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Assessment of Body Composition by Bioelectrical Impedance Analysis in Type 2 Diabetes Mellitus Women of Central India

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ABSTRACT- Diabetes mellitus, an impaired blood glucose status is a major cause for loss of valuable human life. The important risk factors include: High familial aggregation, insulin resistance, lifestyle changes due to rapid urbanization and obesity specially central one. This study was carried out in diabetics (study group) & non-diabetic (control group) women of 30-50 years age. They were subjected to anthropometric measurement and body composition assessment by bioelectrical impedance analysis. This include waist circumference (WC), hip circumference (HC), waist hip ratio (WHR), body mass index (BMI), body fat % (BF %) and lean body mass % (LBM %). It was found that the BMI of study group was significantly higher as compared to that of controls. Values of WC and WHR were significantly higher in Type 2 DM women than control. This shows that there is association of abdominal obesity (WC and WHR) with Type 2 DM. BF % gives the relative percentage of fat in human body. BF% was significantly high in diabetic women than in control. Mean value of body fat % in study group was 35.67±3.03% while that of controls was 28.29±2.66%. This shows that Asians having higher BF % at low BMI values and also individuals with a similar BMI can vary considerably in their abdominal fat mass. In such a situation, body fat would constitute the only true measure of obesity.

Key-words- Body Composition, Bioelectrical impedance, Type 2 Diabetes Mellitus

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INTRODUCTION

Diabetes mellitus, an impaired blood glucose status is a serious condition which is a major cause for body organ malfunction and loss of valuable human life. WHO projects that diabetes will be the 7th leading cause of death in 2030 [1]. The countries with the largest number of diabetic people will be India, China and USA by 2030 [2]. It is estimated that every fifth person with diabetes will be an Indian [3]. Type 2 DM is the commonest form of diabetes. The prevalence of Type 2 DM is 2.4% in rural population and 11.6% in urban population of India [4].

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Obesity, particularly visceral or central as evidenced by the WHR, is very common in Type 2 DM [5]. The incidence of Type 2 DM is increased with increasing age. It is associated with sedentary life style [6]. Changes in lifestyle can delay the progression of diabetes [7].

Healthy diet, regular physical activity, maintaining a normal body weight can prevent or delay the onset of Type 2 DM [8]. Physical activity is recommended by physician to patients with Type 2 DM as it increases sensitivity to insulin [9]. Exercise is one of the recommended strategies for Type 2 DM in promoting Glycemic control [10].

Recent development in modern anthropology is bioelectrical impedance measurements used to determine the individual's body composition [11]. BIA is a commonly used method for estimating body composition, particularly body fat [12]. The use of BIA as a bedside method has increased because the equipment is portable and safe, the procedure is simple and non invasive also the results are reproducible and rapidly obtained [13]. Bioelectrical impedance analysis actually determines the electrical impedance or opposition to the flow of an electric current

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through body tissues which can then be used to calculate an estimate of total body water (TBW) [13].

Human body stores fat in two places (1) in the abdomen (viscerally) and (2) fat under the skin (peripherally). The fat accumulated in the viscera is generally thought to be a stronger factor causing Type 2 DM. Abdominal fat accumulation as evidenced by WHR, is more closely associated with Type 2 DM than general obesity because visceral fat is more active metabolically and more potent inducer of insulin resistance.

When obesity becomes general it is the regional fat distribution that becomes the major factor for inducing insulin resistance and glucose homeostasis disturbance [11].

A lot of information is available in literature, taking into consideration the western sedentary life style habits. But little information is available in Indian diabetic patients specially in women. So, the present study was designed to estimate the parameters related to body composition in Indian Type 2 DM and to compare them with normal healthy women.

MATERIALS AND METHODS

The present study was carried out in Department of Physiology, IGGMC and Mayo Hospital, Nagpur in the Diabetic (study group) & non-diabetic (control) women in the age group 30-50 years, from July 2012 to December 2015. The study was conducted after approval by the institutional ethics committee. Controls were taken from the same population. Their age, height, weight, socioeconomic and environmental statuses were matching with that of study group.

Selection of women: Sample size is calculated n = 60 in each group by using Mean ± SD of body fat percentage taking allowable error of 5% C.I. at 80% power.

