Original Article

Relationship between Anthropometric Indices and Dyslipidemia among Sudanese Women in Khartoum State.

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Abstract

Background: Several studies were undertaken in both developed and developing countries to investigate the relationship between lipid abnormalities and anthropometric indices. In Sudan, however, no data are available, particularly among Sudanese women.

Objectives: This study aimed at investigating the relationship between dyslipidemia and anthropometric indices among a group of Sudanese women living in Khartoum state.

Methods: A total sample of two hundred and four women aged 25 to 69 years old participated in this study. Anthropometric measures and blood chemistries were obtained. The relationship between obesity indices and lipid profile were investigated.

Results: Body Mass Index (BMI) was strongly correlated with cholesterol (TC) (R=.434 P=.000), low-density lipoprotein (R=.423, P=.000), triglycerides (R=.258, P=.000), TC: HDL (R=.455, P=.000) and high-density lipoprotein (R=-.383, P=.000). Regarding the relationship between central obesity and lipid profile, significant correlation was detected between waist circumference and total cholesterol. Waist to height ratio was also significantly correlated with total cholesterol, low-density lipoprotein, triglycerides, high-density lipoprotein, and TC: HDL, while no correlation was detected between waist to hip ratio, height and lipid profile.

BMI was the strongest predictor and important indicator of dyslipidemia among Sudanese women even after inclusion of all the variables in the study. Regarding age, except for triglycerides age was strongly associated with dyslipidemia among Sudanese women ($p < 0.05$).

Conclusions: The study concluded that anthropometric measurement (BMI, WC, WHtR) were strongly correlated with dyslipidemia among Sudanese women, while no correlation was found between WHpR and lipid abnormalities.

Key words: Triglyceride, waist , BMI.

Obesity has always been regarded as a global epidemic disease in light of its close association with a cluster of cardiovascular risk factors including hypertension, hyperglycemia and dyslipidemia[1], with the latter branded as highly correlated with coronary heart diseases [2].

Dyslipidemia is one of the most common metabolic disorders associated with obesity. Indices of body size including Body Mass Index (BMI), waist to height ratio are strongly correlated with hypertriglycerdemia, hypercholesterolemia and low high density lipoprotein(HDL)[3].

Various lipid and lipoprotein abnormalities (dyslipidemia) have been observed in obese individuals[4]. General and central obesity were related to lipid and lipoprotein abnormalities among adults. These adverse lipid and lipoprotein profiles in overweight and obese individuals are of great significance as they may be responsible for increasing the risk of Coronary Heart Diseases (CHD)[5].

Attempts to delineate the association between lipid levels and obesity have resulted in a multitude of epidemiological studies. The majority of research has been cross-sectional in design. As previously cited, in a Canadian adult study, it was found that BMI was strongly correlated with total plasma cholesterol (R=0.40,P=0.001), low density lipoprotein(LDL) (R=0.38,P=0.00) and triglycerides level(TG) (R=0.29, P=0.005),

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and inversely correlated with high density lipoprotein(HDL) (R=-0.47, P=0.000)[6]. A study among Chinese women revealed that high BMI (≥30) was the main explanatory variable for reducing high-density lipoprotein(HDL) (<40 mg/dl)[7]. Later, study on the relationship between anthropometric measures and cardiovascular risk factors among Chinese population, proved that higher BMI (≥30) is directly associated with higher levels of serum cholesterol (≥200mg/dl), triglycerides ((≥150mg/dl) and lower levels of high density lipoprotein cholesterol (HDL) (<40mg/dl)[8].

The importance of fat distribution was recognized already in the middle of the last century, when subjects with an android body type (upper body fat accumulation) were shown to have a higher probability of various diseases than gyncoid-type subjects (lower body fat accumulation)[9]. More recently, the absolute amount of intra-abdominal fat rather than the fat distribution pattern has been suggested to influence health risks, though the independent contribution of visceral fat accumulation to disease development is still under review[10].

