Original paper

Evaluation of Lifestyle Characteristics among Patients with Metabolic Syndrome in AL-Najaf 2022

Rand A. Al-Ogaili[1], Shahrazad S. Al Jobori[2], Shaymaa A. Alfedhul[3]

[1]*Al Najaf Health Directorate, Al Najaf, Iraq*
[2] *College of Medicine, University of Kerbala. Karbala, Iraq*
[3] *College of Medicine, University of Kufa, Al Najaf, Iraq*

Article information:

Received: 2023-06-14
Accepted: 2022-08-15
Vol. 16, No. 1, Aug, 2023.

Correspondence: Rand A. Al-Ogaili
Email: randalaanaser1990@gmail.com

Abstract

Background: A grouping of many metabolic risk factors, such as central obesity, hypertension, hyperglycemia, and dyslipidemia, known as the metabolic syndrome, can coexist in the same person. Globally, it is estimated that 25% of the adult population can be characterized as having metabolic syndrome.

Objectives: To evaluate the demographic and clinical charecteristics of metabolic syndrome patients and to assess the association of some lifestyle risk factors and the components of metabolic syndrome. This study also aimed to assess gender differences regarding demographic, clinical and lifeslyle risk factors.

Methods: A cross-sectional study was carried out in The Specialist Center of Endocrine Disease and Diabetes in Al- Alsader Medical City.

The diagnosis of metabolic syndrome was confirmed according to the recently (2009) revised International Diabetes Federation definition.

Each patient's data were collected through a 15-minute direct interview using a self-structured questionnaire. The questionnaire included information about demographic, anthropometric measurements, biochemical tests, physical measurements, and lifestyle information.

Results: This study found that Physical activity was irregular among the majority of the study participants (54.0%), smokers formed (38.0%) of the study participants, and Body-mass index of the study participants ranged from (22.3 kg/m2) to (42.8 kg/m2). Females had significantly higher BMI (34.9 ± 3.4 kg/m2) compared to males (30.3 ± 3.0 kg/m2). A multiple linear regression was calculated to predict MetS characteristics based on smoking, BMI, and irregular physical activity. Smoking was a significant predictor with P-value < 0.001 for all MetS components.

Conclusion: Patients with Metabolic syndrome are more commonly males, aged 50-69 years, of lower educational level, and urban residents. Males with metabolic syndrome had a higher systolic and diastolic Blood pressure, additionally; they had higher serum cholesterol, triglycerides, and waist circumference than females.

A significant number of patients with metabolic syndrome had risky behaviors including smoking, irregular physical activity, and obesity.

Key words: Metabolic syndrome (MetS), Physical activity, BMI, Obesity, Lifestyle characteristic

Introduction

The term "metabolic syndrome" (MetS) describes a grouping of many metabolic risk factors that co-occur in the same person, such as central obesity, hypertension, hyperglycemia, and dyslipidemia. It increases cardiovascular morbidity and mortality and has been related to various cancers, including breast, pancreatic, colon, and liver cancer [(1)].

Metabolic syndrome itself also caused a lot of controversy, clinical definitions and diagnostic criteria. The terms “syndrome X”, “pluri-metabolic syndrome”, “Reaven's syndrome”, “the deadly quartet”, “the awesome foursome”, “the metabolic syndrome” and many other terms were used [(2)].

Three aberrant results out of five would be required to diagnose someone with the metabolic syndrome, according to a 2009 conference of many key organizations to try and harmonize the criteria. Waist measurement would still be a valuable initial screening tool [(2)].

Following that, both the world Health Organization (WHO) and National Heart, Lung, and Blood Institute (NHLBI) began reevaluating their definition of the metabolic syndrome in order to create a new declaration with the goal of having a single, universally accepted set of diagnostic criteria [(2)].

These organizations each have their own set of clinical definitions and diagnostic standards. All of these criteria accept that obesity, hypertension,

dyslipidemia, and abnormalities of glucose metabolism are all aspects of the metabolic syndrome [3].

Numerous ethnic groups, including European Americans, African Americans, Mexican Americans, Asian Indians, Chinese, Australians, Aborigines, Polynesians, and Micronesians, have a high prevalence of the Metabolic Syndrome, according to epidemiological research [4].

