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# ANTHROPOMETRIC CHARACTERISTICS OF OFFSPRING OF NIGERIAN TYPE 2 DIABETICS

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ABSTRACT

**Objectives:** Type 2 diabetes mellitus (DM) has a strong genetic component. Overall obesity and central obesity have strong associations with insulin resistance, which is a major factor in the development of impaired glucose tolerance (IGT) and Type 2 DM. The impact of a parental history of Type 2 DM on anthropometric measurements known to govern glucose tolerance was examined in this study.

**Materials and Methods:** Weight, height, body mass index, waist circumference, hip circumference and waist-hip ratio were measured in 52 offspring of Nigerian Type 2 diabetic patients and compared with 50 control subjects who had a similar distribution of age, sex and socio-economic class.

**Results:** Offspring of diabetics had a significantly higher mean (SD) (i) weight [69.9 (15.1) kg vs. 63.8 (11.2) kg; p=0.024]; (ii) body mass index [25.0 (4.9) kg/m$^2$ vs. 23.0 (3.0) kg/m$^2$; p=0.013]; (iii) waist circumference [82.3 (12.2) cm vs. 77.2 (8.3) cm; p=0.014]; (iv) hip circumference [99.0 (11.4) cm vs. 93.0 (7.2) cm; p=0.005]. The waist-hip ratio for both groups of subjects did not differ significantly [0.83 (0.06) versus 0.82 (0.05); p=0.52].

**Conclusion:** These results suggest that a parental history of Type 2 DM influences body fat and its distribution resulting in greater degrees of generalized and central/abdominal fat, implying a greater risk of developing Type 2 DM in view of the relationship between body fat distribution and insulin resistance. Long term prospective studies are needed to define anthropometric indices predictive of the development of Type 2 DM, as well as its relation to insulin sensitivity, amongst Nigerians.

**KEY WORDS: - Type 2 diabetic parents, offspring, Anthropometry.**

## INTRODUCTION

Type 2 diabetes mellitus (DM) has a strong genetic component as shown by a concordance rate of up to 90% among monozygotic twins[1,2]. First degree relatives of diabetics also have an increased risk of developing diabetes, ranging from 25-50% compared to 15% in first degree relatives of non diabetics [3].

It is well established that obesity is a risk factor for the development of Type 2 DM [4,5,6]. Current knowledge suggests that it acts as a potentiator in those with genetic susceptibility [6,7]. There is also evidence that upper body (central or abdominal) obesity, an unfavourable regional distribution of fat, may be the most important parameter of obesity in relation to the risk of developing Type 2 DM [8-10]. Thus, overall obesity and central obesity are well established as parameters governing glucose homeostasis. These two parameters have strong associations with insulin resistance. Abdominal obesity is believed to be a powerful determinant of insulin sensitivity, independent of overall obesity[11] .The detrimental influence of abdominal obesity on metabolic processes is thought to be mediated by the intra-abdominal (visceral) fat depot. Anthropometric indices which reflect overall body mass or overall obesity include the body weight and body mass index (B.M.I) determined by the equation weight (kg)/height$^2$(m$^2$). The degree of abdominal/central obesity is reflected by anthropometric measurements such as the waist circumference and waist-hip-ratio (WHR)[11-13]. Cross sectional surveys have shown a strong association between WHR and Type 2 DM [14]. Some studies have shown the waist circumference to be a more reliable and valid measure than waist-hip-ratio. In these studies, relative to WHR, waist circumferences showed stronger associations with visceral adiposity[12], metabolic and cardiovascular outcomes[13,15-17]. Insulin resistance is a major factor in the development of impaired glucose tolerance (IGT) and Type 2 DM. It is present early in the disease evolution and current evidence tilts it towards being the primary lesion[18,19]. There is thus an inter relationship between insulin resistance, anthropometric indices of obesity and Type 2 DM.

The impact of a parental history of Type 2 DM on anthropometric measurements known to govern glucose tolerance was examined in this study.

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## MATERIALS AND METHODS

The study was conducted at the University College Hospital (U.C.H) Ibadan, a city located in the South Western part of Nigeria. The study group consisted of 52 apparently healthy offspring of patients with Type 2 DM attending the diabetic clinic of the hospital. Type 2 DM was diagnosed according to the following criterion: - age of diagnosis after the age of 40 years, the absence of ketosis and management of diabetes with oral hypoglycaemic agents and or diet only. Offspring recruited in the study were those between the ages of 20 – 40 years. Patients with Type 2 DM attending the diabetic clinic were randomly selected and interviewed regarding the ages of their children. Apparently healthy offsprings within the age of 20 and 40 years who consented to participate in the study were then consecutively recruited into the study.

