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Association between Lipids and Metabolic Syndrome Components among Metabolic Syndrome Patients

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ABSTRACT

Metabolic syndrome (MetS) associates with higher morbidity and mortality. This study aimed to correlate between lipids and metabolic syndrome components among MetS patients. This case control study included 215 metabolic syndrome patients and 215 apparently healthy individuals.The demographic data, waist circumference (WC) and blood pressure (BP) were obtained; fasting blood glucose (FBG) and lipid profile were measured by Mindray automated analyzer, small dense low-density lipoprotein (sdLDL) was measured by ELISA. The associations between lipids and metabolic syndrome components were investigated by Pearson's correlation test of SPSS version 21. Compared to control group, FBG, cholesterol, triglycerides, and LDL-C levels were significantly increased with *p*.value (0.000, 0.000, 0.000 and 0.000 respectively) whereas HDL-C was reduced *p*.value (0.000), while no difference was found in sd-LDL level with *p*.value (0.209). The mean body mass index (BMI) in females was significantly higher than males with *p*-value (0.016), systolic BP was positively associated with BMI, FBG, WC, cholesterol and LDL-C with *p*-value (0.009, 0.000,0.002, 0.000 and 0.006 respectively) whereas LDL-C was positively associated with FBG with *p*-value(0.014). MetS patients had elevated triglycerides, cholesterol, LDL-C, and reduced HDL-C. Lipids were found potentially associated with MetS components.

Introduction:

Metabolic syndrome (MetS) is recently of priority for health care practitioners due to the accompanied impact on the quality of life of affected individuals (Wassink et al., 2008). Globally, one quarter of the world's population had metabolic syndrome comprising more than a billion of the world population. The incidence of metabolic syndrome equals the incidence of obesity and type 2 diabetes; this makes metabolic syndrome a major factor for mortality and morbidity in developed and underdeveloped countries like Sudan (Saklayen , 2018).

Several previous studies addressed the relationship between lipid profile and MetS and reported an increased risk of cardiovascular diseases (CVD) in patients with MetS associated with higher triglycerides, LDL-C, sd-LDL particles, and HDL-C (Paredes et al., 2019, Singh et al., 2015). Also some reports indicated abdominal obesity as a main hazard factor for insulin resistance, hyperlipidaemia and CVD (Paley and Johnson, 2018).

In Sudan there are limited disseminated data regarding lipid profile and risk factors associated with metabolic syndrome, hence, the aim of this study was to evaluate lipids profile and risk factors associated with metabolic syndrome in Sudanese patients.

Materials and methods:

This case control study, conducted from December 2016 to November 2018. The study protocol was ethically approved by Khartoum State Ministry of Health Research Department. A total of 430 individuals were enrolled in this study, 215 of them were metabolic syndrome patients who admitted to Zinam Diabetic Centre, Gaber-Aboeliz, and Rebate Teaching Hospital and diagnosed according to international diabetes federation (IDF) criteria (Sabir et al., 2016) (as case group) and matched (age and sex), 215 healthy individuals (as control group). Pregnant women; patients with renal diseases, liver diseases, severe illness, chronic inflammation and diabetics on insulin therapy were excluded from the study. Complete history and clinical data collection including blood pressure and anthropometric measures, and blood samples were collected after obtaining an informed consent from all participants.

Sampling:

Four ml of venous blood was collected from each participant; in the morning after an overnight fasting; and poured into two tubes: plain container for serum measurement of cholesterol, triglyceride, HDL-C, LDL-C and sd-LDL, and fluoride oxalate tube for the measurement of fasting glucose. The samples were allowed to clot (for serum) before centrifugation for 5 minutes in 3000 rpm, then sample was obtained. The plasma was assayed immediately for fasting glucose, while serum was frozen at -20 until assayed later for other parameters**.**

Anthropometric and biochemical measurements:

Waist circumference (WC/cm) was measured by tap meter; body mass index (BMI kg/m2) was calculated as divided body mass by the square of the body height; and blood pressure was measured by a physician using sphygmomanometers. FBG, cholesterol, triglycerides, LDL-C and HDL-C were measured by Mindray automated analyzer (BS380) (Rifai et al.,1999; CLSI, 2008; Tietz, 1995) and sd-LDL was gauged by Enzyme Linked Immune Sorbent Assay (ELISA) kit (Glory science CO., LTD).Commercial control sera was used to assure the accuracy and validity of results.