The primary risk factors for MetS include high blood pressure, dyslipidemia (increased triglycerides and reduced HDL cholesterol), elevated fasting glucose, inactivity, and excessive calorie consumption, which lead to central obesity and insulin resistance [5].

According to studies, 25% of adult people worldwide are thought to have metabolic syndrome. The incidence of metabolic syndrome is expanding quickly in both the developed and developing worlds due to the worldwide obesity epidemic and obesity, which are both important components of metabolic syndrome [6].

Individuals with metabolic syndrome (MetS) have a fivefold increased risk of type II diabetes and a twofold increased risk of cardiovascular disease. The metabolic syndrome refers to the risk for cardiovascular disease and type II diabetes mellitus, which occur together more frequently than by chance alone.

Patients and Methods

This cross-sectional study included a Purposive sample of 100 Iraqi individuals, 54 male and 46 female, aged more than 18 years, visiting outpatient clinic of Al-Najaf Center for Diabetes and Endocrine in AL-Najaf-Ashraf province/Iraq, who fit metabolic syndrome criteria. Data was collected over a half year (March 2022- August 2022). Protocol was done in March; we needed 2-3 days/week, at average of 3-4 hours/day. Each patient data was collected through a 15-minuts direct interview using a questionnaire.

Study variables:

Demographic variables: The level of education is categorized as illiterate, primary (grade 1 to 6), intermediate (grade 7–9), and high school (≥10 grade). On the basis of occupation related data, participants were categorized into employed, self-employed (running their own business or farming), household work, and unemployed (student, non-paid worker, or retired) [3]. Physical inactivity assessed based on the International Physical Activity Questionnaire (IPAQ). This questionnaire assesses the intensity and frequency of weekly physical activity, which categorized to routine daily task, regular physical activity, and irregular physical activity. This questionnaire can be answered affirmatively (yes) or negatively (no) [6,7].

Anthropometric variables: The body height is the measurement of the angle between the vertex at the top of the head and the base of the feet [8,9]. Similarly, a weighing machine of Marubeni Company was used to measure weight to the nearest 0.1 kilograms (kg). Participants were classified as underweight (<18.5 kg/m2), normal (18.5–24.9 kg/m2), overweight (25–29.9 kg/m2), or obese (> 30 kg/m2) based on their body mass index [10].

Using a plastic, non-stretchable measuring anthropometric tape from the horizontal plane at the umbilical level, the waist circumference (WC) was measured once in centimeters. If a participant's waist measured more than 88 cm for a woman and more than 102 cm for a man, their waist circumference was considered raised [8,10].

Biochemical variables: In the lab, 2 ml of blood were collected to test the fasting lipid profile and fasting blood sugar levels. High total cholesterol (>200 mg/dl), high triglycerides (>150 mg/dl), high low-density lipoprotein (>130 mg/dl), low high-density lipoprotein (40 mg/dl in men and 50 mg/dl in women), and/or usage of antilipidemic medications were all considered to be signs of dyslipidemia [11,12].

Inclusion criteria: Individuals were included in the current study, which their nationality was Iraqi and aged between 18-64years, they were screened for MS criteria. The diagnosis of metabolic syndrome (MetS) was confirmed according to the recently (2009) revised International Diabetes Federation definition, according to which it is necessary to present three of the five risk factors (WC ≥94 cm in men and ≥80 in women; TG ≥ 150 mg/dL (1.7 mmol/L); HDL-c < 40 mg/dL (1.0 mmol/L) in men and <50 mg/dL (1.3 mmol/L) in women; systolic blood pressure ≥ 130 and diastolic ≥ 85 mmHg); fasting glucose ≥ 100 mg/dL).

Exclusion criteria: Individuals who were diagnosed with Type1DM, physical disabilities, severe chronic illness requiring bed rest, active liver injury, mental disability and pregnant women were excluded.