The correlations were significant (p<0.001) in women of all ages with waist circumference consistently demonstrating the highest loading values. The strength of these associations peaked among 35-54 years age groups[11].

No correlation was found between BMI and metabolic parameters (TC, TG, and HDL). TC, LDL and HDL were significantly correlated with waist in both men and women, while waist and WHR were highly correlated with TG, especially in women of both populations (R=0.41, P<0.002 for waist and R=0.31, P<0.004 for WHpR)[12].

In study aimed at investigating the correlation of obesity with cardiovascular disease risk factors among Iranian children and adolescent girls. Values Serum HDL, LDL and cholesterol levels increased with age up to the age of 12 years and decreased thereafter with advancing age. Compared with non-obese girls, obese girls had greater risks of high TG (OR=1.76, CI=0.48–5.08), high LDL (OR=1.3, CI=0.86–0.95), high cholesterol (OR=2.0, CI=0.06–3.72), low HDL (OR=1.46, CI=0.21–5.20)[13].

Another study was conducted in an attempt to define optimal cutoff values for several anthropometric variables in an Iranian population revealed; significant correlations were found between waists: height ratio and hypertension, diabetes mellitus, dyslipidemia, and metabolic syndrome, particularly in women. Waist circumference cutoffs were higher for women than men for hypertension, diabetes mellitus, and dyslipidemia[14, 15].

Little is known about the association between obesity and chronic diseases in Africa[16]. Cardiovascular diseases have reached nearly epidemic proportions in Africa. According to the WHO Report 2002, cardiovascular diseases accounted for 9.2% of total deaths in the African region in 2001, and hypertension, dyslipidemia, Stroke, cardiomyopathies and rheumatic heart diseases were the most prevalent causes[17].

An empirical study conducted in Senegal and South Africa examined the association between obesity and chronic diseases. The results reveal that obese respondents are more likely to face the risks of diabetes and heart diseases in South Africa and of heart diseases and asthma in Senegal than their leaner counterparts[18].

In Sudan, dyslipidemia, obesity and other cardiovascular risk factors such as hypertension, and diabetes mellitus have been documented; yet studies highlighting the relationship between obesity indices and these cardiovascular risk factors still lag behind[19-21]. According to Sudan Ministry of Health[22], the prevalence of coronary heart diseases among Sudanese women exceeds that in men (1317, 1157 respectively). At any rate, there is no specifically published information available on the relationship between total fat and body fat distribution indices and dyslipidemia, particularly among Sudanese women. General and central obesity have received much attention in health risk assessment of excess body weight, but as mentioned before there is a gap in the Sudanese literature concerning this area. This drew the researcher's attention to establish a relationship between total fat, regional distribution of fat and dyslipidemia.

Materials and methods:

Cross-sectional research design was used in this study enabling the use of data for assessing the prevalence of acute or chronic condition of population at a particular point in time. Two hundred and four Sudanese women were selected to participate in this study. The following equation was used: ($N=z^2PQ/d^2*deff$)[23]. The sample design was a two-stage cluster sample, stage one consists of the selection of the primary sampling unit (cluster).The selection is done through the probability proportional to size (PPS procedure). Two quarters from each locality were selected, with each representing a distinct place in Khartoum State: Omdurman (Wadnubayi, Abroof). Khartoum (Sahafa, Riyad) Khartoum North (Shabeia and Safia). Stage two included the selection of the secondary sampling unit (ultimate unit), was done through systematic random sampling (thirty four women from each, quarter).

Physical characteristics:

A digital scale type (MS 01.2 771.95 LOS/Lot.No.PO.5) was used to measure body weight (BW). Subjects were weighed without shoes. Standing body height (BH) was measured without shoes to the nearest 0.5 cm with the use of a stadiometer (Secca240 wall-mounted Stadiometer) with the shoulders in relaxed position and arms hanging freely. Body Mass Index (BMI) was calculated as weight in kilograms (kg) divided by the square of the height in meters (m^2). Waist circumference (WC) was measured in the middle between 12^{th} rib and iliac crest at the level of umbilicus and the hips circumference (HC) at the fullest point around the buttocks. WC (cm) was divided by HC (cm) and BH (m) in order to calculate the waist-to-hip (WHpR) and waist-to-height (WHtR) ratio respectively. Means of replicates were used in all anthropometric measurements.

