RESEARCH ARTICLE

Comparative study of anthropometric parameters in diabetic and non-diabetic human beings

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ABSTRACT

Background: Diabetes mellitus is a group of metabolic disorders sharing the common underlying feature of hyperglycemia. Peripheral resistance to insulin is a prominent feature of diabetes. Skeletal muscle is the primary site responsible for decreased insulin-induced glucose utilization in diabetics. **Aims and Objectives**: The study was done to compare the anthropometric parameters in non-diabetics and controlled diabetics. **Materials and Methods:** The study population consists of two groups of male participants in the age group of 30-40 years. The control group consists of 50 healthy volunteers. The test group consists of 50 controlled diabetics. Anthropometric assessment was done. Windostat version 9.2 software was used for all statistical analysis. Comparison of variables between the two study groups was done using ANOVA. **Results:** Participants were age-matched but weight was significantly higher in diabetics. Abdominal skinfold thickness, mid arm circumference, maximum forearm circumference, and body mass index were significantly higher in diabetics than non-diabetics ($P < 0.005$). The forearm skinfold thickness, forearm muscle area (FAMA), corrected FAMA, and forearm muscle volume were found to be significantly higher in diabetics than non-diabetics ($P < 0.01$). **Conclusion:** The anthropometric parameters can be used as a predictor for diabetes mellitus.

 KEY WORDS: Anthropometric Parameters; Diabetes Mellitus; Height; Weight; Skinfold Thickness

INTRODUCTION

India leads the world with the largest number of diabetic patients. According to the Diabetes Atlas 2006 published by the International Diabetes Federation, the number of people with diabetes in India is expected to rise to 69.9 million by 2025 unless urgent preventive steps are taken. The most disturbing trend is the shift in age of onset of diabetes to a younger age in the recent years.[1] This could have long-lasting adverse effects on nation's health and economy.

Diabetes mellitus is a group of metabolic disorders sharing the common underlying feature of hyperglycemia. Hyperglycemia in diabetes results from defects in insulin secretion, insulin action or most commonly, both. Blood glucose values are normally maintained in a very narrow range, usually 70-120 mg/dL. The diagnosis of diabetes is established by noting elevation of blood glucose by any of the three criteria: (i) A random glucose >200 mg/dL, with classical signs and symptoms; (ii) a fasting glucose >126 mg/dL on more than one occasion; (iii) an abnormal oral glucose tolerance test, in which the glucose is >200 mg/dL 2 h after a standard carbohydrate load.[2]

The current diagnostic criteria for the diagnosis of diabetes (from American Diabetes Association [ADA], WHO)

AACE/ACE endorse the use of glycated hemoglobin (HbA1c) to diagnose diabetes. They recommend that A1c test should be performed using a method that is certified by NGSP (National HbA1c Standardization Program). HbA1c >6.5 is diagnostic of diabetes according to current ADA criteria.[3] In 2011, WHO also recommended that an A1c of >6.5 can be used to diagnose diabetes provided no condition is present that impair its accurate measurement (hemoglobinopathy, certain drugs, increased red cell turnover). HbA1c is a better predictor of complications than plasma glucose and is a better reflection of overall glycemia than plasma glucose, which reflects glucose only at a particular point of time.[4]

Peripheral resistance to insulin is a prominent feature of diabetes. Skeletal muscle is the primary site responsible for decreased insulin-induced glucose utilization in diabetic participants. Intracellular triglyceride (TG) is an important energy source for skeletal muscle. However, recent evidence suggests that if muscle contains abnormally high TG stores its sensitivity to insulin may be reduced, and this could predispose to Type II diabetes.[5] Increased intramyocellular lipid has been reported to be associated with impaired insulin-stimulated glucose disposal.[6]

Since skeletal muscle is the primary site responsible for decreased insulin-induced glucose utilization in diabetic participants, a comparison of anthropometric parameters such as muscle mass, muscle area, and muscle volume between diabetics and nondiabetics is done in this study.

MATERIALS AND METHODS

Participants

A sample size of 100 male participants in the age group of 30-40 years is assessed. The control group consists of 50 healthy volunteers, and the test group consists of 50 controlled diabetics on oral hypoglycemics.

Inclusion Criteria

Male participants aged between 30 and 40 years with HbA1c value <6.5% are included in the study. Non-diabetic group includes healthy, well-nourished, and normotensive individuals.

Exclusion Criteria

Patients with thyroid dysfunction, anemia and neuromuscular disorders are excluded from the study. Trained individuals are excluded from the study. Participants on medication other than oral hypoglycemics are excluded from the study.

