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Research Article

A Comparative Cross-sectional Study on Anthropometry and Body Composition of Selected Female Type 2 Diabetics and Non-diabetics

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Abstract

A study was designed to compare the body composition of female diabetics and non-diabetics in the age group of 35 - 45 years. A validated questionnaire was used to collect background information. The tools used to measure anthropometric measurements were properly calibrated and used according to the NHANES protocol. The Waist-to-Height Ratio (WHtR) and Body Adiposity Index (BAI) are focused in this article. Other anthropometric measurements are also presented. We found BMI to be significantly different ($p \leq 0.05$) between the diabetics and non-diabetics. The diabetic women had greater subcutaneous fat in the trunk and legs. The skeletal muscle percentage was also lower. We recommend that body composition may be studied using the hand-held BIA device to make a better assessment of the metabolic condition to suggest suitable management.

Keywords: T2DM; WHtR; BAI; Body Composition; Sub-cutaneous Fat

Introduction

The burden of diabetes has steadily increased over the past quarter century in India and across the globe, with India contributing a major part of the global burden. Diabetes was identified as one of four priority non-communicable diseases (NCDs) targeted for action by the United Nations due to its growing disease burden. Physical activity helps to improve the body's response to insulin which can lower blood glucose levels, lower blood pressure and cholesterol levels, reducing the risk of heart disease, control weight, reduce the risk of developing diabetes complications [1].

Simple anthropometric measurements have been used as surrogate measurements of obesity and have more practical value in both clinical practice and for large-scale epidemiological studies [2]. BMI is a simple method which is used to calculate the prevalence of overweight and obesity in the population. Waist circumference (WC) is the best measure of both intra-abdominal fat mass and total fat [2]. But BMI can be misleading, such as in individuals with a high proportion of lean muscle mass [3]. WC, a more accurate measure of the distribution of body fat, has been shown to be more strongly associated with morbidity and mortality [3]. Recently, the waist-to-stature ratio (WSR) has been proposed as a better screening tool than WC and BMI for adult metabolic risk factors [4].

While there are several research endeavors and journal articles on the conventional anthropometric measurements the world over and even among South Asians, we did not find any on waist to height ratio and body adiposity index among Indians. Therefore, in this article we present our findings which we believe is the first of its kind.

Materials and Methods

PSG - Periya Veedu or Peelamedu Samanaidu Govindasamy. The study was conducted at PSG Institute of Medical Sciences and Research, Peelamedu, Coimbatore, India which has an Institutional Human Ethics Committee. This committee is registered with the Institutional Review Board Organizations IORG of Office for Human Research Protections OHRP, United States Department of Health

& Human Services. Ethical clearance was obtained to conduct the present study. The study was conducted in the out-patient facility of the Endocrinology Department of the same hospital.

Sample size was calculated using the online facility www.http//surveysystem.com by using data on current adult population of Coimbatore, number of type 2 diabetics, prevalence rate and 95% confidence level. The study participants were selected on the bases of inclusion viz. all the participants were the children of type 2 diabetics. They were women diabetic (≤ 5 years) and Non-Diabetics in the age group of 35 - 45 years. Those excluded were the ones' with Sarcoidosis, kidney diseases, Systemic disease, Early menopause, HRT, usage of medicines for corticosteroids, diuretics, blood pressure and persons with Hypothyroid, hyperthyroid, Cushing syndrome, primary hyperparathyroidism, renal failure, liver disease, inflammatory bowel disease, malabsorption syndrome, alcoholism, osteoporotic breakage history and scoliosis.

The study design

Our study was an observational study, as the study participants were in a non-controlled environment without actually interfering or manipulating with other aspects of life and therefore is non-experimental. The observations were current and at a specified point of time. We can further describe our study design as a case-control study as we tried to determine the degree of associations of the selected parameters between diabetic and non-diabetic. Typically, we identified appropriate representative controls for the cases that we were studying [5].