Assignment of risk factors:

Based on the International Obesity Task Force convened by the World Health Organization, a subject with BMI of 25.0 to 29.9 kg/m^2 was defined as overweight; a BMI $\geq$ 30.0 kg/m^2 was defined as obese. The WHO provided two WC risk categories: increased risk for men $\geq$94 cm and for women $\geq$80 cm, substantially increased risk for men $\geq$102 cm and for women $\geq$88 cm. A WHpR $\geq$ 0.9 in men and $\geq$ 0.8 in women was considered to represent central obesity and WHtR values of $\geq$ 0.5 in either sex were adopted as cut-offs [24].

Plasma lipids:

Dyslipidemia was defined as total cholesterol equal $\geq$200 mg/dl, low density lipoprotein-cholesterol equal $\geq$130 mg/dl, high density lipoprotein-cholesterol equal <40 mg/dl, and triglyceride equal $\geq$150 mg/dl. A TC/HDL $\geq$5 was also considered as adverse serum lipid profile. An overnight 12-hours fasting blood sample was collected and serum levels of total cholesterol (TC),triglycerides (TG), LDL, and HDL were measured using enzymatic procedure[25]. TG was determined using Fossati's method[26]. TC was determined by Allain's method[27]. HDL was measured by Phosphotungstic –precipitation using Burstein's method[28] while low-density lipoprotein cholesterol (LDL-C) was calculated using Assman methods[29]. The ratio of TC to HDL-C (TC: HDL-C) was calculated.

Statistical analysis:

To obtain baseline data of the Sudanese women in Khartoum State, statistical analyses were performed using statistical package for the social sciences version 12, (SPSS). Descriptive analyses were performed including frequencies of all variables and percentages, mean and standard deviation, correlation and multiple linear regressions. A level of $p<0.05/0.01$ was used to indicate statistical significance in all analyses.

Table (1) Relationship between age group and Lipid Profile among Sudanese woman.

Lipid level	TC/200-239		TC/ ≥240		LDL/130-159		LDL/ ≥160		HDL/ <40		TG/150-200		TG/ >200		TC:HDL/≥5		Total
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No
25-29	0	0	0	0	0	0	0	0	2	6.9	1	3.4	0	0	0	0	29
30-34	0	0	1	5	0	0	1	5	1	5	0	0	1	5	1	5	20
35-39	0	0	0	0	1	4.5	0	0	0	0	0	0	0	0	1	4.5	22
40-44	1	2.9	1	2.9	0	0	1	2.9	2	5.9	2	5.9	0	0	4	11.8	34
45-49	3	7.5	4	10	2	5	4	10	7	17.5	2	5	1	2.5	6	15	40
50-54	4	14.3	6	21.4	0	0	8	28.6	9	32.1	2	7.1	1	3.6	10	35.7	28
55-59	1	4.5	2	9.1	0	0	3	13.6	5	22.7	0	0	1	4.5	2	9.1	22
60-64	0	0	2	22.2	0	0	2	22.2	3	33.3	1	11.1	1	11.1	3	33.3	9
	p=.013**				P=.011**				p=.006**				P=.666		P=.002**		

Results:

The study included 204 women representing samples obtained from six areas in Khartoum State. Selected age group ranged from 25 to 64, with the exception of triglycerides; there were significant differences in lipid profile according to the age group (P value < 0.05). It was observed that dyslipidemia was more prevalent among the age groups of (50-54) (55-59) and (60-64) years old (table1)

Distribution of the women according to the BMI:

Using the categories suggested by the WHO, table 2 drew out the distribution of the women according to their BMI. As shown, 2.9% of the total samples were underweight, about 45.1% were at normal weight and about 27% were considered overweight. The prevalence of obesity class one, two and three among the women were 15.2%, 6.4% and 3.4% respectively.

