Acta Scientific MEDICAL SCIENCES (ISSN: 2582-0931)

Volume 8 Issue 1 January 2024

Research Article

# Prevalence of Metabolic Syndrome in Young Adult Female Students in the Holy City of Makkah

**Aiman Alsaegh***

*Department of Laboratory Medicine, Faculty of Applied Medical Sciences, Umm Al-Qura University, Makkah, Saudi Arabia*

***Corresponding Author:** Aiman Alsaegh, Department of Laboratory Medicine, Faculty of Applied Medical Sciences, Umm Al-Qura University, Makkah, Saudi Arabia.

**DOI:** 10.31080/ASMS.2024.08.1731

**Received:** December 05, 2023

**Published:** December 21, 2023



## Abstract

**Background and Objectives:** Metabolic syndrome is a constellation of several risk aspects that considered to be the leading cause of cardiovascular disease and type 2 diabetes mellitus. Globally, the prevalence of metabolic syndrome was extremely high. As a result, this study was initiated to clarify the prevalence of metabolic syndrome among young adult females aged between 18 to 25 years old who were attending at Umm Al-Qura University.

**Materials and Methods:** A total of 120 participants was included in this cross-sectional study. The data was collected through an online questionnaire regarding their demographic and socioeconomic states, lifestyle characteristics, menstrual cycle, and measurement that necessary to identify metabolic syndrome.

**Results:** Out of 120 students 22.5% was classified as overweight,12.5% were obese. The total prevalence of metabolic syndrome was 2.5% (n = 3). Metabolic syndrome was significantly associated with waist circumference (p-value = 0.005), total cholesterol (p-value = 0.03), low-density lipoprotein (p-value = 0.02), fasting blood sugar (p-value = < 0.0001). where the most frequent observed component of metabolic syndrome was high body mass index (25%), followed by hypertension (15.8%), low high-density lipoprotein (7.5%), high fasting blood sugar (7.5%).

**Conclusion:** This study shows the prevalence of metabolic syndrome among female students at Umm Al- Qura University, which is nearly 2.5%. This result is considered very low since only three participants have been diagnosed with this syndrome in our study based on the national cholesterol education program - adult treatment panel III criteria.

**Keywords:** Cholesterol; Metabolic Syndrome; Hypertension

## Introduction

Metabolic Syndrome (MetS), is considered as a global dilemma. The International Diabetes Federation (IDF) states that nearly 25% of the worldwide population has MetS [1]. MetS is defined as a cluster of multiple factors that may elevate the chance of having Cardiovascular Diseases (CVD) and other health issues such as Type 2 Diabetes Mellitus (T2DM) and Stroke [2]. During 2015, the morbidity rates of CVD and T2DM increased significantly to three-fold and five-fold [1]. Furthermore, the presence of these chronic diseases will lead to an increase in mortality's conditions. The initial discovery of MetS was in the twentieth century. In 1923, MetS was firstly recognized by Kylin, who illustrated the following health problems: high uric acid level, blood pressure and blood glucose [3]. During 1988, MetS had renamed as syndrome X [4].

Five studies were conducted in Saudi Arabia to estimate the prevalence of MetS cases in different regions. In 2012, Bayameen., *et al*. (2018) have been assessed the prevalence of MetS among the primary health care who works at King Fahad Armed Forces Hospital in Jeddah. His study was focused on recruiting participants from both genders with age 19 years and above. The used of both NCEP-ATPIII and IDF criteria have shown that the prevalence of MetS was around 40.6% [5]. However, the prevalence of MetS based on the NCEP-ATPIII was 41.3% while it was 54.3% according to IDF standards as shown in Table 1 [5]. Moreover, his study has highlighted the correlation between MetS and age, obesity, and DM [5].

| Metabolic Syndrome Criteria | Prevalence % |
|---|---|
| NCEP-ATPIII | 41.3% |
| IDF | 54.3% |

**Table 1:** Prevalence of metabolic syndrome using NCEP-ATPIII and IDF standards adapted from [5].

Another study has been conducted by Al-Rubeaan., *et al*. (2018) which aims to study the prevalence of MetS among men and women in the 13 regions from 2007 to 2009. As in Bayameen., *et al*. (2018) study, Al- Rubeaan., *et al*. (2018) have also used NCEP-ATPIII and IDF criteria to assess the included participants aged 18 and above. His research findings have highlighted the prevalence of MetS based on NCEP-ATPIII standard was 39.8% (29.2% in females and 34.4% in males), while the IDF standard was 31.6% (35.4% in females and 45.0% in males). This means that MetS were more observed among men and elderly [6]. Moreover, his research has shown the predominant aspects of MetS were the low level of HDL and abdominal obesity [6]. Moreover, his research has shown the predominant aspects of MetS were the low level of HDL and abdominal obesity.

