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Full Length Research Paper

Prevalence of metabolic syndrome using NCEP-ATPIII and ınternational dietetics federation (IDF) definitions: A cross- sectional study in Turkish adults

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To estimate the prevalence of metabolic syndrome using ınternational dietetics federation (IDF) versus National cholesterol education program; adult treatment panel III (NCEP-ATPIII) definitions in Turkish adults. A cross-sectional study was conducted on a total of 1531 (male 758 and female 773) Turkish adults, aged between 20 to 64 years. Subjects were randomly selected from the general population of Ankara. The overall prevalence of MetS, as defined by NCEP-ATPIII and IDF was 48.2 and 56.4%, respectively. The agreement between National cholesterol education program (NCEP) and IDF definitions was substantial (kappa: 0.79). The prevalence was increased significantly according to increasing age in women, but was not different by age group in men. The prevalence of MetS in all age groups was higher in women. Hypertriglyceridemia and low High-density lipoprotein cholesterol (HDL-C) were the criteria of metabolic syndrome (MetS) with the highest prevalence. According to IDF criteria, the frequency of participants with high fasting plasma glucose (FPG) and Waist circumference (WC) was higher than the participants with adult treatment panel III (ATP III) criteria. The prevalence of the MetS was found to be very high, especially in women. The IDF definition resulted in a higher prevalence of metabolic syndrome than the NCEP-ATPIII in the entire Turkish population. The agreement between the IDF and NCEP definitions for metabolic syndrome was very good.

Key words: Metabolic syndrome, NCEP-ATPIII, IDF, adult.

INTRODUCTION

Metabolic syndrome (MetS) is a constellation of interrelated risk factors including hypertension, dyslipidemia (low levels of HDL-C, elevated triglycerides (TG), obesity, insulin resistance and elevated blood glucose that increase the risk for cardiovascular disease and type 2 diabetes mellitus (Kirkendoll et al., 2010; WHO Consultation, 1999). Various definition criteria of MetS are currently available. The first proposed criteria for the diagnosis of MetS were from the World Health Organisation (WHO) (WHO, 1999), followed by the European Group for the Study of Insulin Resistance (EGIR) (Balkau and Charles, 1999), and subsequently from the NCEP ATP III (NCEP, 2001; Cheal et al., 2004) Expert Panel and the IDF (IDF, 2006). Although these organizations have proposed measuring the same components, they have suggested different combinations and different cut-off points. Therefore, the prevalence of MetS varies according to the diagnostic criteria used (Can and Bersot, 2007; Day, 2007; Lechleitner, 2008; Cornier et al., 2008) and different countries have reported varying MetS prevalence rates depending on the definition used. Estimates of prevalence using the IDF criteria are often slightly higher than when the NCEP: ATPIII definition of MetS is used within the same population (Can and Bersot, 2007; Skilton et al., 2007; DECODA, 2007; Deepa et al., 2007). Within each

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definition, the prevalence of metabolic syndrome increases with age and varies with gender and ethnicity. Furthermore, there is lack of diagnostic concordance between different definitions. Generally, approximately 30% of people could be given a diagnosis of MetS using most definitions, and about 35 to 40% of people diagnosed with MetS are classified as such using only one definition (Day, 2007). With this background, the objective of the present study was to estimate the prevalence of MetS using the IDF and NCEP-ATPIII definitions in Turkish adults.

MATERIALS AND METHODS

A cross-sectional study was conducted on total of 1531 (male 758 and female 773) Turkish adults, between the ages of 20 to 64 years. We used data of people who had fasting plasma glucose (FPG) and lipid profile analyses in the last month. Participants who had not had FPG analyses and lipid profile analyses in the last month were excluded from the study. The participants were informed about the subject, purpose and rules of the research. Each participant signed a voluntary participation form which adhered to Declaration of Helsinki protocols (World Medical Association). The study was approved by the Gazi University Faculty of Health Sciences. In this study, the following criteria were investigated:

(a) General information and anthropometric measurements were taken by trained dieticians and with participants wearing light clothes and no shoes. A portable scale was used to measure body weight to the nearest half-kilogram. Height was measured to the nearest 0.1 cm with a wall-mounted stadiometer. WC was measured above the iliac crest and below the lowest rib margin at minimum respiration. Hip circumference (HC) was measured at the widest part of the hip at the level of the greater trochanter to the nearest half-centimeter (Lohman et al., 1988). The waist and hip circumferences were measured with a flexible tape.
(b) Measurement of blood pressure (BP; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure) was measured after 10 min resting in a sitting position, and was expressed as the average of three consecutive measurements taken from each arm,
(c) We used data of participants who had lipid profile and fasting plasma glucose analysis in the last month. Subjects were included who had any chronic diseases in the study. Measurement of FPG was obtained from subjects not receiving insulin and/or oral hypoglycaemic agents.
(d) Fasting plasma lipids and concentrations of triglycerides (TG), HDL-C and total cholesterol (TC) were analyzed and low-density lipoprotein cholesterol (LDL-C) concentrations were calculated. Early-morning venous blood samples were obtained from each participant for biochemical screening tests, following a twelve-hour overnight fast. Professional staff performed venipuncture by using vacutainers to obtain 15 ml of whole blood. Blood was centrifuged for plasma separation at government hospitals where the actual biochemical analyses were performed. The LDL-C was calculated using the formula of Friedewald and colleagues: LDL-C= TC - (HDL-C + (TG/5) (Mikkola et al., 2007).

Definition of metabolic syndrome

The IDF definition (IDF, 2006) requires central abdominal obesity as a mandatory component for the diagnosis of MetS. Additionally, the IDF criteria require any two of the four components below:

- Abdominal obesity; WC greater than 94 cm in men or greater than 80 cm in women.
- High TG (150 mg/dL or greater).
- Low HDL cholesterol (less than 40 mg/dL in men or less than 50 mg/dL in women).
- Hypertension (130/85 mmHg or greater).
- Hyperglycemia (100 mg/dL or greater).

MetS was also defined analogous to the NCEP: ATP III criteria (Cheal et al., 2004) definition, which requires the presence of at least three or more of the five components of the following categorically-defined risk factors below:

- Abdominal obesity; WC greater than 102 cm in men or greater than 88 cm in women.
- High TG (150 mg/dL or greater).
- Low HDL cholesterol (less than 40 mg/dL in men or less than 50 mg/dL in women).
- Hypertension (130/85 mmHg or greater).
- Hyperglycemia (110 mg/dL or greater).

The participants were informed about the subject, purpose and rules of the research and each participant signed a voluntary participation form.

Data analysis

Data analysis was carried out using SPSS version 13.0 software (SPSS Inc., Chicago, IL, USA). The descriptive statistics of means with 95% CI were used to summarize the data collected. Means were compared by using ANOVA according to body mass index (BMI) classification and the data were analyzed by independent sample t-tests for the definition criteria. The agreement between the two definitions of MetS was determined by the kappa statistic (κ). The level of agreement is considered poor with $\kappa \le 0.20$, fair with $\kappa = 0.21$ to 0.40, moderate with $\kappa = 0.41$ to 0.60, substantial with $\kappa = 0.61$ to 0.80, and very good with $\kappa > 0.80$. In all analyses, 5 and 1% significance levels were used.

RESULTS

The mean age of the study population was 45.4±10.9 years (men: 45.2±10.86 years, women: 45.6±10.99 years) ($p>0.05$). In the study, overweight and obesity were seen in 32.8% (502/1531) and 22.2% (340/1531) in men and women of the study group, respectively (Figure 1). Thus, it was worth noting that 54.9% of the Turkish adults who participated in this study had a BMI exceeding 25 kg/m^2. The overall prevalence of MetS according to the IDF and NCEP ATP III criteria were found to be 51.5 and 41.6% for men, and 61.1and 54.9% for women, respectively. The prevalence of MetS increased with increasing age up to 60 to 65 years. In all age groups, women were more often diagnosed than men. Various combinations and components by which the subjects fulfilled the criteria of MetS (according to the IDF and NCEP ATPIII criteria) are presented in detail in Tables 1 and 2. Generally, regarding IDF and ATP III criteria, prevalence of MetS and its components increased in parallel with increasing BMI values.