Women were divided in following groups:

Study group - Women having Type 2 DM (n=60)

Control group - Non diabetic women (n=60)

Both groups were subjected for anthropometric measurements and body composition analysis. Body composition was done in fasting state and with set protocol by Body stat Quad Scan 4000 body composition and fluid monitoring unit made by Bodystat Isle of man limited. Exclusion criteria: Women with Type 1 diabetes mellitus, having history of cardiovascular disease, pulmonary diseases, pregnancy, undergoing regular exercise, overweight with BMI >25 were excluded from study. Women diagnosed as Type 2 DM were included in study group. Statistical analysis was done by using Microsoft Excel 2007.

Standing Height was measured in cm [14]. Weight was done by KRUPS weighing machine in light weight garments without foot wear. BMI was calculated by Quetelete's index, Waist Circumference (WC) was measured at the level of umbilicus in cm. Hip Circumference (HC) was measured at maximum protrusion of hip with heels together in centimetres in standing position with the help of measuring tape. The tape was applied lightly to the skin surface so the tape remains taut but not light [15]. Body composition analysis was done by Quadscan 4000 as per guidelines [16]. It includes Body Fat percentage (BF %) and Lean body mass percentage (LBM %). Fasting and Post meal blood sugar level (in mg/dl) of study and control was quantitatively estimated in the laboratory of department of biochemistry [17]. Data was summarized in the form of mean ± SD for two groups and analyzed with Student t-test in Excel 2007, for two independent groups. P value <0.05 was considered statistically significant.

RESULTS AND OBSERVATIONS

Table No. 1 shows that there is no statistical significant difference in the mean age, height, weight, of Type 2 DM women and controls with their standard deviation and p value. BMI was significantly higher in Type 2 DM women than control ($p<0.05$).

Table No. 2 shows that WC and WHR were significantly higher in Type 2 DM women than control. There was no significant difference in Hip circumference (HC) in Type 2 Diabetic women and control ($p>0.05$).

Table No. 3 Shows comparison of Fasting Blood Sugar and Post meal Blood Sugar in (mg/dl) Type 2 DM women and control. Fasting Blood Sugar and Post meal Blood Sugar was significantly higher in Type 2 DM women than control ($p<0.001$).

Table No. 4 shows that the Body fat percentage (BF %) was significantly higher and Lean Body Mass percentage (LBM %) was significantly lower in women with Type 2 DM as compared to controls ($p<0.05$).

Table 1: Showing comparison of anthropometric parameters

	Type 2 Diabetics (n=60) Mean ± SD	Controls (n=60) Mean ± SD
Age (Yrs)	42.26 ± 2.81	41.21 ± 4.29
Height(cm)	152.4 ± 4.59	153.58 ± 4.83
Weight(Kg)	52.3 ± 4.46	51.11 ± 5.26
BMI(Kg/m2)	22.47 ± 1.26	21.61 ± 1.45***

***p < 0.001 statistically very highly significant

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Table 2: Showing comparison of Waist circumference (WC), Hip circumference (HC) & Waist- Hip ratio (WHR) in Type 2 Diabetic women and controls

	Type 2 Diabetic Mean ± SD	Controls Mean ± SD
Waist circumference (WC) in cm	82.81 ± 5.35	72.3 ± 5.72***
Hip circumference (HC) in cm	91.28 ± 4.48	91.61 ± 4.95
Waist -Hip ratio (WHR)	0.90 ± 0.05	0.78 ± 0.04***

*** p < 0.001 statistically very highly significant

Table 3: Showing comparison of Fasting Blood Sugar and Post meal Blood Sugar in (mg/dl) Type 2 Diabetic women and control

Parameters	Type 2 DM Mean ± SD	Control Mean ± SD
FBS(mg/dl)	132.18±6.94	84.1±7.37***
PMBS(mg/dl)	233.26±15.47	122.15±8.17***

***p < 0.001 statistically very highly significant

Table 4: Showing Body fat percentage (BF %) and Lean Body Mass percentage (LBM %) in Type 2 Diabetic women and control

Parameters	Type 2 DM Mean ± SD	Control Mean ± SD
BF %	35.67 ± 3.03	28.29 ± 2.66***
LBM %	64.46 ± 2.60	71.73 ± 2.64***

***p < 0.001 statistically very highly significant

DISCUSSION

In the present study the mean BMI of women with Type 2 DM was significantly higher as compared to that of controls but both were in normal range. Mean BMI in our study was comparable to Roopkala *et al.* [18] and it is less than Miyatani *et al.* [19] Habib *et al.* [20] Marjini e*t al.* [21], & Hersimeran *et al.* [22]. Our mean BMI values are less because as we included only women with normal BMI.

The World Health Organization (WHO) had shown a simplistic relationship between BMI and the risk of comorbidity, in which a normal range was considered between 18.5 and 24.9 kg/m2. Because of variations in body proportions, BMI may not correspond to the same body fat in different populations.

