SHORT REPORT

Body composition profiling and obesity analysis of healthy adults: A cross-sectional study

Zara Khalid[1], Muhammad Naveed Babur[2], Furqan Ahmed Siddiqi[3], Sana Khalid[4], Muhammad Ali Arshad Tareen[5], Naureen Tassadaq[6]

Abstract

Obesity as depicted by changes in the body composition is considered a global epidemic of the 21st century, predisposing to cardiometabolic diseases. This analytical cross-sectional study evaluated body composition parameters in both genders and conducted an obesity analysis of healthy adult Pakistani population. Using non-probability purposive sampling technique, data was collected from 205 healthy adults (aged 18-45 years), who had not been participating in any structured exercise or dietary regime over the last six months. Body composition was assessed using bioelectrical impedance analyser. For data analysis, descriptive statistics, Mann-Whitney U-test and one-sample T-test were applied. The mean body mass index was 24.3±4.93 kg/m^2. Body composition components which were significantly higher in males included soft lean mass, fat-free mass index, skeletal muscle mass index and bone mineral content, whereas females had significantly higher percentage of body fat (PBF), visceral fat area and fat mass index (p<0.05). For obesity analysis, the mean PBF (34.61±9.68%) of our sample was higher than White, Hispanics and European adults. Majority of healthy adults had greater body fat mass and lower skeletal muscle mass. The primary obesity index was significantly higher in Pakistani population compared to other ethnicities, with females exhibiting a higher trend towards obesity.

Keywords: Adult, body composition, body fat distribution, obesity.

DOI: https://doi.org/10.47391/JPMA.4673

Introduction

Obesity is one of the major public health problems of this century. The prevalence of obesity has increased globally in the last few years, making it an emerging pandemic. The global disease estimates in 2014 showed that Pakistan ranks at number eight among the 10 countries which comprise half of the total 693 million obese people in the world.[1]

There are multiple indicators of obesity, such as body composition indices. These parameters are estimators of overall health risks in healthy individuals. The internal human body comprises four major components which include water, protein, fat, and inorganic salts or minerals. In order to maintain optimal health and physical fitness standards, the proportion and balance of these constituents should be adequate.[2]

The evaluation of body composition is commonly done using the bicompartmental model, which splits the body into fat mass and fat-free mass (comprising soft lean mass, i.e. total body water, proteins, and bone mineral content). One of the low cost, non-invasive and yet a reliable means for body composition evaluation is bioimpedance analysis (BIA). It measures the electrical properties of various tissues, utilising a low voltage electric current that flows through the body. It is one of the most widely used modes of body composition assessment in clinical settings and epidemiological studies.[3]

The evaluation of body composition parameters is thus quite essential as it provides valuable information regarding nutritional and health status as well as diagnosis of various diseases. Several cultural, geographical, age, gender, developmental, and nutritional variations exist when comparing body composition measurements and other factors related to health or diseased states.[4] To the best of our knowledge, no such study has been conducted in Pakistan which comprehensively assessed or reported the average body composition status of adult population. Hence, the main objectives of this study were to conduct an obesity analysis of healthy adult Pakistani population and to evaluate the body composition parameters in both genders.

Methodology

An analytical cross-sectional study was conducted on 205 healthy adults from October 2020 to March 2021. Sample size was calculated by Raosoft, keeping 5% margin of error and 95% confidence interval for adult population of Rawalpindi and Islamabad.[5] Participants were recruited using non-probability purposive sampling. The inclusion

[1,3,4]Department of Rehabilitation Sciences, Foundation University, Islamabad, Pakistan; [2]Department of Rehabilitation Sciences, Isra University, Islamabad, Pakistan; [5,6]Department of Physical Medicine and Rehabilitation, Fauji Foundation Hospital, Rawalpindi, Pakistan.

Correspondence: Zara Khalid. e-mail: zara.khalid@fui.edu.pk

criteria comprised healthy adults aged 18-45 years, both males and females, who had not been participating in any structured exercise or dietary regime for the last six months prior to the study. Whereas, individuals with a history of any neuromuscular, cardiac, renal, lung or liver disease, with implantable electrical devices such as pacemakers, pregnant females or those experiencing any hormonal imbalances or diagnosed gynaecological/obstetrical conditions were excluded.