A control group of 50 was also selected consisting of offspring of persons with no known history of Type 2 DM as could be ascertained by a detailed interview. The control group selected also had no other first degree relative known to be diabetic to the best of their knowledge. The control group was selected to achieve a similar distribution of age, gender and socio-economic class. The socio-economic classification scheme used was developed by the Department of Preventive and Social Medicine and the Institute of Child Health and is as shown below.

Socio-economic classification scheme (developed by the Department of Preventive and Social Medicine and the Institute of Child Health, University of Ibadan, Ibadan).

I Academic Professors, Senior Administrators, Owners of large scale business concerns, Senior Military Officers, large scale contractors.

II. Non academic professionals such as nurses, secretaries and owners of medium scale businesses.

IIIa. Non manual skilled workers, including clerks, typists, tele phonists and policeofficers.

IIIb. Manual skilled workers e.g. drivers, carpenters.

IV. Semi-skilled workers and small scale traders.

V. Unskilled workers e.g. farmers, petty traders, peddlers.

Ethical clearance was obtained from the Joint University of Ibadan/ University College Hospital ethical committee. Informed consent was obtained from all patients involved in the study.

Subjects reported to the medical out patient's clinic in the morning. A questionnaire was initially administered to obtain biodata.

The weight (kg) of each person was recorded without them wearing a coat, jacket, shoes or agbada, using a beam type scale. Height (metres) was also measured without the subjects wearing shoes, caps or headgear and standing with the back to the measuring rod, and looking straight ahead. The body mass index (B.M.I) was subsequently calculated using the formula - weight (kg)/ height$^2$ (metres$^2$).

The waist circumference was measured using a flexible tape measure to the nearest 0.5cm at the level of the umbilicus with the subject standing and breathing normally. The hip circumference was measured with the same tape measure to the nearest 0.5 cm at the level of the greater trochanter[20]. All measurements were made by the author with an assistant to cross check that the tape measure did not slant. The waist to hip ratio (WHR) was then calculated.

**Definitions of Criteria: -**

1) B.M.I[20].
   a) B.M.I < 20 was regarded as underweight.
   b) B.M.I of 20-24.9 was regarded as normal.
   c) B.M.I of 25-29.9 was regarded as overweight.
   d) B.M.I > 30 was regarded as obese.
2) WHR > 0.95 and 0.85 was regarded as abnormal for men and women respectively[21].
3) Waist circumference greater than 100cm and 90cm were regarded as abnormal for men and women respectively[21].

## STATISTICAL ANALYSIS: -

Results are expressed as means (SD) except where otherwise stated. Comparisons between means were performed using the t-test for unpaired data. Chi square test of significance was used to compare proportions. The level of significance was taken to be P<0.05.

## RESULTS

**Characteristics of Offspring of Type 2 Diabetics and Control Subjects**

The age and gender distribution of the offspring of diabetics and control subjects are shown in Table 1. The mean (SD) age for the offspring of diabetics was 28.8 (6.7) years, while for the control subjects, the mean age was 29.1 (6.1) years. The mean ages of the offspring of diabetics and control subjects were similar (p=0.81). Both groups were also were well matched for gender as shown in Table 1 (p=0.84).

The frequency distribution of the subjects according to tribe, socio-economic class and educational status is shown in Table 2. No significant difference was observed between the 2 study groups (p>0.05).

*Table 1:* **Age and Gender Distribution of Offspring of type 2 Diabetics and Control Subjects**

| Parameters | Offspring of diabetic Parents n = 52 | Control Subjects n = 50 | Level of significance (p) |
|---|---|---|---|
| **Mean Age*** | 28.8 (6.7) | 29.1 (6.1) | 0.81 |
| **Age groups (years)** | Number (%) | Number (%) | |
| **20 – 24** | 18 (34.6%) | 18 (36%) | |
| **25 – 29** | 10 (19.2%) | 10 (20%) | |
| 30 – 34 | 9 (17.3%) | 8 (16%) | |
| 35 – 40 | 15 (28.9%) | 14 (28%) | |
| **Gender** | | | |
| Male | 26 (50%) | 24 (48%) | 0.84 |
| Female | 26 (50%) | 26 (52%) | |