Statistical analysis:

Analysis of the results was done using windows based statistical package for social science (SPSS) version 21, independent sample-t test was used for the comparison between the measured levels in case and control groups, Person's correlation test was used to detect correlations between study variables and biochemical parameters. *P-value* less than 0.05 was considered statistically significant.

Results:

Table (1) shows the demographic and characteristic data of cases compared to control group. The results revealed a significant increase in BMI, WC, systolic and diastolic blood pressure, fasting plasma glucose, total cholesterol, triglycerides and LDL-C in patients when compared

to control group, while HDL-C was significantly lower in patients group. No statistical difference was found in sd-LDL in patients when compared to control group (Table 2).
Among the two sexes significant increase of BMI means in females compared to males was observed (Table 3). Also significant positive correlation was reported between systolic BP with BMI, WC and FBG, and diastolic with FBG, whereas LDL-C was positively associated with FBG (Table 4).
Table (5) shows the significant positive correlation between cholesterol level and systolic and diastolic BP, and LDL-C level with systolic BP.

Table (1) Demographic and anthropometric characteristics and risk factors associated with the metabolic syndrome

Variables	Classes	Patients Frequency (%)	Control Frequency (%)
Sex	Female	132 (61.4%)	132 (61.4%)
	Male	83.0 (38.6%)	83.0 (38.6%)
Age	<55 Years	104 (48.4%)	104 (48.4%)
	≥55 Years	111 (51.6%)	111 (51.6%)
BMI	<35	151 (70.2%)	215 (100.0%)
	≥35	64.0 (29.8%)	0.00 (0.00%)
WC (cm)	<94 mg/dl	0.00 (0.00%)	215 (100.0%)
	≥94 mg/dl	215 (100.0%)	0.00 (0.00%)
FBG (mg/dl)	<126 mg/dl	95.0 (44.2%)	211 (98.1%)
	≥126 mg/dl	120 (55.8%)	4.00 (1.9%)
Systolic (mmHg)	<130	2.00 (0.9%)	158 (73.5%)
	≥130	213 (99.1%)	57.0 (26.5%)
Diastolic (mmHg)	<80	15.0 (7.0%)	166 (77.2%)
	≥80	200 (93.0%)	49.0 (22.8%)
Chol (mg/dl)	<200 mg/dl	156 (72.6%)	215 (100.0%)
	≥200 mg/dl	59.0 (27.4%)	0.00 (0.00%)
TG (mg/dl)	<150 mg/dl	127 (59.1%)	207 (96.3%)
	≥150 mg/dl	88.0 (40.9%)	8.00 (3.70%)
HDL-C (mg/dl)	<40 mg/dl	45.0 (20.9%)	1.00 (0.50%)
	≥40 mg/dl	170 (79.1%)	214 (99.5%)
LDL-C (mg/dl)	<150 mg/dl	197 (91.6%)	197 (91.6%)
	≥150 mg/dl	18.0 (8.40%)	18.0 (8.40%)
sdLDL (ng/dl)	<0.5 ng/dl	134 (62.2%)	162 (75.6%)
	≥0.5 ng/dl	81.0 (37.8 %)	53.0 (24.4 %)

Table (2) Comparison of means of metabolic syndrome Components and clinical parameters among study groups