Ethical approval: The current study was approved by the Iraqi Ministry of Higher Education and Scientific Research. After Kerbala Medical College Ethical Committee approved the study protocol, a written official letter was obtained from the University of Kerbala-Collage of Medicine to Alsader Medical City from which other official

documents were sent to the specialized center of endocrine and diabetic in AL-Najaf city. Each patient's verbal agreement was obtained before starting to collect information. The questionnaire was anonymous and personal information was collected with serial identification numbers without an identity. Complete confidentiality was ensured and all the collected data will be used for research purposes only.

Pilot study: Before starting to collect information, pilot study was carried out through two weeks. The pilot study included 10 patients, who attended the diabetes center in Al-Sader Medical City, Najaf/Iraq.

Results

This study included a total of (100) patients diagnosed with metabolic syndrome, age of the participants ranged from 35 to 72 years with a mean age of (54.98 ± 7.78) years and a median age of 55 years. Age groups distribution of the study participants is illustrated in Figure (1).

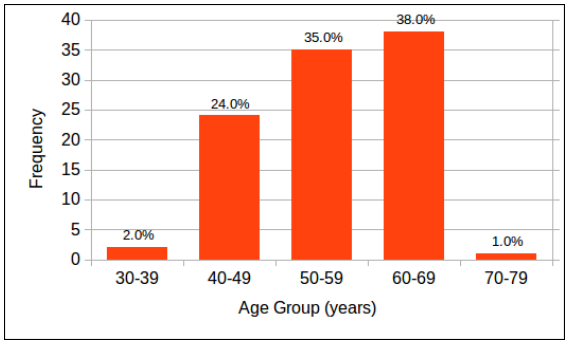

Figure 1. Age group distribution among study patients (n=100)

Demographic characteristics of the study participants are summarized in table (1), which revealed that majority of participants (95%) were married, about half of them were of male gender, and almost all of them were living in urban areas. More than two-third of the participants (72%) had primary education, with almost equal proportions between males and females (47.2% vs. 52.8%, respectively). Largest proportion of males had free job, while largest proportion of females were housewives.

Clinical characteristics among study participants are detailed in table (2), which revealed the mean and stander deviation of metabolic syndrome components as following: Systolic BP (155.5 ± 11.6mmHg), Diastolic BP (94.8 ± 11.6mmHg), FBS (255.6 ± 68.9 mg/dl), Serum Cholesterol (221.8 ± 35.6 mg/dl), Triglycerides (210.3 ± 34.4 mg/dl), Waist circumference (108.0 ± 6.8cm).

Significant differences to male were observed regarding systolic blood pressure, diastolic blood pressure, serum cholesterol, triglyceride and waist circumference, with P-values of (<0.001, <0.001, 0.050, 0.016 and <0.001, respectively), as detailed in table (3).

Comparison between males and females regarding lifestyle characteristics revealed that there are significant differences in smoking and irregular physical activity, with P-value of (<0.001, 0.019, respectively).

Regarding smoking, the male participants formed (100%) of the study participants, similarly, irregular physical activity formed (64.8%) of male gender and (35.2%) of female gender as detailed in table 4

Table 1. Demographic characteristics of the study participants

Characteristics		Gender		Total
		Male	Female	
Marital Status	Single	-	1(100%)	1(1.0%)
	Married	52(54.7%)	43(45.3%)	95(95.0%)
	Divorced	1(50.0%)	1(50.0%)	2(2.0%)
	Widow/Widower	1(50.0%)	1(50.0%)	2(2.0%)
Residence	Urban	53(53.5%)	46(46.5%)	99(99.0%)
	Rural	1(100%)	-	1(1.0%)
Education	Illiterate	12(75.0%)	4(25.0%)	16(16.0%)
	Primary	34(47.2%)	38(52.8%)	72(72.0%)
	Secondary	4(80.0%)	1(20.0%)	5(5.0%)
	College and higher	4(57.1%)	3(42.9%)	7(7.0%)
Occupation	Housewife	-	42(100%)	42(42.0%)
	Free Job	47(97.9%)	1(2.1%)	48(48.0%)
	Employee	4(66.7%)	2(33.3%)	6(6.0%)
	Retired	3(75.0%)	1(25.0%)	4(4.0%)

Table 2. Clinical characteristics of the study participants (n=100)

