Obesity among Sudanese adults with diabetes: a population-based survey

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Background: The aim of this study was to determine the prevalence of obesity among Sudanese individuals with diabetes.

Methods: Demographic and clinical data from 1,337 individuals with type 2 diabetes were collected using a pretested, standardized, interviewer administered questionnaire. Subjects were recruited from three states namely Khartoum, Northern and River Nile States. Anthropometric measurements including body weight, height and waist circumference were determined using standardized techniques and calibrated equipment.

Results: Total of 1,337 subjects with type 2 diabetes from Khartoum and North of Sudan were enrolled in this study and completed the questionnaires; the results showed that prevalence of obesity among individuals with diabetes was found to be 24.5%, with a higher rate of obesity in females than males (29.2% versus 18.1%). The prevalence of central obesity was also higher in women (43.6%) than men (21.8%). The prevalence of overweight was 39.9%. The overall prevalence of overweight and obesity was 64.4%. Obesity was associated with age, sex and blood pressure. While central obesity was associated with an increase in age, female sex and hypertension. Logistic regression analysis showed that female sex and hypertension are absolute risk factors for both obesity and central obesity.

Conclusions: The prevalence of obesity was 24.5% and overweight was 39.9% among Sudanese individuals with diabetes and more among women than men. Obesity and central obesity were significantly associated with female sex and hypertension.

Keywords: Obesity; diabetes; hypertension and Sudan

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Introduction

Obesity epidemic is increasing worldwide at an alarming rate in particular in African countries (1). The prevalence of obesity in America, Europe, Africa and Eastern Mediterranean was 61%, 55%, 26.9% and 46% respectively (2,3). Higher prevalence of obesity was noted in Gulf countries like Kuwait (42.8%) and Saudi Arabia (35.2%), while the prevalence of obesity in UK was estimated to

be around 25% (4-6). Metabolic changes associated with obesity are type 2 diabetes, hypertension, sleep apnoea and dyslipidaemia (3,7,8). Importantly, it is predicated that diabetes and obesity will put tremendous pressure on the health systems of many Sub-Sahara African countries (6). The prevalence of obesity with diabetes was shown to be also increasing at an alarming rate. For instance, in UK 86% of individuals with type 2 diabetes attending the hospital-based diabetes clinic, were found to be either overweight or obese (9). In USA, the prevalence of overweight or obesity was 85.2%, and the prevalence of obesity was 54.8% in adult diagnosed with diabetes between 1999 and 2002 (10). In Palestine the prevalence of obesity (individuals with diabetes) in men was 30% and women around 34% (11). In Louisiana, 84% of individuals with diabetes were overweight or obese and extreme obesity was reported in 20%, while in New Jersey, approximately 26.8% of hospitalized type 2 diabetes patients were overweight and 57.7% were obese and total percentage of obesity and overweight is 84.5% (12,13). Similar results were also reported in African countries. For instance, in Nigeria 83% were either overweight or obese among individuals with diabetes attending diabetes clinic at hospital, while in South Africa the prevalence of overweight and obesity were 31.8% and 60.2%, respectively (14,15). Importantly, abdominal obesity was found in 91.6% of individuals with type 2 diabetes in China (16). The aim of this study was to determine the prevalence of overweight and obesity among Sudanese adults with type 2 diabetes.

Methods

This is a descriptive, cross sectional study recruited 1,337 individuals with type 2 diabetes from Khartoum, Northern and River Nile States during January 2014–December 2015. Fasting blood glucose and 2-hour post-prandial glucose was tested by a fully-automated biochemical analyser. A multi-stage random clustering technique was used for selection of study population. The total population in these three states is estimated about 10 million individuals, therefore a sample size of 483 was considered representative for the total population with a 95% confidence level. However; we tripled that number to overcome the problem of representativeness in this large geographical area (more than 400,000 km^2, and a population of more than 10 million individuals).