Study Design

It is a case–control study ($N = 100$) comprising male participants aged 30-40 years, conducted from November 2011 to November 2013 in the Department of Physiology,

Mediciti Institute of Medical Sciences. The study population consisted of two groups of male participants in the age group of 30-40 years. The control group consisted of 50 healthy volunteers. The test group consisted of 50 controlled diabetics. The participants were recruited from Mediciti Institute of Medical Sciences and surrounding areas of Ghanpur village, Medchal Mandal. Before recruitment, informed consent was taken from all the participants. The study was approved by the Institutional Ethical Committee. HbA1c test was done 2 days before the day of the experiment to establish the glycemic status of the participants.

Anthropometric Assessment

Anthropometric assessment was made with measurements carried out according to the procedure adopted at the NIH sponsored ARLIC conference on standardization of anthropometric measurements.[7] The following measurements were taken using appropriate instruments: (i) Height: Height is measured to the nearest 0.1 cm using a stadiometer; (ii) Weight: Weight is measured to the nearest 0.5 kg using a standard calibrated weighing machine; (iii) Skinfold thickness: Measured with a pincer calipers to nearest 0.1 mm. Skinfold measurement was carried out in triplicate, in the standing position and the mean was taken for further calculation. A fold of skin and subcutaneous adipose tissue is grasped gently with thumb and fingers approximately 2.0 cm above the marked level with the skinfold parallel to the long axis of the arm. The jaws of the calipers are placed at the marked level, perpendicular to the length of the fold, and the skinfold thickness is measured to the nearest 0.1 mm while the fingers continue to hold the skinfold. Biceps, triceps, abdominal, and forearm skinfold thickness (BSF, TSF, ASF, FSF) are measured; (iv) Mid-arm circumference (MAC): MAC is measured using a measuring tape to the nearest 0.1 cm; (v) Maximum forearm circumference (MFAC): MFAC is measured using a measuring tape to the nearest 0.1 cm; (vi) Radial styloid circumference (RSC): RSC is measured using a measuring tape to the nearest 0.1 cm; (vii) Forearm length (FAL): FAL is measured using a measuring tape to the nearest 0.1 cm.

The following indices are calculated from the above parameters using appropriate formulae: (i) Body mass index (BMI) = Weight in kg/Height in m^2; (ii) Density = Cm × log (sum of skinfold thickness); (iii) Percentage of fat = (4.95/density-4.5) 100; (iv) Fore arm muscle area (cm^2) = MFAC − (π × FSF)^2/4; (v) Corrected forearm muscle area (CFAMA) (cm^2) = MFAC − (π × FSF)^2/4π-10; (vi) Muscle mass = Height × [0.0264+(0.0029×CFMA)]; (vii) Fore arm volume= (π/3 × H) × (R_1 + R_2) + (R_1 × R_2); where, H: Fore arm length; R_1: Radius at the base = MFC/2π, R_2: Radius at the truncated base = RSC/2π.

Statistical Analysis

WindoStat version 9.2 software was used for all statistical analysis. The data were summarized using descriptive

statistics (i.e., means, standard deviations). Comparison of variables between the two study groups was done using ANOVA.

RESULTS

It is a case–control study (*N* = 100) comprising male gender within the age group of 30-40 years. The study population consists of two groups of male participants in the age group of 30-40 years. The control group consists of 50 healthy volunteers. The test group consists of 50 controlled diabetics.

The mean values of all the measured parameters are depicted in Table 1. Among the measured parameters, height, BSF, TSF, RSC, and FAL did not show any significant difference between the two study groups. Weight was significantly higher in diabetics than non-diabetics ($P < 0.005$). The mean weight was 63.44 kg in non-diabetics and 68.22 kg in diabetics. The ASF was significantly higher in diabetics than non-diabetics ($P < 0.005$). The mean ASF was 25.58 mm in non-diabetics and 28.46 mm in diabetics. The FSF was significantly higher in diabetics than non-diabetics ($P < 0.01$). The mean FSF was 6.96 mm in non-diabetics and 7.52 mm in diabetics. The MAC was significantly higher in diabetics than non-diabetics ($P < 0.005$). The mean MAC was 26.9 cm in non-diabetics and 28.6 cm in diabetics. The MFAC was significantly higher in diabetics than nondiabetics ($P < 0.005$). The mean MFAC was 25.48 cm in non-diabetics and 26.26 cm in diabetics.