Heading		Frequency	Percentage (%)
Hypertension		100	100%
Systolic BP in mm Hg	Mean ± SD	155.5 ± 11.6	
Diastolic BP in mm Hg	Mean ± SD	94.8 ± 11.6	
Diabetes		98	98.0%
FBS in mg/dl	Mean ± SD	255.6 ± 68.9	
Serum Cholesterol in mg/dl	Mean ± SD	221.8 ± 35.6	
Triglycerides in mg/dl	Mean ± SD	210.3 ± 34.4	
Waist circumference in centimeters	Mean ± SD	108.0 ± 6.8	

Table 3. Comparison between males and females regarding clinical characteristics

Variable	Mean ± SD		P-value
	Male (n=54)	Female (n=46)	
Systolic BP in mm Hg	160.1 ± 11.4	150.2 ± 9.5	< 0.001*
Diastolic BP in mm Hg	101.1 ± 10.8	87.5 ± 7.5	< 0.001*
FBS in mg/dl	262.1 ± 77.8	247.9 ± 56.7	0.305
Serum Cholesterol in mg/dl	228.1 ± 39.7	214.5 ± 28.8	0.050*
Triglycerides in mg/dl	217.9 ± 33.5	201.4 ± 33.7	0.016
Waist circumference in centimeters	111.9 ± 4.9	103.3 ± 5.7	< 0.001*

* Significant at P ≤ 0.05

Table 4. Comparison between males and females regarding lifestyle characteristic

Variable		Gender		Total	P-value
		Male	Female		
Smoking	**Yes**	46(100%)	-	46(100%)	<0.001*
	No	8(14.8%)	46(85.2%)	54%(100%)	
Irregular physical activity	**Yes**	35(64.8%)	19(35.2%)	54(100%)	0.019*
	No	19(41.3%)	27(58.7%)	46(100%)	
BMI	**Mean ± SD**	30.3 ± 3.0	34.9 ± 3.4	32.4 ± 3.9	<0.001*

* Significant at P ≤ 0.05

Discussion

Metabolic syndrome's (MetS) high prevalence is a global issue. Because of the concurrent growth in obesity prevalence, this prevalence appears to be rising [13]. The metabolic issues brought on by obesity and metabolic vulnerability is of concern to many different medical specialties. One of them is the MetS, which is frequently considered to be a risky cardiovascular health issue [1].

In spite of limited study about metabolic syndrome prevalence in Iraq, it is high in all other previous studies done, regardless of the criteria used [3].

In our cross-sectional study, which targeting 100 patients aged 18-64 years, the mean age was 54.9 years approximately three quarters of them were above 50 years, more than half of them were males and the remaining were females, 72.0 % had primary education. Similar results were found in Iraqi analysis using nationally cross-sectional data from the "2015 Iraq STEPS survey" [14], additionally, several studies showed an increased risk of MetS in people with lower education [14], which was confirmed in our study. Persons with lower education may have lesser knowledge on health risk behavior/s that is implicated in the development of MetS.

The study found a significant rural-urban difference, thus a 99.0% were urban residence, which is slightly different from the results of previous studies conducted in Iraq, this could mean that MetS risk behavior (sedentary lifestyle, stress and diet changes) have been invaded urban life more than rural; furthermore, the setting of study could make a quite difference in the sample collection [14,15].

Significant differences were observed between males and females regarding systolic blood

pressure, diastolic blood pressure, serum cholesterol, and waist circumference, with P-values of (<0.001, <0.001, 0.050, and <0.001, respectively), two studies assessing sex related differences of hypertension and CVD risk factors in the NHANES 1999–2004 population and the Coronary Artery Risk Development in Young Adults (CARDIA),in which women were noted to have higher mean systolic pressures and lower mean diastolic pressures as compared to men [23]. Another study assessing variability in the incidence of hypertension between women and men have found that men demonstrate a steep increase in blood pressure during and after adolescence, while women demonstrate a steep rise in blood pressure in the postmenopausal period [16].

In contrast to our findings, results from the analyses of the DECODE (Diabetes Epidemiology: Collaborative analysis Of Diagnostic criteria in Europe) and DECODA (Diabetes Epidemiology: Collaborative analysis Of Diagnostic criteria in Asia) groups, that included 13 European and 10 Asian studies, indicate that the prevalence of type II diabetes is significantly higher in men compared to women, typically 1.5–3 times higher in men between 50 and 70 years of age [16,17].