**Values are expressed as means (SD)*

*Table 2:* **Tribe, Socio-Economic Class and Educational Status of Offspring of Type 2 Diabetics And Control Subjects**

| Parameters | Offspring of Diabetic Parents n = 52 Number (%) | Control Subjects n = 50 Number (%) | Level of Significance (P) |
|---|---|---|---|
| **TRIBE** | | | |
| Yoruba | 40(76.9%) | 38 (76%) | 0.91 |
| Others | 12 (23.1%) | 12 (24%) | |
| **SOCIO-ECONOMIC CLASS** | | | |
| 1 | 12 (23.1%) | 16 (32%) | 0.57 |
| 2 | 5 (9.6%) | 3 (6%) | |
| 3 | 2 (3.8%) | 5 (6%) | |
| 4 | 6 (11.5%) | 5 (10%) | |
| 5 | 11 (30.9%) | 7 (16%) | |
| Students | 16 (30.9%) | 14 (28%) | |
| **EDUCATIONAL STATUS** | | | |
| Primary School education or none | 6 (11.5%) | 5 (10%) | 0.56 |
| Secondary school education | 17 (32.7%) | 12 (24%) | |
| Post secondary school education (Polytechnic, University, School of Nursing) | 29 (55.8%) | 33 (66%) | |

*n = number of subjects*

*Table 3:* **Weight and Body Mass Index (BMI) of Offspring Of Type 2 Diabetics and Control Subjects**

| Gender | WEIGHT (KG) Offspring of diabetics | Control subject | Level of significance (P) | BMI (Kg/M²) Offspring of diabetics | Control subjects | Level of significance (P) |
|---|---|---|---|---|---|---|
| MALES | 69.2 (12.9) n=26 | 67.8 (11.5) n=24 | 0.59 | 23.4 (3.4) n=26 | 22.6 (2.6) n=24 | 0.61 |
| FEMALES | 70.5 (17.3) n=26 | 60.2 (9.9) n=26 | 0.011 | 26.6 (5.6) n=26 | 23.3 (3.4) n=26 | 0.012 |
| BOTH GENDER | 69.9 (15.1) n=52 | 63.8 (11.3) n=50 | 0.024 | 25.0 (4.9) n=52 | 23.0 (3.0) n=50 | 0.013 |

*Values are expressed as means (SD).*

**Anthropometric Measurements of Offspring of Type 2 Diabetics and Control Subjects**

The offspring of Type 2 diabetics had a significantly higher mean (SD) weight than the control subjects [69.9 (15.1) kg] versus 63.8 (11.3) kg, p=0.024] (Table 3). When the weights of the two groups of subjects were compared according to gender, both male and female offspring of diabetics weighed more than the corresponding controls, but statistically significant differences were observed amongst the females only (p=0.011) (Table 3).

The mean (SD) body mass index (BMI) was also higher amongst offspring of diabetics [25.0 (4.9) kg/m$^2$] than the control subjects [23.0 (3.0) kg/m$^2$] (Table3). This difference was found to be statistically significant (p=0.013). Both male and female offspring of diabetics had a higher BMI than the corresponding control subjects, but the difference was only statistically significant amongst the females (p=0.012) (Table 3). 17 offspring of diabetics and 15 control subjects had a BMI greater than or equal to 25. Body mass index greater than or equal to 30 was present in 8 offspring of diabetics and 2 control subjects.

*Table 4:* **Waist and Hip Circumferences of Offspring of Type 2 Diabetics and Control Subjects**

| | Waist circumference (cm) | | | Hip circumference (cm) | | |
|---|---|---|---|---|---|---|
| **Gender** | **Offspring of diabetics** | **Control subject** | **Level of significance (P)** | **Offspring of diabetics** | **Control subjects** | **Level of significance (P)** |
| Males | 81.1 (10.6) n=26 | 78.0 (8.1) n=24 | 0.26 | 95.0 (9.1) n=26 | 92.8 (7.3) n=24 | 0.66 |
| Females | 83.6 (13.7) | 76.4 (8.6) | 0.026 | 103.0 (12.3) | 94.2 (7.3) | 0.003 |
| | n=26 | n=26 | | n=26 | n=26 | |
| Both Gender | 82.3 (12.2) n=52 | 77.2 (8.3) n=50 | 0.014 | 99.0 (11.4) n=52 | 93.0 (7.2) n=50 | 0.005 0.005 |

*Values are expressed as means (SD).*
*n = number of subjects*

The mean waist and hip circumferences for offspring of diabetics and control subjects are shown in Table 4. The mean (SD) waist circumference was significantly higher in offspring of diabetics when compared with controls [82.3 (12.2) cm versus 77.2 (8.3) cm; P=0.014]. Amongst the offspring of diabetics, 4 females had a waist circumference greater than 90 cm, while none of the males had a waist circumference greater than 100 cm. Two (3) of the female control subjects had a waist circumference greater than 90 cm, while none of the male control subjects had a waist circumference greater than 100 cm.

The mean (SD) hip circumference was also significantly higher in offspring of diabetics than in controls[99.0 (11.4) cm versus 93.5 (7.2) cm; p=0.005]. The mean waist and hip circumferences of both groups of subjects were further examined according to gender (Table4). Both male and female offspring of diabetics had larger mean waist and hip circumferences than the corresponding control subjects, but this was only statistically significant amongst the females (p=0.003), as shown in Table 4.