Epidemiological studies have shown that the ideal BMI may differ for different populations. In Asian subjects, the risk association with diabetes occurs at lower levels of BMI when compared with the white population. This is attributed to body fat distribution. Asian Indians tend to have more visceral/adipose tissue, causing higher insulin resistance, despite having normal BMI [23].

Values of WC and WHR were significantly higher in Type 2 DM women than control. There is no difference in HC in Type 2 DM women and control. The WC and HC were more than that reported by Roopkala *et al.* [18] but less than values reported by Marjini *et al.* [21] WHR was similar to Aghili *et al.* [29] and more than that found by Padaki *et al.* [24], Marjini *et al.* [21] and Roopkala *et al.* [18].

WC is convenient and simple measure of body fatness that is unrelated to height and an approximate index of intra abdominal fat mass and total body fat. The difference between the Waist circumference and Waist to Hip ratio of both groups was significant. Hence there is association of abdominal obesity (WC and WHR) with Type 2 diabetes. It is also observed that Indians have higher upper-body adiposity, measured as WHR or WC. Central obesity is known to be an important risk factor in the development of metabolic syndrome and intra abdominal fat thickness has been found to be a reliable indicator of central obesity. WC was found to be the best predictor of intra abdominal fat thickness and therefore of central obesity. According to Astradia et al. [25] abdominal fat accumulation carries a greater risk for Type 2 DM and highlights the importance of lifestyle intervention in the prevention of Type 2 DM.

Visceral adipocytes release an excess amount of free fatty acids (FFAs) and are very resistant to the antilipolytic effect of insulin. There is association among abdominal adiposity, insulin resistance and hyperglycemia. There is an increased risk of metabolic complications for men with WC >102 cm, and women with a WC>88cm. WHR indicates relative fat distribution in adults [25].

The BF% gives the relative percentage of fat in human body. BF% was significantly high in diabetic women than in control. Mean value of BF % in diabetic women was 35.67±3.03 while that of controls was 28.29±2.66 in our study. The values were highly significant with $p<0.05$ ($p=0.001$). Values of BF% in our study were similar to Habib *et al.* [20] and more than those reported by Atanas *et al.* [11].

Total body fat mass was independently associated with diabetes status in our patients suggestive of high risk for the development of DM. Our findings confirm the outcome drawn by, Vikram et al. [26], Hersimran *et al.* [22], Atanas *et al.* [11], Aghili et al. [29] and Syed *et al.* [20] and Abdul *et al.* [21].

Misra *et al*. [27] stated that BMI is an imperfect measure of obesity as it is calculated by combined estimates of fat, bone, muscles and body water. In Asian Indians, the relative contribution of fat is more and muscle is decreased, therefore, theoretically BMI would not accurately assess obesity. Studies have demonstrated the unreliability of BMI in predicting obesity [27].

Kayode *et al*. [28] stated that Asians having large percentages of body fat at low BMI values and individuals with a similar BMI can vary considerably in their

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abdominal fat mass. In such a situation, body fat would constitute the only true measure of obesity. It is extremely important to accurately diagnose obesity in diabetic and/or dyslipidaemic patients for correct application of lifestyle measures and drug therapy.

Asian Indians have a characteristic obesity phenotype, consisting of relatively lower body mass index (BMI), excess body fat, abdominal and truncal adiposity and less lean tissue. Excess body fat and lesser amount of lean tissue complement each other in volume and weight so that the value of BMI does not increase.

It has been reported that "ectopic" fat stored in visceral adipocytes, myocytes and hepatocytes, plays a pathogenic role in the insulin resistance. It is necessary to classify obesity condition on the basis of body fat composition and distribution, rather than simply on the increase of body weight. Therefore, the BMI, usually used in population studies to correlate overweight and obesity, leads to a large error and misclassification. Renzo *et al.* [23] showed some obesity related abnormalities, such Fat Mass percentage.

LBM % was assessed and we found statistically significant low mean value in diabetic women as compared to control. High BF % and low LBM % along with central obesity is a major risk factor for Type 2 DM in women. This high fat level is distributed in female pattern of fat deposition and is a risk factor for Type 2 DM.

CONCLUSION: Our study suggests that in addition to other parameters, BF % and LBM % also play important role in patho-physiology of Diabetes Mellitus. As significantly high body fat percentage observed in diabetic group suggests that it is an important factor for development of diabetes mellitus which can be prevented by adopting healthy life style including daily exercise and appropriate dietary habits.

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