This may be explained by the fact that Type II diabetes, which is an integral component of MetS, measured as impaired fasting glucose (IFG) or impaired glucose tolerance (IGT). The prevalence of IGT is higher in women while IFG is higher in men compared to women, Both IFG and IGT have a similar risk for progression to Type II diabetes mellitus, studies on sex differences in insulin resistance support this explanation [16,17]

Previous studies have shown that biologically, there is no difference between men and women in the prevalence and characteristics of type II diabetes [18].

Additionally, significant sex differences in serum cholesterol and triglycerides, males had a significantly higher level of serum total cholesterol and triglycerides. Various mechanisms have been proposed to explain the differences in lipid profile patterns between men and women. These include differences in hepatic lipase and lipoprotein lipase activity and the effect of hormones. This sex-based difference in lipid patterns has been reported by many prospective epidemiological studies such as the MESA study [16-18].

The International Diabetes Federation (IDF) proposed that central obesity, as assessed by waist circumference (WC) cutoff values specific for ethnicity and gender, is mandatory for a diagnosis of MetS, thus all the study participants' WC override the cutoff point for our population, which was 99 cm in women and 97 cm in men, as had previously been reported in Japan [19,20].

Our study findings showed, the mean of WC in males was higher than that of females, which is confirm the former research conducted in the Medical City/Baghdad Teaching Hospital, 2013 [3].

A prominent feature of the IDF definition is that central obesity is an essential, not an optional; WC in women may be even more sensitive marker for detecting central obesity than measures of total fatness [20].

This study showed that irregular physical activity in this representative sample of the selected Iraqi population was about half of the study participants, these findings confirm the high prevalence of physical inactivity among adult males, females and adolescents reported by previous studies; consequently, these findings were comparable to other Arab Gulf countries in which the prevalence of adults being physically active ranged from 39.0% to 42.1% for men and 26.3%–28.4% for women. Other studies from various regions reported a wide range of physical inactivity of between 43.3% and 99.5% [15].

Countrywide studies have reported wide variations of physical activity; the ranges of the prevalence of physical activity, the mode of data collection, and the determination of meeting a physical activity threshold vary markedly between countries. It is worthy to mention that, physical inactivity is one the leading cause of disabilities, morbidities and death among non-communicable chronic conditions [15].

Our results indicate that irregular physical activity is higher among women than men respectively, the biggest difference in the prevalence of physical activity observed in the eastern Mediterranean region. The lower prevalence of physical activity among females is more likely caused by cultural and social variables rather than biological factors. Culturally, women are not expected to practice physical activities in public. Although walking-for-fitness is relatively acceptable for women living in cities, it may not be the case in rural regions.

Regarding body mass index (BMI), our study shows relatively high measures with a mean BMI

of (32.6 kg/m^2). Females had significantly higher BMI compared to male.

Our study also analyzed the most commonly associated risk for the development of MetS as waist circumference, low HDL; high triglycerides are usually due to bad eating habits, lack of exercise and sedentary life style which all are common in Iraq, especially for females. Because of the traditions, it is not usual to see a female or even a male jogging early in the morning, or visiting a gymnasium (gym) even once in his life time. Also we are used to serve high calorie, high fat diets on a daily bases, although it is quite tasty but we think it is time to change.

Regarding smoking history, smokers formed about one third of the study population, who all were of male gender, which was surprising because it leads to a quite difference in the results; nevertheless, it was averse to other study done in Iraq: results of the 2015 STEPS survey. The small sample size of the study and the fact that we did not take into account the passive smoker's status of the participants, might explain the discrepancy in these results. However, we noticed the prevalence of MetS in a large study population which stratified by smoking, it gives a more reliable estimation, which is consistence with The Life-Lines Cohort Study done in The Netherlands 2013 [14, 21, 22].