Demographic and clinical data were collected by an interview using a pretested standardized questionnaire. Anthropometric measurements including age, blood pressure (hypertension will be diagnosed if three readings >140/90 were obtained), body weight, height and waist circumference were taken using standardized techniques and calibrated equipment (2,3,7,16). Body mass index (BMI) was calculated by the formula: weight in kilograms divided by height in meters squared. BMI <18.5 kg/m^2 was defined underweight, 18.5–24.9 kg/m^2 as normal, 25–29.9 kg/m^2 as overweight and >30 kg/m^2 as obesity (2,3) .Waist circumference was measured at the midpoint between the lower margin of the least palpable rib and the top of the iliac crest, using a stretch-resistant tape that provides a constant 100 g tension. Cut-off points for waist circumference of 94 and 80 cm (determined for men and women, respectively) (2,3,7,16).

Inclusion criteria

Inclusion criteria included adults 18 years and above with established diagnosis or a newly diagnosed case of diabetes mellitus. New diagnosis of diabetes was established if symptoms of diabetes were observed in addition to random venous plasma glucose concentration ≥11.1 mmol/L or a fasting plasma glucose concentration ≥7.0 mmol/L or 2 hours plasma glucose concentration ≥11.1 mmol/L 2 hours after 75 g anhydrous glucose in an oral glucose tolerance test (OGTT). In symptomatic individuals with diabetes, two samples are needed in two different days using different methods (random, fasting or 2 hours glucose tolerance test).

Exclusion criteria

Exclusion criteria included: individuals below 18 years and pregnant ladies.

Statistical methods

Descriptive statistics was used including frequency, distribution tables as well as graphs. Chi square test for associations between obesity and risk factors was used. For all test a P value <0.05 is considered significant. SPSS (version 20, IBM Statistics, Chicago, IL,USA) was used for data analysis. Logistic regression analysis was used to establish absolute risk factors.

Ethical consideration

Ethical approval was both obtained from University

Medical and Science and Technology (UMST), Khartoum, Sudan (IRB No. 00008867). Informed and written consent had been taken from each individual before being included in the study.

Results

A total of 1,337 persons with established diagnosis of type 2 diabetes living in the area extending from Khartoum, the capital of Sudan to the border of Egypt in Halfa city completed the questionnaires. The social-demographic features of this population are shown in *Table 1*. The overall prevalence of obesity was 24.5% (morbid obesity was present in 7.8%) while central obesity was 34.4%. Obesity and central obesity are significantly higher in women (29.2%, 43.6%) than men (18.1%, 21.8%) respectively [*Tables 2*,*3* (P<0.001)]. Overweight was also significantly higher in women (P<0.001). Furthermore, no significant difference was seen between males and females with normal weight and underweight. Obesity is higher among those aged 36–65 years old. The prevalence of overweight was 39.9%. The overall prevalence of overweight/obesity was 64.4%. Obesity was associated with hypertension, sex and age (P<0.0005). Obesity is more prevalent among those aged ranged between 36–65 years old (*Table 2*). Central obesity was significantly associated with age, sex, and hypertension (P<0.005), *Table 3*.

Logistic regression analysis

Logistic regression analysis (*Table 4*) showed that the absolute factors that have statistical relationship with obesity and central obesity are sex and high blood pressure (BP). Female sex has more than 1.7 times risk of being obese odd ratio (OR) 1.74 (1.38–2.19) with P value of 0.00. Nevertheless, central obesity is less common among females, OR 0.36 (0.28–0.46) with statistical significant P value of 0.00. Having high blood pressure has strong statistical association with BMI (P=0.00) and weak association with central obesity (P=0.038). Those with high BP have almost double chance of being obese OR 1.95 (1.52–2.50).

