1 and 2. A total of 115 subjects were included in the study. 50 subjects had normal BF% as per the criterion and were classified as Group I. The remaining 65 subjects had increased BF% and were thus classified into Group II. In brief the mean age of Group II was significantly higher compared to Group I (44.47 ± 9.59 yrsvs36.06 ±7.64 yrs; p<0.01) but the gender distribution was similar in both the groups (64% vs. 49.2%; p= 0.164). The study group means of Weight (72.92 ±10.63vs 61.64 ± 9.31; p<0.01), BMI (28.09 ± 3.33vs 22.33 ± 1.85; p<0.01) and WC (94.29 ±

7.78vs 80 ± 9.71; p<0.01) were significantly greater in the group with Increased BF%.

Cardiometabolic Risk Parameters of the study group; The high BF% group II had significantly higher values for systolic blood pressure (141.87 ± 15.18 vs 129.48 ± 9.48; p<0.01), FBS (109.7 ± 21.19 vs 92.16 ± 10.15; p<0.01) , Total-C (191.83± 34.99 vs 173.72 ± 32.67; p<0.01), LDL (119.94 ± 27.81vs 106.08 ± 30.16; p<0.01) and TG(166.07 ± 87.27 vs 132.28 ± 58.21; p<0.01) compared to those in the normal BF% groupI (Table 3).

Pearson's correlation coefficient between Cardiometabolic risk factors and Body Fat Percentage was calculated and we found that there was a significant (p< 0.05) positive relationship of Total cholesterol, Triglycerides, LDL, FBS and SBP with the increased BF% (Table 4).

Table 1. Clinical Characteristics of the study group

VARIABLES	Group I - Normal %BFM (N=50)	Group II- Increased %BFM (N=65)	P value
Age (years)	36.06 ±7.64	44.47 ± 9.59	0.000
Height (m)	1.66 ± .080	1.60 ± .087	0.000
Weight (kg)	61.64 ± 9.31	72.92 ±10.63	0.000
BMI(kg/m2)	22.33 ± 1.85	28.09 ± 3.33	0.000
W.C. (cm)	80 ± 9.71	94.29 ± 7.78	0.000
H.C. (cm)	91.20 ± 7.36	100.86 ± 7.93	0.000

Table 2. General Characteristics of the study group

VARIABLES	Group I -Normal %BFM (N=50)	Group II- Increased %BFM (N=65)	Odds ratio	95%C.I.	2tailed sig
Gender (Male)	32(64%)	32(49.2%)	0.545	0.256- 1.160	0.164
Urban (yes) %	26(52%)	53(81.5%)	4.076	1.765- 9.414	0.001
Employment status (yes) %	34(68%)	40(61.5%)	0.752	0.346 1.636	0.602
Alcohol consumption status (yes) %	18(36%)	15(23.1%)	0.533	0.235- 1.206	0.189
Tobacco consumption(yes) %	23(46%)	20(30.8%)	0.521	0.242 -1.122	0.139
Physical Activity (yes)%	32(64%)	22(33.8%)	0.287	0.132- 0.623	0.002

Table 3. Cardiometabolic Risk Parameters of the study group

VARIABLES	Group I - Normal %BFM (N=50)	Group II- Increased %BFM (N=65)	P value
SBP(mmHg)	129.48 ± 9.48	141.87 ± 15.18	0.000
DBP(mmHg)	88.44 ± 10.39	91.35 ± 8.30	0.086
MAP(mmHg)	103.09 ± 7.44	108.61 ±9.38	0.016
FBS(mg/dl)	92.16 ± 10.15	109.7 ± 21.19	0.000
Total-C(mg/dl)	173.72 ± 32.67	191.83± 34.99	0.006
LDL-C(mg/dl)	106.08 ± 30.16	119.94 ± 27.81	0.021
HDL-C(mg/dl)	43.56 ± 8.50	44.98 ± 13.67	0.872
TG(mg/dl)	132.28 ± 58.21	166.07 ± 87.27	0.004

Table 4. Pearson's correlation co-efficient of Cardiometabolic risk factors with Body Fat Percentage among the study population

Correlations

		FAT	CHO	TG	SBP	FBS	LDL
FAT	Pearson Correlation	1	.257[**]	.217[*]	.430[**]	.452[**]	.234[*]
	Sig. (2-tailed)		.005	.020	.000	.000	.012
	N	115	115	115	115	115	115
CHO	Pearson Correlation	.257[**]	1	.574[**]	.292[**]	.075	.579[**]
	Sig. (2-tailed)	.005		.000	.002	.423	.000
	N	115	115	115	115	115	115
TG	Pearson Correlation	.217[*]	.574[**]	1	.256[**]	.019	.206[*]
	Sig. (2-tailed)	.020	.000		.006	.841	.027
	N	115	115	115	115	115	115
SBP	Pearson Correlation	.430[**]	.292[**]	.256[**]	1	.218[*]	.263[**]
	Sig. (2-tailed)	.000	.002	.006		.019	.004
	N	115	115	115	115	115	115
FBS	Pearson Correlation	.452[**]	.075	.019	.218[*]	1	.083
	Sig. (2-tailed)	.000	.423	.841	.019		.379
	N	115	115	115	115	115	115
LDL	Pearson Correlation	.234[*]	.579[**]	.206[*]	.263[**]	.083	1
	Sig. (2-tailed)	.012	.000	.027	.004	.379	
	N	115	115	115	115	115	115

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Discussion

The association between obesity and increased risk for acquiring cardiovascular disease has already been well established. In our study too, we analyzed the association between BF% and cardiovascular risk factors.

