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Variations in Anthropometric Parameters in Offspring of Type 2 Diabetes Patients

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Abstract

Background: The risk of developing diabetes mellitus for an individual with a positive family history of the disease is two-to fourfold higher in an offspring of a diabetic compared with offspring of non-diabetic.

Objectives: This study aimed to assess the anthropometric parameters of offspring of type 2 diabetes mellitus (T2DM) patients in Sagamu, Nigeria.

Methods: Study subjects were 100 offspring of consecutive T2DM patients' attending a hospital endocrinology clinic. Diabetic offspring were exempted from the study. FBS was determined employing enzymatic hexokinase method. Height, weight, waist circumference (WC), and hip circumference (HC) were measured utilizing standard methods while body mass index (BMI) and waist-hip ratio (WHR) were calculated.

Results: There were 50 males and 50 females study subjects, aged 16 to 65 years. The most populated aged group was 16 to 25 years of which 48.6% (n=36) were males and 51.4% (n=38) were females. Totally, 18 subjects were either obese or overweight. Significantly, male subjects had a greater mean weight compared to females ($P=0.021$) while females had greater mean BMI ($P=0.037$). Mean WHR was significantly higher among male subjects ($P=0.018$).

Conclusion: Common Anthropometric parameters are normal, female subjects tend to have higher BMI while males have higher weight and WHR.

Keywords: Diabetes Mellitus, Overweight, Body Mass Index, Waist Circumference, Waist-Hip Ratio

1. Background

Obesity is a major risk factor for type 2 diabetes mellitus (T2DM). Clinical evidence indicates a stronger association of diabetes with central obesity than general obesity.[1] The risk of becoming diabetic for an individual with a positive family history of diabetes varies with the age of the proband when the diagnosis was made and also the type of diabetes. A recent review concluded that having a parent with non-insulin-dependent diabetes mellitus (NIDDM) increases by two- to fourfold an offspring's chance of developing this condition, and that in this respect concordance between siblings appeared stronger than that between parent and child.[1] In a study in northern Sudan, a family history of diabetes was 2.3 times more often reported among diabetics than non-diabetics.[1]

Obesity and body fat distribution, lifestyle changes, impaired glucose tolerance (IGT), and a family history of T2DM[2,3] represent risk factors for T2DM. First degree relatives of patients with T2DM frequently show abnormal glucose tolerance and share several metabolic abnormalities of the full blown disease that have a 30%-40% risk of developing T2DM themselves.[4,5] Simple anthropometrical measurements have been utilized as surrogate measure of obesity and have more practical value in both clinical practice and for large-scale epidemiological studies.[6] Body mass index (BMI), which relates weight to height, is a simple measure of body size. Waist circumference (WC) and waist-hip ratio (WHR) are alternatives to BMI. WC is the best simple measure of both intra-abdominal fat mass and total fat.[7] A larger hip circumference (HC) is associated with a lower prevalence of self-reported type-2 diabetes and lower fasting glucose concentrations, independently of BMI and WC. Individuals with a family history of diabetes have higher WHR.[8,9]

2. Objectives

There is paucity of published work on anthropometric parameters in offspring of T2DM with relationship to gender difference in this environment. Many previous studies obtained from literature search are from the Western world and none from sub-Saharan Africa. The type of food we eaten, the rate of consumption and our culture differ, hence this study is to document some anthropometric measurements data in a sub-Saharan African city. More

so, there are few studies relating anthropometry fitness in children whose parents are suffering from T2DM. The present study is aimed to assess the anthropometry data in individuals with a family history of T2DM.

3. Methods

The study conducted between March and September, 2019, involved prospective cross-section selection of offspring of T2DM patients. One hundred offspring of type 2 DM patients attending the endocrinology out-patient clinic of Olabisi Onabanjo University Teaching Hospital, Sagamu, Nigeria were selected. Diabetic offspring were exempted from the study.

