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Prevalence of dyslipidemia and its correlation with anthropometric and blood pressure variables among type-2 diabetic patients

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Co-morbidity of hypertension and dyslipidemia are found to be high in type-2 diabetes mellitus (DM) patients particularly with poor glycemic control. This study was aimed to assess the prevalence of dyslipidemia and its correlations with anthropometric and blood pressure variables among type-2 DM patients. The study was conducted on 314 type-2 DM patients at Hawassa University Comprehensive Specialized Hospital from February 28 to May 30, 2017. Socio-demographic and other data was collected using interview-directed structured questionnaire. In addition, serum biochemical parameters determined after overnight fasting and dyslipidemia was defined based on United State National Cholesterol Education program-III criteria. Statistical analysis such as Chi-square, student's t-test/ Mann-Whitney U test, and Pearson correlation coefficient were conducted using Statistical Package for Social Sciences (SPSS) Version 20. The result showed that two hundred eight six (91.1%) participants had a minimum of one lipid parameter abnormal, which is well suited for the diagnosis of dyslipidemia. The prevalence of low HDL-cholesterol, high LDL-cholesterol, triglycerides and TC (total cholesterol) were 60.8, 14.3, 70.4 and 32.8%, respectively. The mean values of TC, LDL-cholesterol and uric acid (UA) were significantly higher among patients with body max index (BMI) ≥25 kg/m^2 when compared to those with BMI <25 kg/m^2 (p<0.01 for all). In addition, TC and TG were significantly higher among patients with BP ≥130/85 mmHg when compared to those patients with BP <130/85 mmHg (p<0.001 for both parameters). Triglycerides was significantly correlated with BMI, UA and hypertension (r=0.326, 0.553 and 0.22), respectively. TC showed significant correlation with BMI, UA and fasting blood sugar (FBS) (r=0.326, 0.298 and 0.132), respectively. Moreover, LDL-cholesterol was significantly correlated with waist circumference, BMI and FBS (r=0.16, 0.189 and 0.173), respectively. In conclusion, dyslipidemia is significantly higher in diabetes patients and it correlated with BMI, WC, blood pressure and UA. Therefore, lipid profiles should be performed periodically through treatment follow-up and proper management of correlated factors is vital in order to limit risks of cardiovascular diseases.

Key words: Anthropometric parameters, dyslipidemia, uric acid, hypertension, type-2 diabetes.

INTRODUCTION

Diabetes mellitus (DM) is a progressive non-communicable chronic disease and insulin hormone absolute deficiency/resistance caused it. Disturbances in insulin hormone leads to metabolic disturbances like hyperglycemia, lipids, carbohydrates and proteins (Habib, 2006; Mooradian, 2009). Coexistent of hypertension and diabetes is a common risk factor for disease complications, for instance coronary artery disease, cerebrovascular disease, peripheral vascular disease, and DM related kidney disease (Rawshani et al., 2017;

Gregg et al., 2014). Type 2 DM patients are at increased risk of accelerated atherosclerosis and premature death (American diabetic association, 2002). Dyslipidemias may have a contribution to accelerated atherosclerosis and it is a risk factor for developing coronary artery disease (CAD) (American diabetic association, 2000). Different epidemiological studies have pointed out the relationships between the complications of diabetes and blood pressure (BP), glycaemia and LDL-cholesterol (LDL-c) (Sarwar et al., 2011; Stratton et al., 2000). Co-morbidity with hypertension (HTN) and dyslipidemia are found to be high in type-2 DM patients particularly with poor glycemic control. The relationship of these dysregulations proposes that these patients may be at a higher risk of developing cardiovascular diseases (CVDs) (Prabodh et al., 2012). In addition, these combined metabolic disorders like hypertension and hyperlipidemia may lead to cardio-cerebrovascular diseases and stroke, which may eventually lead to death (Sun et al., 2014). One study revealed that Total cholesterol (TC), raised triglycerides (TGs) and low HDL-cholesterol (HDL-c) were increased significantly in type-2 DM patients (Bhowmik et al., 2018). HDL-c showed an inverse association with body mass index (BMI); but LDL-c, TC and TGs were positively correlated with BMI (Omotoye et al., 2016). High concentration of free fatty acids prevents insulin mediated glucose uptake in the body and it predisposes to overproduction of very low-density lipoprotein cholesterol (VLDL-c (Mithal et al., 2014; Shradha and Sisodia, 2010).