This study was carried out at the Fauji Foundation Hospital, Rawalpindi, and Foundation University, Islamabad. The study protocol was approved by the ethical review committee of the Foundation University, Islamabad. Written, informed consent was obtained from all the participants. A demographic sheet was used to collect all relevant information followed by body composition assessment using bioelectrical impedance analyser (Inbody 770). The participant stood on the foot plates of the analyser and two probes were held in both hands, keeping the arms in abducted position, away from the body for 2-3 minutes. It utilises wide range multi frequencies and tetrapolar 8-point electrodes to accurately analyse a range of body composition indices. Waist-to-hip ratio (WHR) was calculated using waist and hip circumference measures. A WHR value of >0.85 for females and >0.9 for males was taken as abnormal. The data gathered during this study was accessible only to the primary investigating team, thus ensuring confidentiality and anonymity for all participants.

Data was entered and analysed on SPSS v 22.0. Kolmogorov-Smirnov normality test was applied on outcome variables and data was found to be non-normally distributed for all variables (p<0.05) except body mass index (BMI). Test of choice was non-parametric Mann Whitney U-test for gender based differences in body composition parameters. One-sample T-test was applied to compare the mean obesity indices of the current sample with international reference standards.

Table-1: Descriptive statistics of body composition components.

Body Composition Parameters	Median (IQR)	n (%)		
		Under the range	Normal	Higher than range
Body Mass Index (kg/m^2)	23.9 (7.25)	21 (10.2)	64 (31.2)	120 (58.5)
Waist-Hip Ratio	0.82 (0.11)	--	154 (75.1)	51 (24.9)
Total Body Water (L)	29.6 (8.9)	106 (51.7)	90 (43.9)	9 (4.4)
Proteins (kg)	7.90 (2.45)	103 (50.2)	92 (44.9)	10 (4.9)
Minerals (kg)	2.80 (0.78)	93 (45.4)	100 (48.8)	12 (5.9)
Body Fat Mass (kg)	22.4 (13.1)	12 (5.9)	48 (23.4)	145 (70.7)
Soft Lean Mass (kg)	38.0 (11.5)	108 (52.7)	89 (43.4)	8 (3.9)
Fat Free Mass (kg)	40.5 (12.1)	104 (50.7)	93 (45.4)	8 (3.9)
Skeletal Muscle Mass (kg)	21.9 (7.5)	110 (53.7)	85 (41.5)	10 (4.9)
Percent Body Fat (%)	35.0 (12.2)	4 (2)	27 (13.2)	174 (84.9)
Visceral Fat Area (cm^2)	111.1 (78)	--	82 (40.0)	123 (60.0%)
Basal metabolic rate (kcal)	1244 (260.5)	160 (78.0)	44 (21.5)	1 (0.5)
Bone Mineral Content (kg)	2.33 (0.7)	89 (43.4)	103 (50.2)	13 (6.3)

Table-2: Gender differences in body composition parameters.

Body Composition Parameters	Median (IQR)		p-value
	Males	Females	
Body Mass Index (kg/m^2)	24.6 (7.3)	23.4 (7.4)	0.207
Waist-Hip Ratio	0.90 (0.1)	0.81 (0.08)	0.000*
Soft Lean Mass (kg)	49.3 (9.0)	35.4 (6.6)	0.000*
Fat Free Mass (kg)	52.2 (9.8)	37.7 (7.1)	0.000*
Percent Body Fat (%)	29.5 (15.3)	38.0 (11.3)	0.000*
Visceral Fat Area (cm^2)	90.8 (70.3)	120.5 (86.4)	0.000*
Basal Metabolic Rate (kcal)	1498 (212)	1184 (153)	0.000*
Fat mass index (kg/m^2)	6.80 (5.9)	8.85 (5.4)	0.000*
Fat free mass index (kg/m^2)	17.7 (2.3)	14.6 (2.4)	0.000*
Skeletal muscle mass index (kg/m^2)	9.92 (1.4)	7.92 (1.4)	0.000*
Bone Mineral Content (kg)	2.83 (0.7)	2.19 (0.4)	0.000*