According to IDF criteria, among the participants with

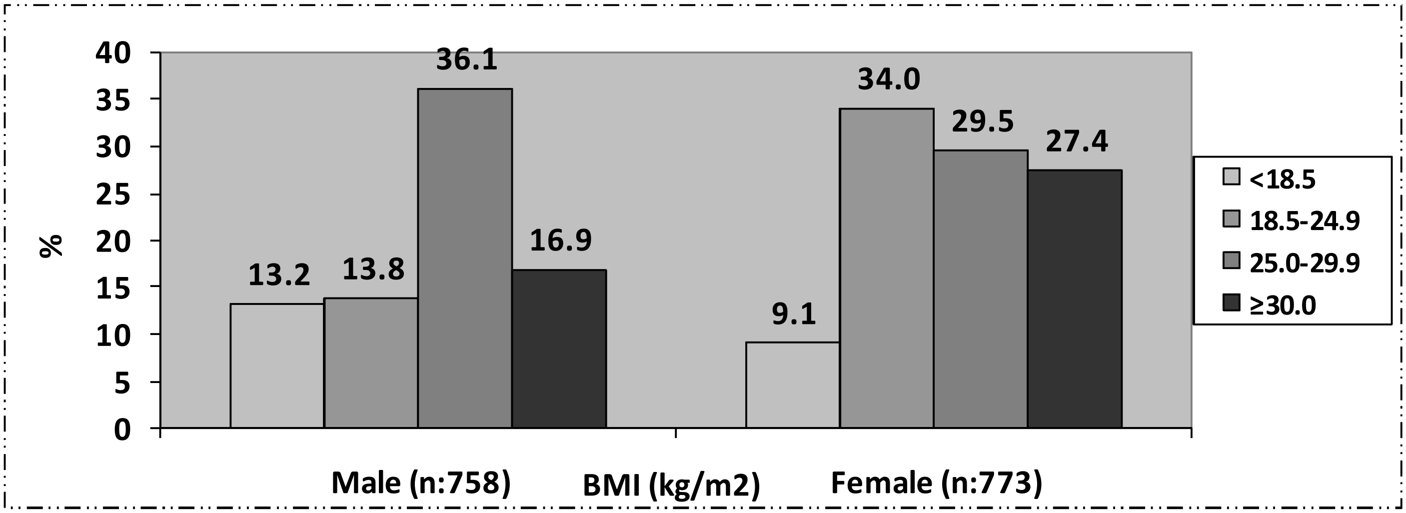

Figure 1. Distribution of participants according to BMI classification (kg/m^2).

Table 1. Metabolic syndrome components in Turkish male (n: 382) and female (n: 517) adults in connection with different categories of BMI (kg/m^2) according to IDF criteria.

	BMI (kg/m^2)			
	Underweight	**Normal**	**Overweight/obese**	
	Mean (±SD)	**Mean (±SD)**	**Mean (±SD)**	**p**
Male	(n=57)	(n=59)	(n=266)	
WC (cm)	97.0±8.23	100.3±10.31	101.2±9.80	<0.001
FPG (mg/dL)	97.2±23.32	102.8±34.20	109.8±43.11	0.008*
TG (mg/dL)	149.8±73.03	130.6±60.81	205.1±122.82	<0.001
HDL-C (mg/dL)	37.7±10.17	40.2±12.44	38.4±9.72	0.115
SBP (mm Hg)	125.1±20.88	128.4±19.91	130.7±20.95	0.048*
DBP (mm Hg)	80.3 ±12.51	80.7±11.80	83.4±11.52	<0.001
MetS	3.2±1.28	3.1±1.17	3.7±1.32	0.001*
Female	(n=32)	(n=114)	(n=371)	
WC (cm)	86.0±5.44	92.9±7.93	98.1±11.22	<0.001*
FPG (mg/dL)	97.9±20.71	100.2±36.98	107.1±47.59	0.070
TG (mg/dL)	144.4±84.88	147.4±106.6	176.5±83.52	<0.001*
HDL-C (mg/dL)	42.4±9.54	46.7±11.6	44.2±11.19	0.534
SBP (mm Hg)	124.4±23.44	129.9±23.3	132.2±20.79	0.318
DBP (mm Hg)	78.3±14.36	81.0±12.43	83.4±11.52	0.011*
MetS	3.2±1.21	3.1±1.22	3.6±1.40	0.001*

WC: Waist circumference, FPG: fasting plasma glucose, TG: triglycerides, HDL-C: high density lipoprotein cholesterol, SBP: systolic blood pressure, DBP: diastolic blood pressure, MetS: metabolic syndrome * *p<0.05*.