Parameters	Patients (Mean ± SD)	Control (Mean ± SD)	*P*-value
BMI (Kg/m2)	33.7 ± 4.38	22.2 ± 1.42	0.000
Waist circumference (cm)	115 ± 7.65	79.0 ± 5.19	0.000
Systolic (mmHg)	148 ± 16.18	120 ± 8.58	0.000
Diastolic (mmHg)	86.0 ± 9.25	71.6 ± 6.82	0.000
FBG (mg/dL)	162 ± 51.28	89.3 ± 15.42	0.000
Total cholesterol (mg/dL)	175 ± 47.70	114 ± 25.62	0.000
Triglycerides (mg/dL)	151 ± 61.43	93.4 ± 31.05	0.000
HDL-C (mg/dL)	47.8 ± 9.23	55.0 ± 7.58	0.000
LDL-C (mg/dL)	104 ± 32.33	64.3 ± 19.00	0.000
sdLDL (ng/mL)	0.57 ± 0.33	0.49 ± 0.26	0.209

Independent- t- test was used *P*- value < 0.05 was considered significant.

Table (3): Comparison of means of anthropometric data and biochemical investigations between females and males among MetS patients

Parameters	Females (Mean ± SD)	Males (Mean ± SD)	*P-value*
BMI	34.3 ± 5.08	32.8 ± 2.75	0.016
Waist circumference	115 ± 8.23	116 ± 6.62	0.375
Systolic	148 ± 16.71	148 ± 15.39	0.788
Diastolic	86.0 ± 9.12	86.1 ± 9.51	0.965
FBG (mg/dL)	164 ± 49.89	159 ± 53.55	0.449
cholesterol/mg/dL	174 ± 47.85	178 ± 47.61	0.486
Triglyceride mg/dL	148 ± 55.04	155 ± 70.57	0.440
HDL-C (mg/dL)	47.7 ± 9.43	48.0 ± 8.96	0.846
LDL-C (mg/dL)	104 ± 30.34	104 ± 35.45	0.989
sdLDL (ng/mL)	0.58 ± 0.36	0.54 ± 0.26	0.691

dependent- t- test was used *P*- value < 0.05 was considered insignificant

Table (4) Correlation between biochemical parameters and risk factors of metabolic syndrome among patients

Parameters	BMI		Waist Circumference		FBG (mg/dL)	
	R-value	*P-value*	*R-value*	*P-value*	*R-value*	*P-value*
FBG (mg/dL)	0.100	0.144	0.132	0.052	-	-
cholesterol/mg/dL	0.064	0.348	0.023	0.733	0.126	0.065
Triglyceride mg/dL	-0.066	0.335	-0.029	0.669	0.077	0.259
HDL-C (mg/dL)	-0.064	0.354	-0.093	0.174	-0.091	0.184
LDL-C (mg/dL)	-0.011	0.870	0.029	0.674	0.168	0.014
Systolic BP	0.177	0.009	0.210	0.002	0.328	0.000
Diastolic BP	0.059	0.388	0.128	0.061	0.210	0.002

Pearson's correlation test was used, R- value: is the coefficient and strength of correlation, *P-values* < 0.05 considered as statistically significant.

Table (5): Correlation between blood pressure and lipid profile among patients

	Systolic		Diastolic	
	R-value	*P-value*	*R-value*	*P-value*
Cholesterol/mg/dL	0.258	0.000	0.195	0.004
Triglyceride mg/dL	-0.009	0.894	-0.027	0.689
HDL-C (mg/dL)	-0.112	0.100	-0.111	0.105
LDL-C (mg/dL)	0.188	0.006	0.114	0.094

Pearson's correlation test was used, R- value: is the coefficient and strength of correlation, P-values < 0.05 considered as statistically significant

Discussion:

Indeed, the most dangerous factor for metabolic syndrome is dyslipidemia because it is related to a change in lipoproteins. It is reported that, patients suffering from MetS, particularly those who have abdominal obesity, are more likely to have elevated atherogenic lipid profile, which is associated to the risk of CVD (Blaton et al., 2008; Nolan et al., 2017).