*indicates significant difference (p-value <0.05)

The study sample consisted of 205 healthy adults, 63 (30.7%) males and 142 (69.3%) females with a mean age of 25.50±6.46 years. As per the BMI categories for Asians, most individuals 66 (32.2%) were in overweight category (BMI 23.0-24.9 kg/m^2) and 64 (31.2%) in normal weight (BMI 18.5-22.9 kg/m^2), followed by 54 (26.3%) participants in obese (≥25.0 kg/m^2) and 21 (10.2%) in underweight category (<18.5 kg/m^2). The mean waist-to-hip ratio of the participants was 0.83±0.07 cm^2 and mean visceral fat area was 116.12± 52.3 cm^2. Eighty-two (40%) subjects in the current study had normal, whereas 123 (60%) had abnormal visceral fat area (>100 cm^2). Table I shows the descriptive statistics of body composition parameters of the participants.

For the accurate estimation of body composition parameters, various derived indices adjusting for height are preferred. The median (IQR) of fat mass index (FMI) and fat free mass index (FFMI) of our sample was 15.3 (3.4) kg/m^2 and 8.50 (5.1) kg/m^2, whereas the skeletal muscle mass index was 8.33 (2.2) kg/m^2.

Statistically significant gender differences were observed in all variables except BMI. The body composition components which were significantly higher in males included WHR, soft lean mass, fat free mass (FFM), fat-free mass index (FFMI), skeletal muscle mass index, bone mineral content and basal metabolic rate. Whereas female participants had significantly higher PBF, fat mass index (FMI) and visceral fat area (p <0.05). (Table 2)

For the comparative obesity analysis of subjects in our sample, the obesity parameters of Asian Pakistani population were compared with normative of other ethnicities. The mean

Table-3: Comparison of Fat Mass Index and Percent Body Fat of Pakistani adults with other ethnicities.

	Gender	Current Study Mean±SD	Chinese Adults Mean±SD	*p*-value
Fat Mass Index (kg/m^2)	Males	7.33±3.55	6.62±2.300.11	
	Females	9.47±3.61	7.37±2.40	0.00*
			Brazilian Adults	
Percent Body Fat (%)	Males	27.7±9.20	26.7±11.4	0.35
	Females	37.6±8.28	35.9±9.40	0.01*

*indicates significant difference (*p*-value <0.05)

percentage body fat [34.61±9.68] of our sample was significantly higher than the mean of White [23.67±6.55], Hispanics [27.30±6.73], and Europeans [29.30±7.30], (*p*=0.00). Gender based comparison of PBF and FMI of our sample with Brazilian and Chinese adults showed no statistically significant difference between the mean fat indices of males but a significantly higher PBF & FMI in Pakistani females (Table 3).

Discussion

The aim of this study was to conduct a body composition profiling of healthy Pakistani adults. The results showed that majority of the sample population was overweight which is in accordance with studies conducted on Americans, Europeans, and Indians as prevalence of overweight and obesity has been noted to be higher in all ethnicities during the last four to five years. This strengthens the importance of monitoring obesity prevalence on priority basis.[6,7]

Among the body composition components, skeletal muscle mass was lower than the desired normal in majority of the sample but was significantly higher in males. Correspondingly, bone mineral content was also significantly higher in males in the current study. Whereas all body fat indices were significantly higher in females. These results are similar to a study conducted by Y Lu et al on Chinese adults which also showed that the SMM, FFM, FFMI, and BMI were higher in men but PBF and FMI were significantly higher in women.[8] These evident variances between both genders could be explained by the different social and health factors, such as hormonal and maternity status, familial obligations, professional work environment, dietary habits and level of physical activity, all of which significantly influence the body composition changes among females.[9]