Data collection

Baseline data was collected using a validated questionnaire. Anthropometric measurements were recorded with the help of the physician assistant. A properly calibrated electronic-digital scale, Omron Digital Body Weight Scale HN-283, Singapore purchased locally was used to measure the weight of the participants. Height measurements were taken using a 'drop down' non-stretchable tape measure fixed at about two meters on the wall. Waist circumference was measured according to the protocol given by National Health and Nutrition Examination Survey NHANES [6] and recorded to the nearest 0.1cm. Waist Circumference (in cm) is divided by Body Height (in cm) is WHtR. A boundary value of WHtR = 0.5 indicates increased health risk for men and women [7].

Fat mass and percent fat mass were estimated using a hand-held BIA (bio-electrical impedance analysis) device (Omron HBF375, Omron Healthcare, Europe). The amount and nature of body water affects the validity of most techniques especially BIA. For this reason, the specified guidelines were followed in preparation for assessment. Subjects were asked to fast for 3 hours, refrain from strenuous exercise for 12 hours, and empty their bladders 30 min prior to measurement. Subjects stood in an upright position and held the BIA device with both hands at 90° away from their body. Each measurement was performed in triplicate by the researcher. Fat-free mass was calculated by subtracting each individual's fat mass from her respective body weight. Percent fat free mass was calculated by subtracting percent fat mass from 100% for each subject [6,8]. The BAI estimates percentage adiposity directly as given below.The BAI measure was validated in the "Triglyceride and Cardiovascular Risk in African-Americans (TARA)" study of African Americans. Correlation between DXA-derived %adiposity and the BAI was R = 0.85 for TARA with a concordance of C_b = 0.95. BAI can be measured without weighing, which may render it useful in settings where measuring accurate body weight is problematic. In summary, we have defined a new parameter, the BAI, which can be calculated from hip circumference and height only. It can be used in the clinical setting even in remote locations with very limited access to reliable scales. The BAI estimates %adiposity directly.

$$\mathrm{BAI}=\frac{\mathrm{Hip}}{\mathrm{Height}^{1.5}}-18$$

Data were entered and analyzed using the SPSS version 25. Quantitative data were expressed as mean, median, standard deviation and 95% confidence interval (CI) was calculated. The 't' value was used to compare the two groups of study participants. For each 't' value the 'p' value is also given to indicate that the sample data is not by chance.

Results

The cutoff value for normal BMI for men and women was 23 kg/m^2. The cutoff values for WC and WHR were lower in women than in men. The values were significantly lower compared with the corresponding values in white populations [9]. This clearly shows that universal standards are not suitable for different population groups to assess the status of health and to decide when interventions are required to correct the health problem. Therefore, in our study we used the WHtR and BAI in type 2 diabetics and non-diabetics.

Independent samples t test; Confidence interval 95%

We found a significant difference in the BMI between the diabetic and non-diabetics ($p \leq 0.05$). Body fat percentage was higher among the diabetic participants but not significantly different (p ≥ 0.05). The waist circumference of diabetics was higher, but not significantly. The data on body composition given in table 2 will reveal greater detains on the fat distribution. This is typical of Asian Indians due to their short stature. All other parameters like weight.

Body fat distribution changes according to menopausal status, with central obesity more pronounced in postmenopausal women [10]. Studies have reported heterogeneity of human body fat distribution across racial groups [11,12].

Indices	Diabetic	Non-diabetic	t value	p value
Height (cm)	155 ± 6.36	156.9 ± 4.9	-1.029	0.310
Weight (Kg)	64.14 ± 6.75	61.27 ± 6.38	1.427	0.161
BMI	26.74 ± 3.05	24.9 ± 2.4	2.161	0.037
Waist(cm)	100.86 ± 9.86	95.85 ± 10.29	1.608	0.116
Hip(cm)	104.73 ± 10.8	103.15 ± 9.38	0.56	0.616
WHR	0.97 ± 0.082	0.93 ± 0.086	1.391	0.172
WHtR	0.65 ± 0.75	0.611 ± 0.72	1.761	0.086
BAI%	36.41 ± 6.47	34.68 ± 6.36	0.873	0.388

Table 1: Means of anthropometric measurements.