*Table 5:* **Waist-Hip Ratio (WHR) of Offspring of Type 2 Diabetics and Control Subjects**

| | Waist-Hip Ratio | | |
|---|---|---|---|
| **Gender** | **Offspring of Diabetic** | **Control Subjects** | **Level of Significance (P)** |
| MALES | 0.85 (0.06) n=26 | 0.81 (0.06) n=24 | 0.61 |
| FEMALES | 0.81 (0.06) n=26 | 0.81 (0.04) n=26 | 0.98 |
| BOTH SEXES | 0.83 (0.06) | 0.82 (0.05) n=52 | 0.52 n=50 |

The mean waist-hip ratio of offspring of diabetic and control subjects were however similar even when considered according to gender (P>0.05) as shown in Table 5.The mean (SD) waist-hip-ratio was 0.83 (0.06) for offspring of diabetics and 0.82 (0.05) in control subjects (p=0.52). Amongst the offspring of diabetics, 5 females had a WHR greater than 0.85, while only 1 male had a WHR greater than 1.0. Three (3) of the female control subjects had a WHR greater than 0.85, while none of the male control subjects had a WHR greater than 0.82.

## DISCUSSION

This study demonstrates the offspring of diabetics to have significantly higher mean weight, BMI, waist and hip circumferences when compared with age and sex matched controls. Indeed, the results show offspring of Type 2 diabetics to have higher measures of body fatness, namely the body weight and BMI as well as an increased measure of abdominal fat as evidenced by the significantly higher waist circumference, when compared with control subjects. It is however noted that the mean waist-hip-ratio did not differ between the 2 groups of subjects.

Increased abdominal fat distribution as demonstrated by a significantly higher WHR has been reported as a characteristic feature of first degree relatives of persons with Type 2 DM[22,23]. Groop et al[22] were of the opinion that a family history of Type 2 DM influenced body fat distribution resulting in abdominal obesity. While these other studies demonstrated an increased waist circumference as well as a higher waist-hip-ratio in the offspring of diabetics when compared with control subjects, this study demonstrated only an increased waist circumference in offspring of diabetics, with no difference observed in the waist-hip-ratio between the two study groups.

While waist circumference and waist-hip-ratio are both considered anthropometric indices reflecting abdominal obesity, some longitudinal studies have shown waist circumference as a better predictor for the development of Type 2 DM[17]. It has also been shown that relative to waist-hip-ratio, waist circumference measures showed stronger associations with visceral adiposity[12] and with metabolic and cardiovascular outcomes[13,15-16]. It is noted, that the findings in this study of similar waist-hip-ratio in offspring of Type 2 diabetics when compared with control subjects, is in contrast with the findings of Groop et al, a study conducted on a Caucasian population[22]. They reported a significantly higher waist-hip-ratio in first degree relatives of Type 2 diabetics than in controls, despite similarity in their BMI.

It is possible that body fat distribution and anthropometric measurements show ethnic variability and this might be responsible for the differences observed in the two studies. In a cross-sectional study conducted to determine anthropometric factors associated with Type 2 DM in a randomly recruited population, there were much greater odds of having Type 2 DM when WHR rather than waist circumference was considered [14]. This is in direct contrast to the findings of Wei et al[17] who conducted a prospective 7 year study and found that waist circumference was a much better predictor than WHR of the development of Type 2 DM. These observations led Han et al[14] to suggest the possibility that excessive intra- abdominal fat causes an increased risk of developing Type 2 DM, but that the development of DM may then affect hip circumference in some way reducing hip size and thus increasing WHR [14].

The anthropometric indices of waist circumference 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 depot. A preponderance of enlarged fat cells in this type of adipose tissue increases the risk of glucose intolerance, hyperinsulinaemia, and hypertriglyceridaemia[24-25].

It is noted from this study that some anthropometric indices governing glucose homeostasis were significantly higher in offspring of diabetics when compared with age and sex matched controls. Body mass index and waist circumference were significantly higher in offspring of diabetics and these have been shown to be predictive of the development of Type 2 DM [4,5,17].

It would appear that studies on fat patterning and insulin sensitivity are needed in African populations, bearing in mind reports from studies which have shown waist circumference to be a more reliable and valid measure of abdominal obesity. The strength of the correlation between intra-abdominal fat and it's anthropometric indices could be further investigated with use of the axial computed–tomography scan or MRI.

Long term prospective studies are needed to define anthropometric indexes predictive of the development of Type 2 DM, as well as it's relationship to insulin sensitivity amongst Nigerians.

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