The mean values of all the calculated parameters are depicted in Table 2. Among the calculated parameters BMI, FAMA, CFAMA, forearm muscle volume were found to be significantly higher in diabetics than non-diabetics. The BMI was significantly higher in diabetics than non-diabetics ($P < 0.005$). The mean value was 23.49 kg/m² in non-diabetics and 25.36 kg/m² in diabetics. The FAMA was significantly higher in diabetics than non-diabetics (P<0.01). The mean value was 43.22 cm² in non-diabetics and 45.063 cm² in diabetics. The CFAMA was significantly higher in diabetics than non-diabetics ($P < 0.01$). The mean value was 33.22 cm² in non-diabetics and 35.08 cm² in diabetics. The forearm muscle volume was significantly higher in diabetics than non-diabetics ($P < 0.01$). The mean value was 467.28 cm³ in non-diabetics and 491.90 cm³ in diabetics.

DISCUSSION

Participants were age-matched but weight was significantly higher in diabetics. Height was matched in both groups. Controlled diabetics had a higher mean weight than non-diabetics. Percentage of participants in diabetics with 65.7 kg was higher than non-diabetics. BSF and TSF was more in non-diabetics than diabetics. ASF was significantly higher in

Table 1: Comparison of mean values of anthropometric parameters across two groups

Variable	Mean±SEM		*t*-test	*P* value
	Control	**Diabetic**		
Height (cm)	164.5±0.860	164.120±0.881	0.309	0.758
Weight (kg)	63.440±0.577	68.200±0.838	4.680	0.000***
BSF (mm)	5.740±0.106	5.540±0.100	1.372	0.173
TSF (mm)	9.860±0.234	9.540±0.162	1.124	0.264
ASF (mm)	25.580±0.321	28.460±0.535	4.614	0.000***
FSF (mm)	6.960±0.143	7.520±0.100	3.214	0.002**
MAC (cm)	26.900±0.170	28.600±0.221	6.097	0.000***
MFAC (cm)	25.480±0.138	26.260±0.136	4.023	0.000***
RSC (cm)	16.400±0.164	16.520±0.177	0.498	0.620
FAL (cm)	25.980±0.182	26.400±0.210	1.512	0.134

**P<0.005: Highly significant, ***P<0.001: Very highly significant. SEM: Standard error of mean; BSF: Skinfold thickness at biceps; TSF: Skinfold thickness at triceps; ASF: Abdominal skinfold thickness; FSF: Skinfold thickness at forearm; MAC: Mid-arm circumference; MFAC: Mid-forearm circumference; RSC: Radial styloid circumference; FAL: Forearm length

Table 2: Comparison of mean values of calculated parameters across two groups

Variable	Mean±SEM		*t*-test	*P* value
	Control	**Diabetic**		
BMI (kg/m²)	23.491±0.180	25.368±0.282	5.618	0.000***
BF (%)	16.781±1.225	18.709±0.846	1.295	0.198
FAMA (cm²)	43.228±0.528	45.063±0.438	2.677	0.009**
CFAMA (cm²)	33.228±0.528	35.081±0.440	2.696	0.008**
Muscle mass	20.220±0.284	20.944±0.252	1.906	0.060
FAMV (cm³)	467.286±5.867	491.908±5.774	2.991	0.004**

**P<0.005: Highly significant; ***P<0.001: Very highly significant. SEM: Standard error of mean; BMI: Body mass index; BF: Body fat; FAMA: Forearm muscle area; CFAMA: Corrected forearm muscle area; FAMV: Forearm volume

diabetics. The FSF was significantly higher in diabetics than non-diabetics ($P < 0.01$). The MAC was significantly higher in diabetics than non-diabetics ($P < 0.005$). The MFAC was significantly higher in diabetics than non-diabetics ($P < 0.005$). BMI was significantly higher in diabetics than non-diabetics ($P < 0.005$). FAMA, CFAMA, and forearm muscle volume were found to be significantly higher in diabetics than non-diabetics ($P < 0.01$).

During the process of analysis of results, it was observed that FAMA, CFAMA, and forearm muscle volume were significantly higher in diabetics than non-diabetics. Anthropometric variables were higher in diabetics. This was an interesting and unexpected finding. This fact could have a future bearing in the expected outcome of the control of diabetes and its effect on the lifestyle. It could also mean whether the anthropometric parameters increasing during

prediabetes/diabetes do not return to normal values even after reaching euglycemic status on treatment. This needs further study and if proved to be true an increase in the anthropometric parameters could be a predictor (set of variables) for risk of diabetes at a later stage.

CONCLUSION

The anthropometric parameters can be used as predictor for diabetes mellitus.

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