Additionally, we noticed there was significant difference in serum triglyceride levels between smokers and non-smokers (p-value=0.007), which was confirmed by study conducted in Netherlands 2014 [22, 23].In contrast, there was no significant difference in total cholesterol between smokers and non-smokers (p-value=0.067), this finding also seen in data from the cross-sectional "2017 Morocco STEPS Survey". It has been suggested that "smoking and nicotine reduce weight both by increasing energy expenditure and by suppressing appetite" [24].

Although some studies have indicated that smoking is related to type II diabetes [25], the overall association was not statistically significant in our population between smoking and fasting blood glucose. This confirms the results obtained in other studies [23, 26, 27]. Ishizaka *et al*. found a higher prevalence of elevated blood glucose in smoking males, but not females.

Regarding limitations of this study, small sample size was one of its weaknesses. The body site for the WC measurement was the second restriction, we measured in accordance with the IDF's suggestion at the umbilical level, which is believed to be several centimeters longer than measurement at the "mid-level" in women but is more or less the same in males. The possibility of recall bias, as a result of the assessment of the physical activity, is carried out via a questionnaire, which might result in an inaccurate assessment of physical activity on many occasions.

Conclusion: Patients with Metabolic syndrome are more commonly males, aged 50-69 years, of lower educational level, and urban residents. Males with metabolic syndrome had a higher systolic, and diastolic Bp. Additionally, they had higher serum cholesterol, triglycerides, and waist circumference than females.

A significant number of patients with metabolic syndrome had risky behaviors including smoking, irregular physical activity, and obesity. Smoking is regarded as predictor for metabolic syndrome components. Risky life styles for metabolic syndrome including smoking, and irregular physical activity are higher in male patients, whereas obesity is higher in females.

The best recommendation is earlier MetS discovered and treated, the better the long-term prevention. Health-care systems must be reorganized to prioritize preventive medicine, particularly for obesity and MetS.

Population-level interventions are strongly advised to address this epidemic and to strengthen efforts to avoid noncommunicable diseases, such as type II diabetes mellitus, which has a high prevalence in Iraq and around the world.

References

1. Luo H, Li L, Li T, Liao X, Wang Q. Association between metabolic syndrome and body constitution of traditional Chinese medicine: a systematic review and meta-analysis. Journal of Traditional Chinese Medical Sciences. 2020;7(4):355-65.
2. O. A-A. Prevalence of prediabetes and metabolic syndrome and their association in an Iraqi sample. IOSR-JDMS. 2015.
3. Al-Azzawi OF. Metabolic syndrome; comparing the results of three definition criteria in an Iraqi sample. AL-Kindy College Medical Journal. 2018;14(2):7-12.
4. Zimmet PZ, McCarty DJ, De Courten MP. The global epidemiology of non-insulin-dependent diabetes mellitus and the metabolic syndrome. Journal of Diabetes and its Complications. 1997;11(2):60-8.
5. Grundy SM. Metabolic syndrome: a multiplex cardiovascular risk factor. The Journal of Clinical Endocrinology & Metabolism. 2007;92(2):399-404.
6. Leite LEA, Cruz IBM, Baptista R, Heidner GS, Rosemberg L, Nogueira G, et al. Comparative study of anthropometric and body composition variables , and