abdominal obesity, the mean of MetS gradually increased in overweight/obese (*p<0.001*) subjects (Table 1), whereas no relationship was found between BMI and the mean of MetS in women according to the NCEP ATP III criteria (*p>0.05*) (Table 2). The mean WC, FPG, TG, SBP, and DBP were significantly higher in overweight/obese males (*p<0.05*) whereas no differences was found in FPG, HDL-C and SBP levels among the females according to BMI classification (*p>0.05*) (Table 1). According to ATP III criteria, in males only the mean TG levels was found statistically high in overweight/obese (*p<0.001*) whereas in females it was found significant

Table 2. MetS components in Turkish males and females adults in connection with different categories of BMI (kg/m^2) according to ATP III criteria.

	BMI (kg/m^2)			
	Underweight	**Normal**	**Overweight/obese**	
	Mean (±SD)	**Mean (±SD)**	**Mean (±SD)**	**p**
Male (n: 171)	(n=17)	(n=30)	(n=124)	
WC (cm)	105.3±3.49	108.1±4.50	108.6±7.74	0.247
FPG (mg/dL)	106.5±32.85	112.5±37.36	113.1±43.8	0.797
TG (mg/dL)	158.1±103.20	121.8±60.67	215.7±128.3	<0.001*
HDL-C (mg/dL)	34.8±8.81	38.5±13.45	36.8±9.68	0.072
SBP (mm Hg)	128.2±24.68	133.5±21.09	136.2±21.65	0.246
DBP (mm Hg)	83.2±14.35	83.3±11.18	86.3±11.89	0.129
MetS	3.4±1.37	3.2±1.22	3.9±1.23	0.032*
Female (n: 398)	(n=8)	(n=83)	(n=307)	
WC (cm)	92.9±6.39	96.3±6.41	101.1±9.92	<0.001*
FPG (mg/dL)	107.5±17.94	98.7±29.23	108.8±48.76	0.364
TG (mg/dL)	155.8±122.79	141.1±65.89	181.8±86.57	<0.001*
HDL-C (mg/dL)	37.7±6.54	467.0±10.51	44.0±11.64	0.185
SBP (mm Hg)	129.0±17.10	131.9±25.17	134.2±20.82	0.717
DBP (mm Hg)	82.5±7.07	81.6±13.14	84.7±11.47	0.216
MetS	3.5±1.06	3.1±1.17	3.68±1.32	0.082

WC: Waist circumference, FPG: fasting plasma glucose, TG: triglycerides, HDL-C: high density lipoprotein cholesterol, SBP: systolic blood pressure, DBP: diastolic blood pressure, MetS: metabolic syndrome * *p<0.05*.

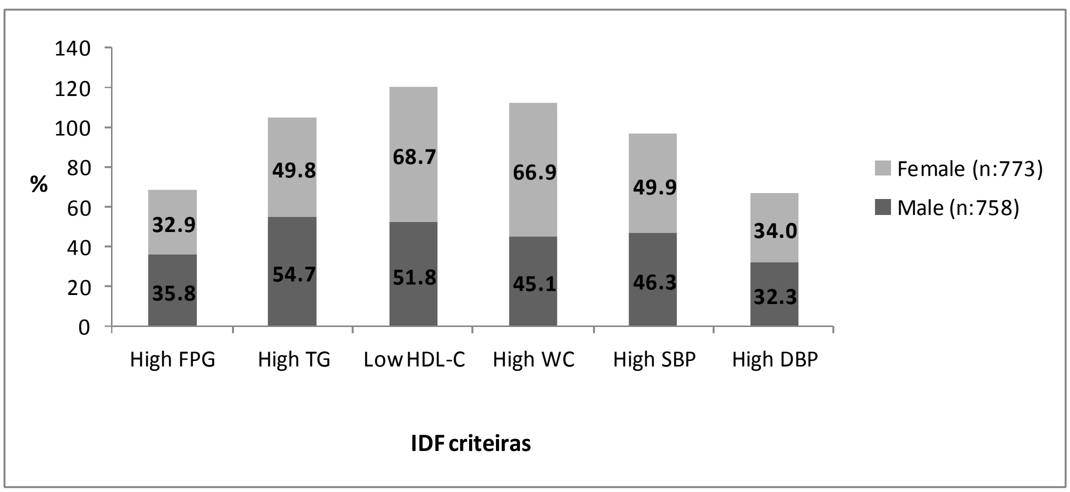

Figure 2. Prevalence of the various components of MetS and the contribution by gender according to IDF criteria; FPG: Fasting plasma glucose, TG: triglycerides, HDL-C: high density lipoprotein cholesterol, WC: waist circumference, SBP: systolic blood pressure, DBP: diastolic blood pressure.