Table2.Distribution of the women according to the BMI:

Body mass index/kg/m²	No	%
<18.5	6	2.9
18.5-24.9	92	45.1
25-29.9	55	27
30-34.9	31	15.2
35-39.9	13	6.4
≥40	7	3.4
Total	204	100

Distribution of the women according to WC, WHpR, WHtR:

Almost two thirds (65.2%) of the women had waist circumference equal to or more than 80 cm; and 34.8 % had less than 80cm. More than half of them (54.4%) had waist-to-height ratio equal to or more than ≥0.5, while about 45.6% had waist-to-height ratio less than 0.5.

The majority (81.9%) of the women had normal waist-to hip-ratio (<0.8) and only 18.1% of them had waist-to-hip ratio equal to or more than 0.8 (table.3)

Table (3) Distribution of the women according to WC, WHpR, WHtR:

Waist circumference	No.	%
<80	71	34.8
80-<88	72	35.3
≥88	61	29.9
Total	204	100
WHR	No.	%
<0.8	167	81.9
≥0.8	37	18.1
Total	204	100
WHtR	No.	%
<0.5	93	45.6
≥0.5	111	54.4
Total	204	100

Prevalence of dyslipidemia among the women:

Table (4) revealed that of the 204 subjects, 7.8% of the women had high cholesterol level, 9.3% had high LDL-C, and 14.2% had low level of HDL cholesterol. Only 2.5% women had high triglyceride. Regarding the ratio of total cholesterol to the HDL-C, it was observed that 13.2% of the participants were above the selected cut-off point (≥5) which was also considered as adverse lipid profile

Correlation between Anthropometric indices and the prevalence of dyslipidemia;

Table (5) demonstrates significant correlations between BMI, WC, and WHtR and lipid profile (p value <0.01). On the other hand, no correlation was detected between WHpR, height and lipid profile

Table.4. Distribution of women according to Lipid profile:

Cholesterol level/mg/dl	No.	%
<200mgdl(normal)	179	87.7
200-239(borderline high)	9	4.4
≥240(high)	16	7.8
Total	204	100
LDL-C/mg/dl	No.	%
<130(normal)	182	89.2
130-159(borderline high)	3	1.5
≥160(high)	19	9.3
Total	204	100
HDL –C/mg/dl	No.	%
<40(high risk)	29	14.2
40-70(moderate)	175	85.8
>70 (low risk)	-	-
Total	204	100
Triglyceride/mg/dl	No.	%
<150	191	93.6
150-200	8	3.9
>200	5	2.5
Total	204	100
TC:HDL	No	%
<5	177	86.8
≥5	27	13.2
Total	204	100

Table(5) Correlation between Anthropometric indices and the prevalence of dyslipidemia;

Variables	TC		LDL-C		HCL-C		TG		TC:HD-C	
	R	P	R	P	R	P	R	P	R	P
BMI	.434**	.000	.423**	.000	-.383**	.000	.258**	.000	.455**	.000
WC	.401**	.000	.342**	.000	-.375**	.000	.219**	.002	.402**	.000
WHpR	.080	.253	.099	.161	-.136	.052	.097	.169	.041	.557
WHtR	.274**	.000	.229**	.001	-.232**	.001	.197*	.005	.270	.000
Height	-.014	.838	-044	.528	.025	.720	-.050	.470	-.091	.195

Table (6) multiple linear regressions of association between anthropometric indices and lipid abnormalities among the women:

Model	B	Std Error	Beta	T	Sig
Dependant variables TC					
Constant	135.654	5.104		26.580	.000
BMI	11.448	2.918	.306	3.923	.000
Waist	10.788	4.700	.206	2.296	.023
Dependent variable LDL-C					
Constant	68.830	4.894		14.065	.000
BMI	11.257	2.798	.315	4.023	.000
Waist	10.769	4.506	.215	2.390	.018
Dependent variable TG					
Constant	78.520	4.572		17.173	.000
BMI	5.575	2.615	.182	2.132	.034
Dependent variable TC:HDL					
Constant	2.539	.168		15.149	.000
BMI	.428	.096	.345	4.461	.000
Waist	.375	.154	.216	2.429	.016