functionality between elderly that perform regular or irregular physical activity. Rev Bras Geriatr Gerontol. 2014;17(1):27–37.
7. CDC- Centers for Disease Control andPrevention. Promoting physical activity: a best buy in public health. A Report from the CDC. Atlanta; 2000. https://www.cdc.gov/obesity/downloads/pa_2011_web.pdf
8. Gharipour M, Sadeghi M, Dianatkhah M, Bidmeshgi S, Ahmadi A, Tahri M, et al. The cut-off values of anthropometric indices for identifying subjects at risk for metabolic syndrome in Iranian elderly men. Journal of obesity. 2014;2014.
9. Vujovic D, Bubanja M, Tanase GD, Milasinovic R. Body height and its estimation utilizing arm span measurements in male adolescents from Central Region in Montenegro. Sport Mont. 2015;12(43-45):283-8.
10. Mansour A, Al-Hassan AA, Al-Jazairi MI. Cut-off values for waist circumference in rural Iraqi adults for the diagnosis of metabolic syndrome. Rural and remote health. 2007;7(4):1-6.
11. Khanal MK, Bhandari P, Dhungana RR, Gurung Y, Rawal LB, Pandey G, et al. Poor glycemic control, cardiovascular disease risk factors and their clustering among patients with type II diabetes mellitus: A cross-sectional study from Nepal. PloS one. 2022;17(7):e0271888.
12. Kudhair AH, Hashim NA, Kudhair AAH, Issa AM, editors. A pilot study of the anthropometric measurement and serum lipid concentrations in diabetics at Al-Najaf governorate. AIP Conference Proceedings; 2022: AIP Publishing LLC.
13. Anahita Aboonabi, Roselyn Rose' Meyer, Indu Singh. The association between metabolic syndrome components and the development of atherosclerosis**.** 2019**;** 33: 844–855**.**
14. Pengpid S, Peltzer K. Prevalence and associated factors of metabolic syndrome among a national population-based sample of 18–108-year-olds in Iraq: results of the 2015 STEPS survey. International Journal of Diabetes in Developing Countries. 2021;41(3):427-34.
15. Al-Zalabani AH, Al-Hamdan NA, Saeed AA. The prevalence of physical activity and its socioeconomic correlates in Kingdom of Saudi Arabia: A cross-sectional population-based national survey. Journal of Taibah University Medical Sciences. 2015;10(2):208-15.
16. Rochlani Y, Pothineni NV, Mehta JL. Metabolic syndrome: does it differ between women and men? Cardiovascular drugs and therapy. 2015;29(4):329-38.
17. Unwin N, Shaw J, Zimmet P, Alberti K. Impaired glucose tolerance and impaired fasting glycaemia: the current status on definition and intervention. Diabetic medicine: a journal of the British Diabetic Association. 2002;19(9):708-23.
18. Shrestha AD, Kosalram K, Gopichandran V. Gender difference in care of type II diabetes. Journal of the Nepal Medical Association. 2013;52(189).
19. Japan ECoCfODi. New criteria for'obesity disease'in Japan. Circulation journal: official journal of the Japanese Circulation Society. 2002;66(11):987-92.
20. Eckel RH, Grundy SM, Zimmet PZ: The metabolic syndrome. Lancet 2005; 365(9468):1415–1428.
21. Slagter SN, van Vliet-Ostaptchouk JV, Vonk JM, Boezen HM, Dullaart RP, Kobold ACM, et al. Combined effects of smoking and alcohol on metabolic syndrome: the LifeLines cohort study. PloS one. 2014;9(4):e96406.
22. Slagter SN, van Vliet-Ostaptchouk JV, Vonk JM, Boezen HM, Dullaart RP, Kobold ACM, et al. Associations between smoking, components of metabolic syndrome and lipoprotein particle size. BMC medicine. 2013;11(1):1-15.
23. Slagter SN, van Vliet-Ostaptchouk JV, Vonk JM, Boezen HM, Dullaart RP, Kobold ACM, et al. Combined effects of smoking and alcohol on metabolic syndrome: the LifeLines cohort study. PloS one. 2014;9(4):e96406.
24. Pengpid S, Peltzer K. Prevalence and correlates of the metabolic syndrome in a cross-sectional community-based sample of 18–100 year-olds in Morocco: Results of the first national STEPS survey in 2017. Diabetes & Metabolic Syndrome: Clinical Research & Reviews. 2020;14(5):1487-93.
25. Hu FB, Manson JE, Stampfer MJ, Colditz G, Liu S, Solomon CG, Willett WC: Diet, lifestyle, and the risk of type II diabetes mellitus in women. N Engl J Med. 2001, 345: 790-797. 10.1056/NEJMoa010492.
26. Berlin I, Lin S, Lima JA, Bertoni AG: Smoking status and metabolic syndrome in the multi-ethnic study of atherosclerosis. A cross-sectional study. Tob Induc Dis. 2012, 10: 9-10.1186/1617-9625-10-9.
27. Chen CC, Li TC, Chang PC, Liu CS, Lin WY, Wu MT, Li CI, Lai MM, Lin CC: Association among cigarette smoking, metabolic syndrome, and its individual components: the metabolic syndrome study in Taiwan. Metabolism. 2008, 57: 544-548.