In addition, TC was higher in hypertensive type-2 DM female patients when compared to hypertensive type-2 DM male patients (Gordon et al., 2010). Mulugeta et al. (2012) reported a significant correlation between glycemic control and dyslipidemia, particularly with serum TG and TC. Moreover, high BP, high BMI, aging, and experiences of prolonged duration with DM were significantly associated with the prevalence of dyslipidemia in DM patients (Bekele et al., 2017).

However, the possible interactions of BP and anthropometric variables with dyslipidemia in diabetic patients have not been studied in detail. Therefore, this study was designed to assess the prevalence of dyslipidemia and its correlations with anthropometric and BP variables among type-2 DM patients.

MATERIALS AND METHODS

Study settings and study population

This cross-sectional study was conducted at Hawassa University comprehensive specialized Hospital, Hawassa, Sidama zone from February 28 to May 30, 2017. Hawassa is an administrative city of Southern Nation, Nationalities and People Regional (SNNPR) State and located 275 km from Addis Ababa, the capital city of Ethiopia. This administrative city encompasses about 133,097 populations (Population of Cities in Ethiopia, 2019). In addition, it has two governmental hospitals and nine public health centers.

Data collection procedures

A written consent was obtained from each study individual before collection of data. Interview-directed pre-structured questionnaire was used to collect socio-demographic and clinical related data. All type 2 DM patients who had a regular follow-up in the hospital were eligible in the study. However, patients on lipid level affecting drugs, pregnant women, patients with known cardiac disorders and renal failure were not included in the study. Anthropometric related data (weight and height) were collected based on WHO guideline (WHO, 2010). BMI was calculated as weight (in kilogram) divided by the height square (in m^2). In addition, Systolic BP (SBP) and diastolic BP (DBP) were measured by mercury-based sphygmomanometer after the subjects had rested for at least 10 min. Repeated BP measurement was done within 3 min differences and average was taken to ensure accuracy.

Moreover, BMI was classified according to international conventions of expert panel (1998): underweight (<18.5 Kg/m^2), normal body weight (18.5 to 24.9 Kg/m^2), overweight (25 to 29.9 kg/m^2), and obesity (≥30 kg/m^2). Waist circumference (WC) was measured at the midpoint between the lower border of the rib cage and the iliac crest by using a flexible non-stretching tape and it expressed in centimeter (cm). The abnormality of WC was rated as >102 cm in men and >88 cm in women (NCEP-III, 2002).

Furthermore, dyslipidemia was defined based on National Cholesterol Education Program Adult Treatment Panel III guideline (NCEP- ATP III, 2002). The following criteria's was used for the diagnosis of overall dyslipidemia: TC ≥200 mg/dl, HDL-c (<40 mg/dl for men and <50mg/dl for women), LDL-c ≥ 130 mg/dl and TG ≥150mg/dl. Hyperuricemia was defined by raised uric acid level (>7.2 mg/dl in males and >6.0 mg/dl in females (Sui et al., 2008).

Sample size calculation and sampling technique

Sample size was calculated based on single population proportion formula with 65.6% prevalence of dyslipidemia among DM patients (Bekele et al., 2017). Using the formula, the final sample size was calculated to be 346. To select participants from the study population, direct patients flow was checked for one week in the diabetic clinic. It showed that the average weekly DM patients flow was about 80 to 90. Finally, every fourth DM patient was nominated using systematic random sampling technique.

Blood sample collection and laboratory diagnosis

About 4 to 5 mL of venous whole blood was taken from each participant after 8 to 12 h fasting. The serum was obtained through centrifugation after a proper clot formation. In addition, serum samples were analyzed for uric acid, fasting blood sugar (FBS) and lipid profile (TC, HDL-c and TGs) using Random access A25

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BioSystem chemistry analyzer [BioSystems S.A. Costa Brava 30, Barcelona (Spain) (BioSystems™, Spain)]. Serum uric acid, TC, TGs and FBS were measured by enzymatic colorimetric assay techniques (Linear chemicals, Montgat, Spain). While HDL-c and LDL-c were analyzed using direct homogeneous enzymatic colorimetric assay techniques (Linear chemicals, Montgat, Spain).