The difference in the mean age of our two study groups was statistically significant which suggests that as individuals age, body composition changes, even in the absence of changes in body weight. Various Studies have shown that fat mass increases and muscle mass decreases with age. It has been proposed that reductions in Resting metabolic rate (RMR) and fat oxidation may lead to changes in body composition favouring increased fat mass and reduced fat-free mass.[23]

Also noticed in our study was that the BMI of the group with increased BF% was significantly higher when compared with the controls which suggests a close association between the two obesity indices. The association between increased BMI and BF% with the risk of developing various cardiometabolic risk factors has been substantiated in various studies. Lohman et al studied the relationship between body composition and BMI. They found that higher BMI was often associated with higher BF%.[24]

The W.C. was also found to be higher in our study in the group with increased BF%. While W.C. provides a simple and practical anthropometric measure for assessing central adiposity, and an increasing number of studies have reported a strong associations between WC, visceral adipose tissue, and obesity-related health risks. Recently, it has also been reported that WC is a better predictor of metabolic abnormalities than BF% measured by bio impedance method in elderly whites.[25]

It was interesting to notice that 81.5% of our study group with increased BF% belonged to urban areas which was in accordance with the findings of Misra et al who found out that about 30- 65%

of adult urban Indians are either overweight, obese or have abdominal obesity.[26] Jervase et al[27] too documented that a larger percentage of urban dwellers were more overweight and also more generally obese than the rural dwellers. Such differences were noted within the individuals of same ethnicity but different socioeconomic settings that have been expressly attributed to influences of westernization. This is seen in the increased consumption of high-fat diets, greater availability and affordability of packaged foods and the reduction of physical activities amongst the urban dwellers which differs greatly from the lifestyle of rural residents who live in areas where long distances are walked, vigorous activities are carried out in farming and other means of livelihood, and foods are locally obtained.

A significant positive association was also noticed between increased BF% and physical inactivity which can further be attributed to urbanisation and sedentary lifestyles. These findings are in agreement with other studies that have reported low physical activity and high engagement in sedentary behaviour among South Asian population.[28]

While focussing our results on the effects of BF% on cardiometabolic risk factors we found a significant association between increased BF% and raised SBP, FBS, TC, LDL-C and TG (p< .05). Similar findings were observed in two other studies also which determined the association among %BF and cardiovascular Risk Factors clustering and suggested that the association is direct and stronger than that seen with body weight or BMI.[29,30] Scott et al too stated that the percent fat was significantly related to CV risk factor levels. At higher levels of percent fat, the prevalence of adverse cardiovascular disease risk factors was higher, particularly above 20% fat in boys and above 30% fat in girls.[31]

A strong positive correlation was also observed in our study between the BF% and CVD risk factors namely SBP, FBS, Total Cholesterol, TG and LDL which indicates that an excess of body fat plays a central role in the development and progression of CVD because of its relationship with lipids and blood pressure. The adipose tissue is the source of proinflammatory adipokines like tumor necrosis factor-alpha,interleukin-6, leptin, plasminogen activator inhibitor-1, angiotens-iongen, resistin and C-reactive protein (CRP) that may play a role in metabolic and cardiovascular complications of obesity. It is also the source of anti inflammatory and anti atherosclerotic adipo-kines i.e. Adiponectin that has been implicated as an important contributor in the pathogenesis of glucose intolerance and atherosclerotic CVD.[32]

To the best of our knowledge, this is the first paper to investigate the association of BF% with cardiovascular risk factors in our region. Our results show that all the studied anthropometric parameters and BF% specifically are strongly and significantly associated with cardiometabolic risk factors. Moreover, we also demonstrated that %BF was significantly related to serum lipids, fasting blood glucose, and BP and to the clustering of cardiovascular and metabolic RFs. These results provide further evidence to confirm that excessive total body fat increases individual risk for cardiovascular disease and metabolic syndrome in a population of apparently healthy subjects without a history of cardiovascular disease. However it would be interesting to do a follow up study with these patients and find out the impact of treatment on variation in BF% and its outcome on CV risk profile.

Limitations

Our study had some limitations,as it was a single-center observational study thus plausible mechanisms relevant to the results in the current study and the potential clinical implications cannot be provided. Also a small study sample makes extrapolation to the general population difficult. Since body composition can vary over time, in our study, these parameters were collected only once—at the time of patient inclusion—so possible variations occuring in the association with Cardiometabolic risk factors have not been accounted for. The inflammatory markers such as

C-reactive protein and insulinemia were not measured. These factors are closely associated with adiposity and could have further clarified the role of %BF in measuring cardiovascular risk.

Conclusion

Obesity is a major determinant of high blood pressure, raised cholesterol and impaired glucose levels and increased BF% is associated with a higher risk of developing Cardiometabolic risk factors. Thus weight control should be an integral part of the prevention of cardiovascular diseases.

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