Indices	Diabetics (n = 22)		Non-Diabetics (n = 20)		t Value	p Value
	Mean	SD	Mean	SD		
Body fat (%)	33.31	5.00	31.42	4.44	1.303	0.200
Visceral fat (%)	14.95	4.65	12.60	3.59	1.845	0.073
BMR (kcal)	1349.59	93.72	1507.00	102.90	-5.165	0.000
Body age (years)	58.96	17.09	47.65	11.01	2.573	0.014
Subcutaneous fat (%)						
Whole body	32.51	5.00	31.30	4.73	0.808	0.424
Trunk	25.37	9.14	19.46	6.70	2.406	0.021
Arm	39.80	12.38	33.47	11.56	1.714	0.095
Leg	42.24	10.41	34.82	10.47	2.302	0.027
Skeletal muscle (%)						
Whole body	22.60	4.04	25.84	4.88	-2.331	0.025
Trunk	17.34	4.92	20.01	4.60	-1.816	0.077
Arm	23.17	7.61	24.46	3.83	-0.705	0.486
Leg	36.15	5.96	36.94	5.06	-0.465	0.645

Table 2: Comparison of mean body composition components.

Studies have also reported that Asian women carry greater abdominal and visceral fat when compared with Caucasian women with similar overall adiposity [13,14]. Thus, greater central relative to leg adiposity may explain why Asian women have a greater risk of diabetes compared with other race and ethnic groups. Results for Asian women suggested lower optimal cut points for anthropometric measures than other race/ethnicity groups [15].

Independent samples t test; Confidence interval 95%

Data presented in table gives new insight into the body composition of diabetics. Though all selected study participants were in the age range of 35 to 45 years, the body composition study shows that diabetics were 58.96 ± 17.09 years. The difference was significant (p ≤ 0.05). The non-diabetics were only 47.65 ± 11.01 years. Other body composition indices that were significantly different include subcutaneous fat in the trunk and legs. With respect to skeletal muscles the whole body and trunk were different. Our observations indicate these changes in anthropometric indices and body composition may be the cause for the precipitation of the condition. Both the diabetic and non-diabetic group had one parent who was diabetic. However, we did not confirm if both parents diabetic.

Obesity associated metabolic diseases have reached epidemic levels in many South Asian countries. Conventional anthropometric indices have poor sensitivity and specificity for detecting people with increased metabolic risks. Jayawardana, *et al.,* [16], compared WHtR (Waist to Height Ratio) as a marker of diabetes and cardiometabolic risks with existing classical anthropometric indices such as; Body Mass Index (BMI), Waist Circumference (WC) and Waist to Hip Ratio (WHR) in a large sub-population of ethnic South Asians. A total of 5000 (Sri Lankans) subjects were recruited from a nationally representative community-based sample using multi-stage random cluster-sampling method. Anthropometric, biochemical and clinical parameters were measured. Receiver-operating characteristic (ROC) curves were performed and area under the curve (AUC) was calculated for each anthropometric index.

Data was analyzed for a sample size of 4485 Sri Lankans. The mean WHtR in all adults was 0.496 (±0.077), males (0.477 ± 0.065) had a significant lower WHtR than females (0.508 ± 0.081) ($p < 0.001$). WHtR had the highest correlation with metabolic parameters. In all adults, males and females the AUC of WHtR was significantly higher than that of BMI, WC and WHR in diabetes mellitus, pre-diabetes, hypertension, metabolic syndrome and hypercholesterolemia. Mean age, fasting blood glucose, 2-h post prandial blood Glucose, total cholesterol, LDL cholesterol, triglycerides, systolic blood pressure and diastolic blood pressure were all significantly higher among all adults, males and females with WHtR ≥ 0.5. They concluded that WHtR is a simple and effective anthropometric index to identify obesity associated metabolic risks among Sri Lankan adults [16].

Qualitative analysis and determination of visceral fat (VF) is more important [17] and bio-electrical impedance analysis (BIA) is a simple, quick, cost-effective and objective method available to assess the same with proven efficacy in Indian population and can be used on large scale even by family physicians and primary care providers [18].

Conclusion

From our study we would like to conclude that BMI is a sensitive indicator to assess the risk of diabetes. The body composition study gives more details of the alterations that may lead to the metabolic disorder. The data on body composition may be useful to draft a personalized management programme and to monitor the progression of the condition. Since our study was on women in the age group of 35 - 45 years, several of the changes in body composition may be attributed to the pre-menopausal stage. This requires further investigation with data on menopause.

Note

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