Ethical approval and consent to participate

Ethical clearance was obtained from the ethical review committee of Institute of Health Sciences, Jimma University (Ref no IHRPGC/283/017). Clearance letter was submitted to Institutional Review Board of Hawassa University, College of Medicine and Health Sciences and Hospital Clinical Director office for the necessary review and research permission, respectively. Moreover, all the study participants were well informed about the procedure of the study and written informed consent was obtained from all the study participants before data collection. In addition, the confidentiality of private information was strictly conserved.

Data quality control management

Before actual data collection, the quality of data was checked by pre-testing of 10% questionnaires in Sidama Zone "Adare Hospital", which is about 5 km away from the study area and then all amendments was done for structuring questionnaires. Trained nurses who were working in the medical outpatient department collected all relevant data of DM patients including primary and secondary data. Quality control samples run were strictly performed before running patients' samples as well as along with patients' samples to assess the reliability of the whole performances status. In addition, standard operating procedure (SOP) was followed from pre-analytical phase to result releasing.

Data analysis

Collected data were coded, entered in to and analyzed using SPSS (Version 22.0). Frequencies and percentages were used for categorical variables, while continuous variables were presented as mean and standard deviation (±SD). Skewed or abnormally distributed data were presented as median and interquartile range (IQR). Chi-square and or fisher's exact test was used for categorical variables In addition the comparison of quantitative variables was done by student t test or Mann-Whitney U test based on the nature of continuous data distribution. Finally, Pearson correlation coefficient was used to assess the correlations between each lipid profiles and independent variables.

RESULTS

Socio-demographic and lipid patterns

A total of 314 study participants were enrolled in the study with 90.7% response rate. Majority, 67.0% (211/314) of the study participants were males and the rest were females. The mean age of the study participants was 49.8 ± 9.8 years with the age range of 30 to 80 years. The mean duration of participants with diabetes was 5 years and 33 (10.5%) were cigarette smokers (Table 1).

The mean values of WC (cm), TC (mg/dl), LDL-c (mg/dl), uric acid (mg/dl) and FBS(mg/dl) were significantly higher among DM patients having BMI greater than or equals to 25 Kg/m^2 when compared to those who have BMI lesser than 25 Kg/m^2 ($p<0.01$ for all). In addition, median values of SBP, DBP and TGs were significantly higher in overweight to obese patients when compared to those patients who have BMI <25 Kg/m^2 ($p<0.0001$ for all, Table 2).

The mean of BMI, WC, TC, LDL-c, uric acid and FBS were significantly higher among DM patients having BP ≥ 130/85 mmHg when compared to those who have BP < 130/85 mmHg ($p<0.05$ for all, Table 3).

Prevalence of dyslipidemia

Two hundred eighty six (91.1%) of the participants had a minimum of one lipid parameter abnormal that is compatible with the diagnosis of dyslipidemia according to NCEP-ATP III guideline. Dyslipidemia is significantly higher in males when compared to females (59.5% vs. 31.5%, p=0.03). In addition, BMI showed significant difference in dyslipidemia (Table 4). Furthermore, hypertriglyceridemia was the most prevalent lipid profile (Figure 1).

Correlations of anthropometric, blood pressure and other variables with dyslipidemia

TGs indicated a significant positive correlation with BMI ($r = 0.326$; $P<0.0001$) and uric acid ($r = 0.553$; $P<0.0001$). TC showed a significant correlation with BMI ($r = 0.326$; $P <0.0001$), uric acid ($r = 0.298$; $P<0.0001$) and FBS ($r=0.132$; $p=0.02$). In addition, a significant positive correlation of LDL-c was observed with WC, DBP, and FBS. Furthermore, age and duration since the diagnosis of DM did not show any significant correlations with lipid profiles (Table 5).

DISCUSSION

This cross-sectional study carried out in a resource poor East African setting was to evaluate the correlations of anthropometric and BP with dyslipidemia (lipid derangements) among diabetic patients in Hawassa. Majority (91.1%) of the participants had a minimum of one lipid parameter abnormal that is compatible with the diagnosis of dyslipidemia. Dyslipidemia is significantly higher in males when compared to females. The present study indicated that the prevalence of dyslipidemia was 91.1%. The finding was comparable with the prevalence reported by Abdel-Aal et al. (2008), which was 90%. However, the rate is much higher when compared with

Table 1. Socio-demographic and other characteristics of diabetes patients.