Discussion

In this study the prevalence of obesity among individuals with diabetes was found to be 24.5%, with a higher rate of

Table 1 Sociodemographic characteristics of diabetic Sudanese patients, 2014–2015 (N=1,337)

Characteristic	N (%)
Sex	
Male	564 (42.2)
Female	773 (57.8)
Age group (years)	
15–25	64 (4.8)
26–35	176 (13.2)
36–45	286 (21.4)
46–55	328 (24.5)
56–65	293 (21.9)
66–75	148 (11.1)
Above 75	42 (3.1)
BMI	
<18 (under weight)	34 (2.5)
18–24.9 (normal)	441 (33.0)
25–30 (over weight)	534 (39.9)
31–35 (obese)	224 (16.8)
>35 (morbid obesity)	104 (7.8)
Glycemic	
Newly diagnosed diabetic	325 (24.3)
Known diabetic	1,012 (75.7)
BP	
High	531(39.7)
Normal	806(60.3)
Locality	
Atbara	118 (8.8)
Berber	122 (9.1)
Ed Dammar	166 (12.4)
Abu hamad	21 (1.6)
Shandi	38 (2.8)
Dongla	213 (15.9)
Aldabba	129 (9.6)
Khartoum	18 (1.3)
Abri	106 (7.9)
Algolid	135 (10.1)
Argo	130 (9.7)
Halfa	64 (4.8)
Karima	77 (5.8)
Waist circumference	
Obese	460 (34.4)
Normal	877 (65.6)

BMI, body mass index; BP, blood pressure.

Table 2 Relationships between weight category and socio-demographic characteristics of diabetic Sudanese patients, 2014–2015 (n=1,337)

Characteristic	Underweight, n (%)	Normal, n(%)	Overweight, n (%)	Obese, n (%)	Morbid obesity, n (%)	χ^2	P value
Sex							
Male	17 (3.0)	225 (39.9)	220 (39.0)	76 (13.5)	26 (4.6)	34.034	0.000
Female	17 (2.2)	216 (27.9)	314 (40.6)	148 (19.1)	78 (10.1)		
Age group (years)							
15–25	7 (10.9)	35 (54.7)	14 (21.9)	7 (10.9)	1 (1.6)	76.287	0.000
26–35	6 (3.4)	66 (37.5)	64 (36.4)	29 (16.5)	11 (6.2)		
36–45	7 (2.4)	76 (26.6)	116 (40.6)	54 (18.9)	33 (11.5)		
46–55	3 (0.9)	97 (29.6)	152 (46.3)	51 (15.5)	25 (7.6)		
56–65	5 (1.7)	90 (30.7)	121 (41.3)	59 (20.1)	18 (6.1)		
66–75	4 (2.7)	58 (39.2)	48 (32.4)	23 (15.5)	15 (10.1)		
Above 75	2 (4.8)	19 (45.2)	19 (45.2)	1 (2.4)	1 (2.4)		
Glycemic							
Newly diagnosed diabetic	12 (3.7)	111 (34.2)	118 (36.3)	58 (17.8)	26 (8.0)	4.160	0.385
Known diabetic	22 (2.2)	330 (32.6)	416 (41.1)	166 (16.4)	78 (7.7)		
BP							
High	5 (0.9)	135 (25.4)	238 (44.8)	103 (19.4)	50 (9.4)	36.112	0.000
Normal	29 (3.6)	306 (38.0)	296 (36.7)	121 (15.0)	54 (6.7)		
Locality							
Atbara	5 (4.2)	38 (32.2)	47 (39.8)	14 (11.9)	14 (11.9)	91.767	0.000
Berber	3 (2.5)	28 (23.0)	60 (49.2)	19 (15.6)	12 (9.8)		
Ed Dammar	3 (1.8)	74 (44.6)	47 (28.3)	27 (16.3)	15 (9.0)		
Abu hamad	1 (4.8)	7 (33.3)	9 (42.9)	4 (19.0)	0 (0.0)		
Shandi	0 (0.0)	13 (34.2)	19 (50.0)	5 (13.2)	1 (2.6)		
Dongla	6 (2.8)	63 (29.6)	97 (45.5)	39 (18.3)	8 (3.8)		
Aldabba	5 (3.9)	53 (41.1)	41 (31.8)	18 (14.0)	12 (9.3)		
Khartoum	0 (0.0)	5 (27.8)	10 (55.6)	2 (11.1)	1 (5.6)		
Abri	0 (0.0)	38 (35.8)	36 (34.0)	21 (19.8)	11 (10.4)		
Algolid	3 (2.2)	47 (34.8)	50 (37.0)	26 (19.3)	9 (6.7)		
Argo	6 (4.6)	39 (30.0)	42 (32.3)	22 (16.9)	21 (16.2)		
Halfa	1 (1.6)	16 (25.0)	34 (53.1)	13 (20.3)	0 (0.0)		
Karima	1 (1.3)	20 (26.0)	42 (54.5)	14 (18.2)	0 (0.0)		