Sample size was performed using formula $(Z_{1-\alpha}/2)^2 \times SD^2 /d^2$ where Z = normal variant with $\alpha = 0.05$, d = 5% and SD = 25 mg/dl of blood glucose from previous study. This is equal to $1.96^2(25)^2 /5^2 = 96$ subjects. Five percent attrition (4.8) made a total of 100.8 subjects.

Blood samples were taken from subjects in the morning after fasting for at least 12 hours. The enzymatic hexokinase method was used to determine glucose concentrations.

The weight of the subjects were recorded in kilograms (to the nearest 1.0 kg) without them wearing any heavy clothing such as a coat, jacket, shoes or agbada, using a calibrated bathroom scale (Soehnle-Waagen GmbH & Co. KG, D 71540 Murrhardt/Germany) positioned on a firm horizontal surface.

Height of subjects were measured in meters (to the nearest 0.1 m) using a stadiometer. Subjects stood erect, without shoes and headgears, on a flat surface with the heels and occiput in contact with the stadiometer (Prestige HM0016D) (India).

The BMI was subsequently calculated employing the formula: weigh (kg)/ height^2 (meteres^2), WC was measured at a level midway between the lowest rib margin and the iliac crest in a horizontal plane using a flexible measuring tape. HC was measured at the widest point over the buttocks. Thigh circumference was measured directly below the gluteal fold in the left thigh or lower limb. WHR was calculated as WC divided by HC. Data of all the study participants were entered into a program design for the study.

The following definitions were utilized: Underweight: BMI < 18.5 kg/m^2, Normal weight: BMI 18.5-24.9 kg/m^2, Overweight: BMI 25.0-29.9 kg/m^2, Obesity: BMI ≥ 30 kg/m^2

The following values for central obesity (cut off values/ normal values) include: the WC ≥ 100 cm (males) ≥ 92 cm (females) are abnormal while 83-98 cm (male) 78-91 cm (female) are normal values. The WHR ≥ 0.90 (males) ≥ 0.85 (females) are abnormal while 0.87-0.90 (male) 0.76-0.84 (female) are normal values. The HC of 97-108 cm (female) and 94-105 cm (male) are normal values.

Data analyzed by Student's *t* test were utilized to compare variability between test and control groups. The data obtained were analyzed using the SPSS version 25.0. Probability value of less than 0.05 was considered statistically significant.

4. Results

There were 50 males and 50 females study subjects, aged 16 to 65 years. The most populated aged group is 16 to 25 years of which 48.6% (n = 36) were males and 51.4% (n = 38) were females (Table 1).

All in all, 18 subjects were either obese or overweight. Significantly, male subjects had a greater mean weight compared to females (P = 0.021) while females had greater mean BMI (*P* = 0.037). The mean WHR significantly higher among male subjects (0.018) (Table 2).

5. Discussion

The present study found out BMI and HC were higher in females than male subjects whereas the WC and WHR were higher in male than female subjects. In this study, some of the subjects were obese; there were more overweight female subjects in this study groups, although the mean BMI was within normal ranges in both sexes. The other parameters such as the mean WC, HC and WHR were normal, but the mean values obtained here were in upper border of normal range. These abnormal anthropometric parameters are important indices which act as precautionary measures in offspring of T2DM patients.

The study conducted by van der Sande et al in 2001 revealed that the risk of becoming diabetic for an individual with a positive family history of diabetes varies with the age of the proband once the diagnosis and the type of diabetes are identified. Their review concluded

Table 1. Anthropometric Characteristics of the Study Group

Variable	Category	Total (n = 100) (%)	Male (n = 50) (%)	Female (n = 50) (%)
Gender	Male	50 (50.0)	50 (100.0)	-
	Female	50 (50.0)	-	50 (100.0)
Age (y)	16-25	74 (74.0)	36 (72.0)	38 (76.0)
	26-35	10 (10.0)	4 (8.0)	6 (12.0)
	36-45	10 (10.0)	6 (12.0)	4 (8.0)
	46-55	6 (6.0)	4 (8.0)	2 (4.0)
BMI (kg/m^2)	Underweight	4 (4.0)	2 (4.0)	2 (4.0)
	Normal weight	78 (78.0)	42 (84.0)	36 (72.0)
	Overweight	8 (8.0)	2 (4.0)	6 (12.0)
	Obese	10 (10.0)	4 (8.0)	6 (12.0)

Abbreviation: BMI, body mass index.