Variable	Category	N (%)
	Female	103(33)
Age(years)†		49.8(9.8)
Residence	Urban	159(50.6)
	Rural	155(49.4)
Ever drink alcohol	No	282(89.8)
	Yes	32(10.2)
Ever smoke cigarette	No	281(89.5)
	Yes	33(10.5)
Family history of DM	No	259(82.5)
	Yes	55(17.5)
Hyperuricemia	No	208(66.2)
	Yes	106(33.8)
Uric acid (mg/dl) *	-	5.5(3.9-7.4)
DM duration (years)	<5	175(55.7)
	5-10	73(23.2)
	11-15	38(12.1)
	>15	28(8.9)
BMI (Kg/m^2) †	-	25.5(4.3)
BMI	<18.5	11(3.5)
	18.5-24.9	130(41.4)
	25-29.9	114(36.3)
	≥30	59(18.8)
WC (cm) †	-	93.6(18)
SBP (mmHg) †	-	123(14.3)
DBP (mmHg) †	-	79.2(9.2)
FBS (mg/dl) *	-	172(117-279)
TC (mg/dl) †	-	183.7(44.9)
TG (mg/dl) *	-	194.5(139.5-246)
HDL-c (mg/dl)*	-	48(38-60.2)
LDL-c (mg/dl) †	-	92.4(36.6)

*, values in median (interquartile range); †, values in mean (standard deviation).

the study conducted in other part of Ethiopia (Bekele et al., 2017) where the prevalence of dyslipidemia was 65.6%. We found that the prevalence of abnormal lipid profiles of low HDL-c, high LDL-c, TG and TC were 60.8, 14.3, 70.4 and 32.8%, respectively. The rate of low HDL-c, raised LDL-c, hypertriglyceridemia and hypercholesterolemia was lower than the finding reported from Jordan (Abdel-Aal et al., 2008) where 83.9, 91.5, 77.2, and 83.1% were the prevalence of low HDL-c, raised LDL-c, TC and TG, respectively. Conversely, lower

Table 2. Characteristics of Diabetes patients according to Body mass index grouping.

Parameter	BMI ≥25 kg/m^2	BMI <25 kg/m^2	P-value
	Mean ±SD (No=141)	Mean ±SD (No=173)	
Age (years)	50.4(9.5)	49.2(10.2)	0.27
WC (cm)	102.8(16)	82.3(13.5)	<0.0001
SBP (mmHg)*	125(110-135)	120(110-130)	<0.0001
DBP (mmHg)*	80(70-90)	76(70-86)	<0.0001
TC (mg/dl)	196.5(44)	167.9(40.9)	<0.0001
TG (mg/dl)*	215(162-271)	159(126-203)	<0.0001
LDL-c (mg/dl)	97.5(36.4)	86.1(35.9)	0.006
HDL-c (mg/dl)*	51(40-63)	46(36-55)	0.007
Uric acid (mg/dl)	6.6(2.7)	4.8(1.8)	<0.0001
FBS (mg/dl)*	187(135-316)	149(126-203)	0.005

*, values in median (interquartile range).

Table 3. Characteristics of Diabetes patients according to blood pressure grouping.

Parameter	BP ≥130/85 mmHg	BP<130/85 mmHg	P-value
	mean ±SD (n=89)	mean ±SD(n=225)	
BMI (Kg/m^2)	26.8(3.5)	25.1(4.4)	0.001
WC (cm)	100(20.2)	91.1(16.5)	<0.0001
TC (mg/dl)	194.4(45.6)	179.4(44)	0.008
TG (mg/dl)*	215(165-279)	176(135-229)	<0.0001
LDL-c (mg/dl)	99(36.7)	89.8(36.2)	0.049
HDL-c (mg/dl)*	46(38-60)	48(39-61)	0.91
Uric acid (mg/dl)	6.7(2.6)	5.4(2.3)	<0.0001
FBS (mg/dl)*	214(131-322)	165(115-264)	0.03

*, values in median (interquartile range).

rate of abnormal lipid profiles was reported from other similar region of South Ethiopia except LDL-c (Bekele et al., 2017). The variability may be attributed to the variations in individual's life style, geographical location, the rate of physical exercise performance.