BP, blood pressure.

Table 3 Relationship between waist circumference and sociodemographic and clinical data of diabetic Sudanese patients, 2014–2015 (n=1,337)

Characteristic	Waist circumference		χ^2	P value
	Obese, n (%)	Normal, n (%)		
Sex				
Male	123 (21.8)	441 (78.2)	68.590	0.000
Female	337 (43.6)	436 (56.4)		
Age group (years)				
15–25	11 (17.2)	53 (82.8)	31.804	0.000
26–35	46 (26.1)	130 (73.9)		
36–45	117 (40.9)	169 (59.1)		
46–55	136 (41.5)	192 (58.5)		
56–65	96 (32.8)	197 (67.2)		
66–75	46 (31.1)	102 (68.9)		
Above 75	8 (19.0)	34 (81.0)		
Glycemic				
Newly diagnosed diabetic	102 (31.4)	223 (68.6)	1.736	0.188
Known diabetic	358 (35.4)	654 (64.6)		
BP				
High	204 (38.4)	327 (61.6)	6.284	0.012
Normal	256 (31.8)	550 (68.2)		
Locality				
Atbara	46 (39.0)	72 (61.0)	170.277	0.000
Berber	84 (68.9)	38 (31.1)		
Ed Dammar	89 (53.6)	77 (46.4)		
Abu hamad	13 (61.9)	8 (38.1)		
Shandi	25 (65.8)	13 (34.2)		
Dongla	52 (24.4)	161 (75.6)		
Aldabba	23 (17.8)	106 (82.2)		
Khartoum	7 (38.9)	11 (61.1)		
Abri	26 (24.5)	80 (75.5)		
Algolid	26 (19.3)	109 (80.7)		
Argo	35 (26.9)	95 (73.1)		
Halfa	18 (28.1)	46 (71.9)		
Karima	16 (20.8)	61 (79.2)		

BP, blood pressure.

Table 4 Logistic regression analysis

Variables	B	S.E.	χ^2	P value	OR	95% CI OR	
						Lower	Upper
Obesity BMI							
Sex: female	0.554	0.118	22.186	0.000	1.740	1.382	2.191
High BP	0.670	0.127	27.867	0.000	1.954	1.524	2.505
Age	0.002	0.004	0.144	0.704	1.002	0.993	1.010
Constant	–0.042	0.224	0.035	0.851	0.959	–	–
Central obesity							
Sex: female	1.023	0.126	65.970	0.000	0.360	0.281	0.460
High BP	0.259	0.125	4.308	0.038	1.295	1.015	1.654
Age	–0.003	0.004	0.406	0.524	0.997	0.989	1.006
Constant	1.262	0.271	21.669	0.000	3.533	–	–

The absolute factors that have statistical relationship with obesity are sex and BP. Female sex has more than 1.7 times risk of being obese OR 1.74 (1.38–2.19) with P value of 0.00. Nevertheless, central obesity is less common among females, OR 0.36 (0.28–0.46) with statistical significant P value of 0.00. Having high blood pressure has strong statistical association with BMI (P=0.00) and weak association with central obesity (P=0.038). Those with high BP have almost double chance of being obese OR 1.95 (1.52–2.50). BP, blood pressure; OR, odd ratio.