differences in WC and TG levels (*p<0.001*) (Table 2).Hypertriglyceridemia and low HDL-C were the criteria of MetS with the highest prevalence (Figures 2 and 3). According to IDF criteria, the frequency of participants with high FPG and WC were higher than the participants according to the ATP III criteria.

DISCUSSION

The variability in prevalence estimates reflects the different cut-off points and different combinations of criteria among the various definitions of MetS. The prevalence estimates of NCEP-ATPIII and IDF definitions

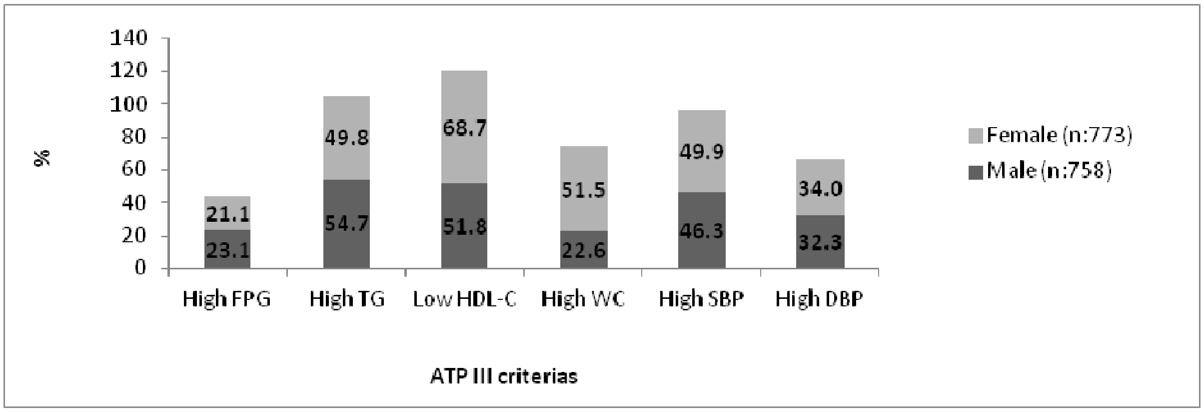

Figure 3. Prevalence of the various components of MetS and the contribution by gender according to ATP III criteria; FPG: Fasting plasma glucose, TG: triglycerides, HDL-C: high density lipoprotein cholesterol, WC: waist circumference, SBP: systolic blood pressure, DBP: diastolic blood pressure.

are close to each other (Can and Bersot et al., 2007). Although there are divergent criteria for the identification of MetS, they all tend to agree that the core components of MetS include obesity, WC, FPG and hypertension (Cornier et al., 2008). Regardless of the definition criteria, MetS prevalence increased in parallel with increasing BMI (Mikkola et al., 2007). In the present study, the prevalence of overweight was 32.8% (36.1% in men and 29.5% in women) and the prevalence of obesity was 22.2% (16.9% in men and 27.4% in women). Among Turkish adults, the prevalence of being overweight is similar to that of Europe, whereas the prevalence of obesity among women is higher than the European average. Previous studies have found the prevalence of overweight as 36.0% (41.5% in men and 30.6% in women) and the prevalence of obesity as 30.4% (20.6% in men and 39.9% in women) in Turkey (Oğuz et al., 2008). The Turkish population has one of the world's highest prevalence of MetS. This suggests a greater burden of MetS in our population compared with most developed countries (Abate, 2000; Thomas et al., 2000; Das, 2002). The results of this study showed that the overall prevalence of MetS, as defined by the NCEP-ATPIII and IDF, was 48.2 and 56.4%, respectively.