We found that TC, LDL-c, uric acid and FBS were significantly higher among patients with BMI ≥25 kg/m^2 when compared to BMI <25 kg/m^2. SBP, DBP and TGs were significantly higher among patients with BMI ≥25 kg/m^2 when compared to those patients with BMI <25 kg/m^2. In addition, TGs indicated a significant positive correlation with BMI and uric acid. Moreover, TC showed a significant correlation with BMI, uric acid and FBS. Furthermore, a significant positive correlation of LDL-c was observed with WC, DBP, FBS and hypertension. Our study indicated that median TGs, mean TC and mean LDL-c were significantly higher among patients who had BMI ≥25 kg/m^2 (215, 196.5, and 97.5) compared to patients with BMI<25 kgm^2 (159, 167.9 and 86.1), respectively. Similarly, most studies have revealed that overweight to obese patients had high hyperlipidemia (Omotoye et al., 2016; Rao et al., 2016; Ranganathan et al., 2015) and this may increase the risks of cardiovascular related complications in DM patients. In addition, we found that TC, LDL-c and TGs levels were significantly higher in patients who had BP ≥130/85 mmHg when compared to patients with normal BP. This finding is in line with the report of Forhad et al. (2015), Rahman et al. (2016), and Choudhury et al. (2014). This revealed that hypertension has close association with dyslipidemia in DM patients. Conversely, one study revealed that dyslipidemia could not be worsening by the presence of hypertension in DM patients (Arshad et al., 2016). This non-correlation may be due to ethnic, geographical, life style and other factors.

The present study revealed statistically significant positive correlations between BMI and LDL-c, BMI and TC, and BMI and TGs in DM patients. This is in line with the study reported by Humaera et al. (2017) from Jatinangor population in Indonesia. Furthermore, different

Table 4. Prevalence of dyslipidemia among the study participants.

Variable	Category	N (%)	Dyslipidemia		P-value
			Yes	No	
			N (%)	N (%)	
Sex	Male	211(67)	187(88.6)	24(11.4)	0.029
	Female	103(33)	99(96.1)	4(3.9)	
Age(years)	<40	79(25.2)	74(93.7)	5(6.3)	0.087
	41-50	118(37.6)	110(93.2)	8(6.8)	
	51-60	77(24.5)	70(90.9)	7(9.1)	
	61-70	33(10.5)	27(81.8)	6(18.2)	
	>70	7(2.2)	5(71.4)	2(28.6)	
Residence	Urban	159(50.6)	144(90.6)	15(9.4)	0.75
	Rural	155(49.4)	142(91.6)	13(8.4)	
Ever drink alcohol	No	282(89.8)	257(91.1)	25(8.9)	0.94
	Yes	32(10.2)	29(90.6)	3(9.4)	
FHDM	No	259(82.5)	235(90.7)	24(9.3)	0.64
	Yes	55(17.5)	51(92.7)	4(7.3)	
Hyperuricemia	No	208(66.2)	184(88.5)	24(11.5)	0.02
	Yes	106(33.8)	102(96.2)	4(3.8)	
Duration of DM (years)	<5	175(55.7)	163(93.1)	12(6.9)	0.009
	5-10	73(23.2)	68(93.2)	5(6.8)	
	11-15	38(12.1)	29(76.3)	9(23.7)	
	>15	28(8.9)	26(92.9)	2(7.1)	
BMI	<18.5	11(3.5)	7(63.6)	4(36.4)	0.001
	18.5-24.9	130(41.4)	114(87.7)	16(12.3)	
	25-29.9	114(36.3)	107(93.9)	7(6.1)	
	>30	59(18.8)	58(98.3)	1(1.7)	
Raised BP	No	234(74.5)	209(89.3)	25(10.7)	0.06
	Yes	80(25.5)	77(96.2)	3(3.8)	

FHDM, family history of DM.

studies reported that a negative correlation between BMI and HDL-c (Humaera et al., 2017; Omotoye et al., 2016; Shamai et al., 2011; Babikr et al., 2016) however, we found that insignificant correlation between HDL-c and BMI and this is in line with the study reported from Tamil Nadu (Ranganathan et al., 2015).

The present study showed that a positive correlation between SBP and DBP with TGs. This is in support with the study of Lani et al. (2015) who revealed that there was a statistically significant correlation between TG and DBP; however, TC correlated with SBP.