obesity among females than males (29.2% versus 18.1%). The prevalence of central obesity was also higher among women (43.6%) than men (21.8%). The prevalence of overweight was 39.9%. The overall prevalence of overweight and obesity was 64.4%. Obesity was associated with age, sex and blood pressure (P<0.05) while central obesity was associated with an increase in age, female sex and hypertension (P<0.05). Logistic regression analysis showed that female sex and hypertension are absolute risk factors for both obesity and central obesity. In Australia 53% of patients with type 2 DM were found to be obese and 32.8% were overweight (17). In Saudi Arabia overweight and obesity among individuals with diabetes was observed in 87.7% and significant higher obesity rate was noted in female in comparison to male (18). In Oman almost half of the individuals with diabetes were overweight and obese (19). The prevalence of overweight in diabetic male population in Yemen was 43% and obesity was 11%, while in women overweight was 40% and obesity was 32% (20). In this study, our results in Sudanese individuals with diabetes were comparable to Yemen diabetic population and less than Saudi Arabia prevalence of (85.7%). This is most likely due to the fact that there was higher prevalence of diabetes in Saudi Arabia (30%) in comparison with Sudan (19%) (18,21).

In this study we have shown higher prevalence of obesity and central obesity in female than male. Several studies in non-diabetic individuals have shown higher prevalence of obesity in women than men. For example, higher prevalence of obesity in women in comparison with men was noted in Belgium, United Kingdom, Mexico, South Africa and Pakistan (2,22,23) . In the WHO regions for Africa, Eastern Mediterranean and South East Asia, women had roughly double obesity prevalence of men (2,22,23). Several studies conducted in the Middle East and Africa showed that the factors behind high prevalence of obesity in females than males can be attributed to less physical activity, rapid urbanization, less employment and cultural reasons, women who are overweight will be socially accepted as well looked after and provide her with more acceptance in the community (24-28). As a part of social and Sudanese cultural aspects, central obesity is regarded as sign of wealth and prosperity for men. Therefore, further research studies are needed to address the specific factors for high prevalence of obesity in Sudanese women with and without diabetes.

In this study, the prevalence of central obesity was 34.4% and was also higher in women (43.6%) than men (21.8%). We have previously determined that central obesity was risk factor for diabetes in Sudanese population (21). In addition, central obesity is also risk

factor for Non Alcoholic fatty liver (NAFLD) in Sudanese individuals with type 2 diabetes (29). Importantly, a 10 cm increase in waist circumference and waist-to-height ratio of >0.5 were associated with a significant 1.26 (India) to 1.77 (Finland), and 1.68 (China, Spain) to 5.40 (Finland) times higher odds for DM respectively (30). Therefore, control of central obesity is a key factor in prevention of diabetes. Importantly, several studies showed central obesity and not general obesity measure may relate well with diabetes and clusters of metabolic syndrome in African population (31-34). Central obesity is also associated with increased risk of dyslipidaemia and coronary artery disease (35,36). In this study we have concluded that obesity and central obesity are associated with an increase in age, female sex and hypertension. Logistic regression analysis showed that female sex and hypertension are absolute risk factors for both obesity and central obesity. Further research is needed to determine whether central obesity can lead to increase in cardiovascular disease in Sudanese population with diabetes or not.

This study is not without limitations, the study design was a cross-sectional survey, and so we could not take account of the temporal relationship between potential risk factors and outcomes. In addition, further research studies are needed to address the specific factors for high prevalence of obesity in Sudanese women with and without diabetes. The impact of dietary habits may reveal important information about obesity in Sudan. Despite these limitations, we believe that this study is novel and its findings reflect the trend of obesity prevalence among adult Sudanese populations with diabetes.

Conclusions

The prevalence of obesity was 24.5% and overweight was 39.9% among individuals with diabetes. Obesity and central obesity have higher prevalence among Sudanese women. Obesity and central obesity are associated with increase in age, female sex and hypertension.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Ethical Statement: Ethical approval was both obtained from University Medical and Science and Technology (UMST), Khartoum, Sudan (IRB No. 00008867). Informed and written consent had been taken from each individual before being included in the study.

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