This prevalence's are higher when compared with the American, Greek and European populations (Ford et al., 2002; Athyros et al., 2005; Qiao, 2006). Although obesity and level of physical activity contribute significantly to the frequency of MetS, other factors, such as a genetic predisposition, may play a role (Abate, 2000; Thomas et al., 2000; Das, 2002). Similarly to our study, in previous studies, assessment of MetS using the IDF criteria identified a higher number of subjects than the NECP-ATPIII definition (DECODA, 2007; Deepa, 2007; Ucar et al., 2009; Lima et al., 2009; Valenzuela et al., 2007; Moebus et al., 2007). Another study conducted on Turkish adults (532 men and 1036 women) showed that age- and sex-adjusted prevalence of MetS was 38% by NECP-ATPIII and 42% by IDF, but similar to our study, the agreement between NCEP and IDF definitions was substantial (kappa: 0.77) (Day, 2007). The kappa value of the agreement between the IDF and NECP-ATPIII definitions was 0.79 in our study. In this study, the prevalence of MetS was different between men and women according to ATPIII and IDF, and it was higher in women than men in all age groups (*$p<0.05$*). The prevalence increased significantly according to increasing age in women, but was not different by age group in men. Although in some countries, MetS is more prevalent among women (Ramachandran et al., 2003; Gupta et al., 2004; Kim et al., 2004; LEE, 2006), in others, the prevalence of the syndrome is similar in both genders (Chuang et al., 2004; Duc, 2005; Enkhmaaa et al., 2005; Thomas et al., 2005).

In earlier studies, the prevalence of MetS and its components was shown to increase in parallel with BMI (Cook et al., 2003; Weiss et al., 2004). In our study, according to the classification of NCEP ATP III criteria, no relationship was found between BMI and the prevalence of MetS in women (*$p>0.05$*), whereas according to IDF classification, the prevalence of MetS increased with BMI in both genders (*$p<0.05$*). These results are similar to our findings (Mikkola, 2007). The definitions of abdominal obesity and high FPG differ between the IDF and ATPIII criteria, but definitions of the other components are the same. In addition, IDF criteria presuppose the presence of abdominal obesity. Thus, stricter criteria for normal values of WC and FPG or the prerequisite of abdominal obesity could lie behind the higher prevalence of the MetS as defined by IDF (2006).

In the present study, hypertriglyceridemia and low HDL-C were the criteria of MetS with the highest prevalence. In Asian countries, the prevalence of MetS is very high and a low HDL-C is the prevalent abnormality (Qiao, 2006). A high prevalence of low HDL-C has been previously reported in Turkey (Mahley et al., 1995; Onat et al., 1999), but the frequency of the low HDL component of MetS is not higher in the Turkish population than in the American population (Jacobson et al., 2004). Our results have shown that, according to IDF criteria, the frequency of participants with high FBG and WC was higher than the frequency of participants fulfilling the ATP III criteria. Valenzuela et al. (2007) analyzed data from a random subsample of 1,833 adults 17 years and older, based on the NCEP ATP III Update 2004 and the IDF 2005 criteria. The results of this study were that the prevalence of MetS components was 46, 30 and 52.6% for hypertension, high triglycerides and low HDL-C, respectively (common to both criteria). The prevalence of high WC was 29.7 and 59.4% for ATPIII and IDF, respectively.

In conclusion, the prevalence of the MetS in the adult Turkish population is very high, especially in women. Also, the IDF definition resulted in an increase in the prevalence of MetS, whereas the agreement between the IDF and NCEP definitions for MetS was substantial. The high prevalence of MetS in Turkey is associated with an increase in the incidence of coronary artery disease and diabetes, which are already high compared with most developed or developing countries. These results indicate that a greater emphasis should be laid on MetS management. Adoption of healthy lifestyle behaviours in mid-life has beneficial health outcomes. Thus, developing culturally-relevant interventions that are effective in helping people with MetS are needed to reduce the long-term negative outcomes.

Abbreviations

HDL-C, High-density lipoprotein cholesterol; **IDF,** international dietetics federation; **NCEP-ATPIII,** national cholesterol education program; adult treatment panel III; **NCEP,** national cholesterol education program; **MetS,** metabolic syndrome; **TG,** triglycerides; **WHO,** world health organization; **EGIR,** European group for the study of insulin resistance; **WC,** waist circumference; **HC,** hip circumference; **BP,** blood pressure; **SBP,** systolic blood pressure; **DBP,** diastolic blood pressure; **FPG,** fasting plasma glucose; **TG,** triglycerides; **TC,** total cholesterol; **LDL-C,** low-density lipoprotein cholesterol; **BMI,** *body mass index.*

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