We found that serum LDL-c, TC and TGs were significantly associated with uric acid. This in line with the study reported from US (Peng et al., 2015). Moreover, the level of uric acid increased in patients with coronary heart diseases (Sathiya et al., 2014). While, Kim et al. (2016) reported the correlation of uric acid with TGs. Furthermore, it was observed that FBS correlated with TC and LDL-c. Conversely, study report of Iranian adults indicated no correlation/association between FBS and lipid profile (Chehrei et al., 2007). The differences may be attributed to variation in glycemic control status of DM

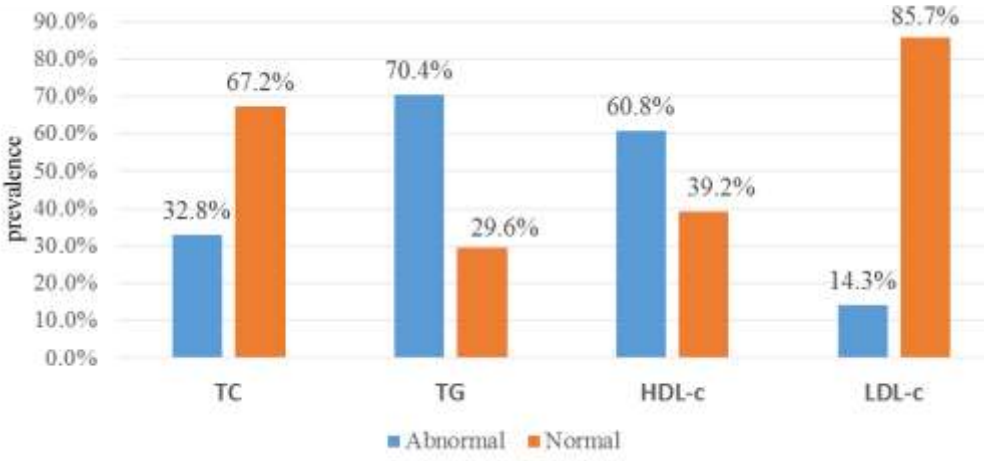

Figure 1. Prevalence of individual components of abnormal lipid profiles.

Table 5. Correlations of independent variables and each lipid profiles of diabetes patients.

Parameter	TC		HDL-c		LDL-c		TG	
	R	P-value	R	P-value	R	P-value	R	P-value
Age	0.04	0.51	0.03	0.54	0.007	0.91	0.05	0.38
DM duration	0.06	0.29	0.02	0.73	0.045	0.42	0.081	0.15
WC	0.274	<0.0001	0.06	0.28	0.160	0.005	0.319	<0.0001
SBP	0.108	0.06	0.03	0.59	0.068	0.23	0.177	0.002
DBP	0.109	0.05	0.075	0.18	0.05	0.38	0.192	0.001
BMI	0.326	<0.0001	0.078	0.17	0.189	0.001	0.326	<0.0001
Uric acid	0.298	<0.0001	0.241	<0.0001	0.042	0.46	0.553	<0.0001
FBS	0.132	0.02	0.054	0.34	0.173	0.002	0.031	0.58

patients.

Conclusion

This study showed a high prevalence of dyslipidemia and it was significantly higher in males when compared to females. BP, BMI, uric acid, FBS and WC appear to be correlated with the progression of dyslipidemia in type 2 diabetes and may assist as extrapolative factor for the progress of significant root causes of cardiovascular related diseases and deaths in developing countries. Therefore, lipid profiles should be checked periodically through treatment follow-up including anthropometric variables and BP management in order to limit risks of cardiovascular diseases in DM patients.

LIMITATION OF THE STUDY

The nature of the study design was cross-sectional and the findings of the study described only about a single point in time. We did not present the frequency of individual lipid profile based on National Cholesterol Education Program Adult Treatment Panel (NCEP-ATP) III criteria rather than the overall dyslipidemia, because the aim was assessing correlations.

CONFLICT OF INTERESTS

The authors declared that they have no conflict of interests.

ABBREVIATIONS

BMI: body mass index, **BP:** blood pressure, **DM:** diabetes mellitus, **FBS:** fasting blood Sugar, **HDL-c:** High-density lipoprotein cholesterol, **LDL-c:** low-density lipoprotein cholesterol, **NCEP:** National Cholesterol Education Program adult treatment panel, **TC:** total cholesterol, **TGs:** triglycerides; **SPSS:** Statistical

Package for Social Sciences, **WC:** waist circumference.

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