Multiple linear regressions of association between anthropometric indices and lipid abnormalities among the women:

In the multiple linear regression models, anthropometric measures represented the independent variables and lipid profile represented dependent variables. As seen in table (6), BMI and waist circumference were strong indicators for TC, LDL-C, and TC: HDL, while BMI alone was a strong indicator for triglycerides among Sudanese women. It was observed that HDL-C was not retained in the model.

Discussion:

Body Mass Index and dyslipidemia:

Assessing the risk of dyslipidemia in adults helps to identify those at high risk for development of clinical coronary heart diseases. Anthropometric measurements providing obesity indices such as BMI and waist circumference are useful methods of obtaining information on dyslipidemia.

According to the statistical investigations performed in this study, BMI was strongly correlated with cholesterol (R=.434 P=.000), low density lipoprotein (R=.423, P=.000), TG (R=.258, P=.000), TC: HDL-C (R=.455, P=.000) and high density lipoprotein (R=-.383, P=.000) (table5). These findings were in conformity with a previous study that demonstrated positive association of higher level of BMI with total cholesterol, LDL-C, TG, as well as negative association with HDL-C among American women[30]. On the other hand marginal correlation was found between BMI and lipid abnormalities among Turkish women[31]. Higher prevalence ratios of high cholesterol levels among overweight and obese women than among normal weight women were also reported[32]. Although these investigators followed different analytical approaches than ours and used different criteria to define high cholesterol levels, and that their estimates of prevalence ratios and ours cannot be compared directly, end results of all studies are strongly concordant in identifying BMI as a risk factor for levels of blood lipids.

Central fat distribution and dyslipidemia:

Central obesity was mostly associated with adverse serum lipid and lipoproteins. The result of this study indicated significant correlation between waist-to- height ratio and TC (R=.274, P=.000), LDL-C (R=.229, P.001), HDL-C (R=-.232, P=001), TG (R=.197, P=.005) and TC: HDL-C (R=.270, P=.000.). Waist circumference was also significantly correlated with TC, LDL-C, TG, HDL-C, and TC: HDL; (R=.401, P=.000), (R=.342, P.000) (R=.219, P=.002) (R=-.375,P=.000), (R=.402,P=.000) respectively, while no correlation was detected between WHpR, height and lipid profile. These results were different from the results in Chinese women that demonstrated strong correlation with TC, LDL, HDL, and triglyceride[8]. They also differ from results that indicated strong positive association between total cholesterol; triglycerides, WC and WHpR, while HDL level had no association with any of these indices among Turkish women[31].

The fact that there was no correlation between WHpR and lipid abnormalities could be best explained by the genetic formulation of the Sudanese women's large hip girth. It was also observed that Sudanese women with a large waist and large hips might have the same WHpR as women with moderately sized waist and hip circumference, or even women with small waist and hips. This was approved by a pervious study which stated that individuals with enlarged waist and hip girth might have healthy waist to-hip-ratio irrespective of the existence of excess abdominal adipose tissues and those changes in both waist and hip circumference may as well occur as a result of weight loss, i.e. the equation used to determine WHpR value for both lean and massively obese individuals may end up having the same WHpR[33].

Thus, the WHpR might not be a decisive factor in verifying dyslipedimia as it may well be influenced by conditions other than regional adipose tissues distribution such as frame size and gluteal muscle mass. Waist to hip ratio could not be considered a reliable index of visceral/subcutaneous fat distribution in obese people[34]. Many difficulties are inherent in the use of ratios values. One of the primary problems with WHpR is the difficulty of biological interpretation. Another pitfall occurs when both waist and hip circumference vary from the norm in the same direction. Therefore, waist circumference alone may be a better indicator of both visceral fat and metabolic risk factors than WHpR and have gained favor as a preferred method for assessing abdominal adiposity, as it has several advantages over waist to-hip ratio. Of primary importance is the facility by which it may be used in a clinical setting and the ease of interpretation. It requires one measurement only as opposed to two; and is, therefore, less susceptible to measurement and calculation error.