Table 2. Mean Anthropometric Measurements of the Study Group

Variable	Total (n = 100)	Male (n = 50)	Female (n = 50)	T	*P*
Age (y)	25.74 ± 0.93	25.86 ± 1.34	24.84 ± 1.56	1.083	0.306
Weight (kg)	64.39 ± 1.18	67.10 ± 1.39	61.68 ± 1.85	2.343	0.021*
BMI (kg/m^2)	22.58 ± 0.45	21.65 ± 0.49	23.52 ± 0.74	2.117	0.037*
WC (cm)	78.00 ± 1.22	78.20 ± 1.21	77.80 ± 2.13	0.164	0.870
HC (cm)	98.06 ± 1.91	96.60 ± 0.91	99.52 ± 2.20	1.228	0.222
WHR	0.79 ± 0.01	0.81 ± 0.01	0.78 ± 0.01	2.404	0.018*

Abbreviations: BMI, body mass index; WC, waist circumference; HC, hip circumference; WHR, waist-hip ratio.
*Significant at *P* < 0.05.

that having a parent with NIDDM increases by two- to fourfold with an offspring's chance of developing this condition, and that in this respect concordance between siblings appeared stronger than that between parents and child. They affirmed to the study in northern Sudan, where a family history of diabetes was 2.3 times more often reported among diabetics than non-diabetics.[1]

They also noted that in Thailand, which has been described as being in a state of transition from a traditional to an industrialized society, a statistically significant relative risk of 3.1 for obesity was reported for those with a positive family history of diabetes.[1]

In the study carried out by Taiwo and Sofola in 2019, they assessed the effect of exercise on skinfold thickness of offspring of T2DM parents compared with those of non-diabetic parents.[10] The sites of skinfold thickness (supra-iliac, Biceps, Triceps and sub-scapula) were measured by skinfold caliper. Weight and BMI were estimated using standard methods at baseline, 6 weeks, 12 weeks, 18 weeks and 24 weeks, respectively. The results indicate that compared to baseline, there were reductions at the four sites of skinfold thickness measurements (supra-iliac, Biceps, Triceps and sub-scapular). Thus, graded exercise reduced skinfold thickness in all the groups.

Studies have shown that the odds of a diabetic individual having high WC was 3.56 times more as compared to a non-diabetic individual.[11] Different anthropometric cut-off values for various ethnic groups and populations always make comparisons difficult and limit generalizability. In the Uppsala study, they concluded that overweight (BMI 25- 30 kg/m^2) or obese men (BMI 30 kg/m^2) without metabolic syndrome were at an increased risk for diabetes which is comparable with the results of this study where many of the subjects were overweight.[12]

WHR for women should be less than 0.80 while in men it should be less than 0.90. Normal variables showed that the WC should be 25 percent less than that of shoulder, hip, bust measurements and 20 to 25cm less than hip and bust measurements. The visceral fat of less than 0.85 in female and 0.90 in male is good but when there is an increased visceral fat, there is an increased risk of development of diabetes mellitus, cardiovascular disease and stroke. Hence, engaging in exercise and unsaturated fat intake will prevent all of these.[13]

BMI of less than 24.5, WHR of 0.86 and WCR of 0.77 are good. It suffices to say in females that apple appearance is bad while pear appearance is good. There are charts for all these measurements for example WHR greater than 1.0 can be a pointer to an increased risk of development of heart disease and metabolic syndrome.[13]