The comparative obesity analysis of the current study sample of Pakistani adults depicted similar results as our population, particularly females, were noted to have a higher percentage of body fat and fat mass index as compared to other ethnicities. These differences in our study could be due to the considerable genetics, environmental heterogeneity, and lifestyle habits in Asian population. A study by Catherine et al on body fat among a multi-ethnic sample of collegiate reported that while similar associations were observed between BMI and PBF of various ethnicities, the BMI of Asian-American females did not represent the actual underlying adiposity. Presence of relatively higher PBF with normal weight and BMI may be responsible for increased risk of obesity-related diseases in the future.[10]

The results of this study have shown the current obesity status of Pakistani adult population. Young adults and middle-aged adult population are the most productive members of a community and the society's survival and progress depends upon optimal and effective functioning by its members. As identification is the first step towards modification of unhealthy life patterns, it is essential to work towards primary prevention of such health problems to reduce the risk of developing chronic diseases such as diabetes and Cardiovascular Diseases in the future.

In the current study, the effect of physical activity and dietary influence was not taken into account. It is recommended that body composition profiling should be conducted at a wider scale keeping in mind these factors as well, and further interventions should be aimed at preventing and reducing the burden of obesity and obesity-related cardio-metabolic diseases.

Conclusion

Body composition profile of majority of healthy adults comprised higher percentage of fat mass and lower than normal soft lean and skeletal muscle mass. Gender-based differences revealed obesity indices to be significantly higher in females as compared to males. Moreover, the primary obesity index- PBF was significantly higher in Pakistanis as compared to international reference standards.

Disclaimer: This manuscript is a part of PhD thesis project.

Conflict of interest: None to declare.

Funding disclosure: None to declare.

References

1. Ng M, Fleming T, Robinson M, Thomson B, Graetz N, Margono C, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet 2014;384:766-81. doi: 10.1016/S0140-6736(14)60460-8.

2. Liang X, Chen X, Li J, Yan M, Yang Y. Study on body composition and its correlation with obesity: A Cohort Study in 5121 Chinese Han participants. Medicine (Baltimore) 2018;97:e10722. doi: 10.1097/MD.0000000000010722.

3. Marra M, Sammarco R, De Lorenzo A, Iellamo F, Siervo M, Pietrobelli A, et al. Assessment of Body Composition in Health and Disease Using Bioelectrical Impedance Analysis (BIA) and Dual Energy X-Ray Absorptiometry (DXA): A Critical Overview. Contrast Media Mol Imaging 2019;2019:e3548284. doi: 10.1155/2019/3548284.
4. Azzeh FS, Bukhari HM, Header EA, Ghabashi MA, Al-Mashi SS, Noorwali NM. Trends in overweight or obesity and other anthropometric indices in adults aged 18-60 years in western Saudi Arabia. Ann Saudi Med 2017;37:106-13. doi: 10.5144/0256-4947.2017.106.
5. Raosoft, Inc. Sample size calculator. [Online] 2004 [Cited 2022 May 15]. Available from URL: http://www.raosoft.com/samplesize.html.
6. Ahirwar R, Mondal PR. Prevalence of obesity in India: A systematic review. Diabetes Metab Syndr 2019;13:318-21. doi: 10.1016/j.dsx.2018.08.032.
7. Hales CM, Carroll MD, Fryar CD, Ogden CL. Prevalence of Obesity Among Adults and Youth: United States, 2015-2016. NCHS Data Brief 2017;(288):1-8.
8. Lu Y, Shu H, Zheng Y, Li C, Liu M, Chen Z, et al. Comparison of fat-free mass index and fat mass index in Chinese adults. Eur J Clin Nutr 2012;66:1004-7. doi: 10.1038/ejcn.2012.86.
9. Rakic S, Dopsaj M, Djordjevic-Nikic M, Vasiljevic N, Dopsaj V, Maksimovic M, et al. Profile and reference values for body fat and skeletal muscle mass percent at females, aged from 18.0 to 69.9, measured by multichannel segmental bioimpedance method: Serbian population study. Int J Morphol 2019;37:1286-93.
10. Carpenter CL, Yan E, Chen S, Hong K, Arechiga A, Kim WS, et al. Body fat and body-mass index among a multiethnic sample of college-age men and women. J Obes 2013;2013:790654. doi: 10.1155/2013/790654.