In the current study lipid profile and risk factors related to metabolic syndrome in Sudanese patients were assessed. The impact of energy intake, unspent energy and genetics, leads to the crystals of disease known as metabolic syndrome (Saklayen, 2018). The present study results revealed an elevation of BMI, waist circumference, systolic blood pressure, diastolic blood pressure, fasting blood glucose, triglycerides, total cholesterol and LDL-C levels, while HDL-C level was decreased but there was no difference in sdLDL level in patients when compared to healthy individuals. These results are in concordance with many previous studies by Fan et al., 2019 (except in sdLDL), Zhang et al., 2018, and Kella et al., 2017. These results confirmed the fact of increase amount of metabolic components due to insulin resistance which leads to defect signaling, lipids are deposited in the arteries, which leads to the formation of plaques that are cholesterol rich in core (Singh and Scmhrd, 2018). Recent prospective studies (Blaton et al., 2008) indicated that elevated triglycerides as an independent risk factor in chronic heart disease (CHD) and linked to several atherogenic factors including increased concentrations of triglyceride-enriched lipoproteins. The atherogenic lipoprotein phenotype consisting of sdLDL particles and low level of HDL-C is also related to insulin resistance, increase in triglycerides, overweight, obesity, lack of exercise, and type2 diabetes.

The gender plays an important role in metabolic syndrome components; most previous studies reported that prevalence of metabolic syndrome is more commonly in females **(**Khella et al., 2017; Lee et al., 2018). The current study revealed insignificant difference in waist circumference, FBG, Triglycerides, total cholesterol, LDL-C, HDL-C, hypertension and sdLDL in females compared to males, these results are partially consistent with Osei-Yeboah et al., 2017 who reported gender differences in FBG and blood pressure but disagreed regarding dyslipidemia results. Most probably the mechanism of hyperlipidemia and elevated blood pressure in people suffering from insulin resistance is not affected by gender among Sudanese.

The current study presented significant increase of BMI in females compared to males; this result comes in line with a previous study in Pakistan (Alamgir et al., 2015) but disagreed with another study in Sudanese population (Sabir et al., 2016). The reported inconsistent findings might be due to sample size or age differences between the two studies.

The current study indicated positive correlation between fasting blood glucose and both systolic and diastolic blood pressure, this result agrees with previous study which showed that type 2diabetes is common among patients with elevated systolic and diastolic blood pressure (Li et al., 2019). In fact, insulin resistance considered a basic cause for hypertension by boosting catecholamine activity or through action of insulin in reabsorption of sodium by renal tubules (Han and Lean, 2016). The results of the present study also showed positive correlation between FBG and LDL-C, but no correlation between fasting blood glucose and HDL-C, cholesterol and triglycerides levels. These findings are consistent with the results of Li et al., 2019, and Gierach et al., 2016 who reported that impaired fasting glucose has a basic effect on the level of LDL-C.

In fact, the combination of elevated blood pressure and elevated total cholesterol was found to increase the risks of cardiovascular disease (Carvalho et al., 2016).

The positive correlation between total cholesterol and LDL-C levels with systolic and diastolic blood pressure among Sudanese MetS patients, agrees with Yan et al., 2016. Indeed, several studies have shown that systolic blood pressure; diastolic blood pressure and LDL-C were associated with developing cardiovascular disease as a result of disturbance in LDL-C metabolism in patients who have raised systolic blood pressures (Ademolu, 2017; Zhang et al., 2019). The current study also indicated positive correlation between waist circumference and systolic blood pressure, a result which is in agreement with previous results (Levine et al., 2011), although the mechanism for this association is unknown, but the good explanation is that, the insulin resistance and free fatty acids play a role for this association.

Conclusions:

The study provides evidence that, MetS patients had elevated cholesterol, triglycerides, LDL-C, and lower HDL-C and lipids were potentially associating with MetS components. Insulin resistance in Sudanese patients was not associated with gender. Therefore, intervention and monitoring program is needed for the prediction of complications related to MetS such as CVD.

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