Groop et al[14] were of the opinion that a family history of T2DM influenced body fat distribution resulting in abdominal obesity. While WC and waits- hip ratio are both considered anthropometric indices reflecting abdominal obesity, some longitudinal studies have shown that WC is a better predictor for the development of T2DM.[11]

It has also been shown that relative to waist- hip ratio, WC measures showed stronger association with visceral adiposity[15] It is noted that the findings in this study of similar WHR in offspring of T2DM is in line with the those of Groop and colleagues'[14] study conducted on Caucasian population. They reported a significantly higher waist-hip ratio in first degree relatives of T2DM than in non-diabetics, despite similarity in BMI.[5]

It is possible that body fat distribution and anthropometric measurements show ethnic variability and this might be responsible for the differences observed in those studies. In a cross-sectional study conducted to determine anthropometric factors associated with T2DM in randomly recruited population, there were much greater odds of having T2DM when WHR rather than WC was considered.[16]

This is in direct contrast to the findings of Wei et al[11] who conducted a prospective seven-year study and found that WC was a much better predictor than WHR of the development of T2DM. These observations led Han et al[16] to suggest the possibility that excessive intra-abdominal fat causing an increased risk of developing T2DM, but that the development of DM may then affect HC in some way reducing hip size and thus increasingWHR.[9]

The anthropometric indices of WC and WHR are surrogates for intra-abdominal (visceral) fat depot. The detrimental influence of abdominal obesity on metabolic processes is thought to be mediated by the intra-abdominal fat deposit. A preponderance of enlarged fat cells in adipose tissue increases the risk of glucose tolerance, hyperinsulinaemia, and hypertriglycreideaemia.[17]

Taiwo et al[18] studied the use of tummy trimmer as exercise apparatus in offspring of T2DM.There was a reduction in the anthropometric parameters after six months of exercise in the offspring. They inferred that engaging in physical exercise improved the anthropometric parameters in the offspring.

The abnormal variation of anthropometry in offspring of type-2 diabetics may be a future risk for either diabetes or obesity. The present study revealed these abnormal trends in offspring of T2DM with a family history of diabetes could predispose them to T2DM.

5.1. Study Limitations

The limitations of this study were that we did not consider 1° relatives or 2° relatives in particular but only in offspring, however, other family relations were not taken into considerations. We did not compare anthropometry in offspring of non- diabetic parents either.

6. Conclusion

In conclusion, common anthropometric parameters are normal, female subjects tend to have higher BMI while males have higher weight and WHR. Based on the outcome of this research, people with family history of T2DM should reduce their tendency to obesity.

Research Highlights

What Is Already Known?

- Obesity is a major risk factor for T2DM.
- Clinical evidence indicates a stronger association of diabetes with central obesity than general obesity.
- The risk of becoming a diabetic for an individual with a positive family history of diabetes is two- to fourfold higher in a diabetic offspring.
- Individuals with a positive family history of diabetes have higher BMI than controls.
- Obesity and abnormal body fat distribution and IGT, are risk factors to developing T2DM.

What Does This Study Add?

- The research has proven that the study of anthropometry of offspring of T2DM may be a pointer to the risk involved if one is an offspring of T2DM patients.
- Female subjects tend to have higher BMI while males have higher weight and WHR.

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Author Contributions

EOT, OPT: Conception, data collection and analysis. LOT: Manuscript writing, editing and approval of final draft.

Conflict of Interest Disclosures

All authors declared that they had no conflict of interest.

Ethical Approval

Ethical clearance for the study was obtained from the Health Research Ethics Committee (HREC) of Olabisi Onabanjo University Teaching Hospital (OOUTH), Sagamu (No HREC/OOU/0040). All participants (100) of this study signed an informed consent form in accordance to the committee regulations prior to completing a questionnaire and taking their anthropometric measurements.

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