As previously stated in the literature one anthropometric measure may be better at predicting a particular risk factor, while another measure may be a better predictor of different risk factors. For example, in the present study the, multiple linear regression analyses suggested that body mass index and waist circumference were strong predictors for total cholesterol, low density lipoprotein-cholesterol, triglycerides and TC:HDL among Sudanese women. Confirming this, it was found that ,among Greek women, only waist circumference was a strong indicator for abnormal serum lipid and lipoproteins[35], and among Iranian women, waist-to-hip ratio was strong predictors for triglycerides and HDL, while waist to-height-ratio were strong predictors for TC, and LDL (13b). Another results showed that, Waist circumference was better predictor of dyslipidemia than either BMI or WHpR[36].

The degree of adiposity was different between Arabs and South Asians in Kuwait, it was reported that abdominal obesity had a different impact on cardiovascular risk factors in these two ethnic groups. South Asians, however, were more prone to develop adverse effects in lipid than Arabs were. According to the multiple linear regression analysis; the WHpR appeared to be the most suitable predictor of dyslipidemia[37]. In fact, total fat and body fat distribution for predicting diseases is population dependent and could vary from race to race. Occurrence of lipid abnormalities at lower categories of central and general obesity among the Sudanese women may, sometimes, be attributed to factors other than obesity; for example, i.e. heredity (genetic factors). It should also be noted that Sudanese multi-ethnic diversity greatly affects standardized anthropometric indices.

It should be noted that no established BMI or waist circumference criteria was recommended so far in the Sudan to evaluate the total fat or fat distribution among Sudanese people. Sudanese studies so far depended on the WHO or other criteria recommended by other concerned international bodies. The multiple linear regression models used in the present study revealed that, of all anthropometric indices, BMI alone was of higher significance in determining elevated lipid profile even after introduction of the other variables.

Age and dyslipidemia:

As previously stated, this cross-sectional study was carried out among Sudanese women in Khartoum State. Their age group ranged from 25 to 64 years. In the present study, with the exception of TG, significant differences were detected in lipid profile according to the age group. The prevalence of lipid abnormalities tend to increase as women gets older. In line to literature, it was reported that older women had higher levels of total cholesterol and triglycerides than did younger women[38], and the prevalence of dyslipidemia was low at younger age group and high at older age group and the age of ≥40 years is the strongest risk factor of high blood cholesterol in women[30]. After the end of the reproductive function, women begins a new stage in their life, the hormonal changes will reflect upon important changes of the body composition and tend to generate a set of symptoms and disorders such as obesity and its related risk factors, resulting from ageing process[39]. The lack of estrogen and progesterone hormones during menopause period, causes many changes in women's physiology that affect their health and wellbeing .These changes included increase in the abdominal fat storage and elevated total cholesterol and LDL-cholesterol, which may increase the risk of coronary heart disease[40].

Conclusions:

Although cross-sectional studies do not provide information on the sequence risk factors development, and cause-and-effect relationships cannot be inferred, these findings are consistent with cross-sectional, longitudinal, and clinical studies that show coronary heart disease risk factors are more prevalent among over weight and obese people.

The study concluded that anthropometric measurement (BMI, WC, WHtR) were strongly correlated with dyslipidemia among Sudanese women, while no correlation was found between WHpR and lipid abnormalities.

BMI and waist circumference are strong predictors for abnormal serum lipid and lipoproteins among Sudanese women.

To reduce the dyslipidemia among Sudanese women, the primary goal should be to decrease percentage of body fat and centrally deposited fat and increase lean body mass, thereby favorably altering the serum lipid profile.

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