A meta-analysis study has been conducted by Shin and Jee (2020) to investigate the prevalence of MetS in GCCs between 2003 to 2019. His study has found that the pooled evaluation of the prevalence rate of MetS in GCCs was 0.28. Moreover, the prevalence of MetS in each country as following: 0.28% in Saudi Arabia, 0.39% in the UAE, 0.22% in Kuwait, 0.25% in Oman and 0.26% in Qatar [7].

The prevalence of MetS has been investigated in Al-Dawadmi and Shaqra Regions in Saudi Arabia by [8]. However, his study has aimed to examine the correlation between the MetS and DM, heart diseases and vitamin D deficiency among young males and females adolescents aged 13 to 20 years old. The study's findings have shown that there is a strong relationship between these aspects and MetS. Despite the participants' age, nearly 50% of obese people had observed to have DM and CVD [8].

In 2010, a cross-sectional study was conducted in Riyadh to assess the prevalence of MetS among 2850 Saudi adult, aged 18-55 years old [9]. Therefore, the prevalence in this study was 35.5% and the predominant factor was low HDL [9].

Since there are limited studies that considered the prevalence of MetS in Makkah province. Besides that, there are limited studies that focus on this issue among women in different age groups. Therefore, this study will investigate the prevalence of MetS among young adult females aged between 18-25 years old at Umm Al-Qura University.

The chance to develop CVD and T2DM has increased specifically with age and among those who are obese or inactive people. Thus, this study aims to determine the prevalence of MetS components using NCEP-ATPIII criteria among young adult females aged between 18 to 25 years old who are attending at Umm Al-Qura University.

## Material and Methods

### Subject and study design

A cross-sectional study was conducted at Umm Al-Qura University, Mecca, Saudi Arabia, from November 2019 to April 2020. The sample population of this study was 120 female students aged 18-25 years old, who were recruited consecutively following their response to the study advertisement. In this study, pregnant and lactation women were excluded.

### Metabolic characteristics

Each participant in this study was informed to sign a consent and was able to withdraw from the study. Participants were invited to complete an online questionnaire regarding their demographic characteristics, personal information, family income, educational level, lifestyle characteristics, exercise, smoking, nutrition and

menstrual cycle. BP was measured for all participant using (Automatic digital blood Co, China). FBS was also determined using (ACCU- CHEK Instant, India). Also, Waist Circumference (WC) measured by using meter tape and Hight (cm) by (beams body scale-detecto, USA). Moreover, In body 570 (Chungcheongnam-do, Korea) was applied to assess several parameters including Weight (Kg), Height (cm), Muscle Fat, Body Mass Index (BMI), Percent Body Fat (PBF), Segmental Lean, Visceral Fat Level and Total Body Water (TBW) (Liter).

### Lab investigations

To determine the FBS, participants were instructed to fast for at least 8 hours then 2.5ml of blood was collected in a plain tube to evaluate serum total Cholesterol, TG, HDL, and Low-Density Lipoprotein (LDL). All reagents and kits were supplied by Human International Co. (Germany). The analysis was conducted using the Fully Automated Humastar-200 (Human Diagnostics International Co, Germany) according to the standard protocols and manufacturer's guidelines.

### Statistical analysis

Statistical analysis was conducted on SPSS software version 25 (NY, USA). The Kolmogorov-Smirnov test for normality and Levene test for homogeneity were performed for continuous data that were expressed either as mean ± standard deviation (SD) or median with the interquartile range (IQR: $25^{th}$ – $75^{th}$ percentiles) depending on data normality. Ordinal and discontinuous data were presented as numbers and percentages, and cross-tabulation followed by Chi-square ($\chi 2$) test was used for frequency analysis. One-way ANOVA or Kruskal– Wallis was used to compare more than two groups according to data normality and, based on variance equality, either Tukey's HSD or Games-Howell post-hoc tests were applied to compare between groups. $P < 0.05$ was considered statistically significant.

### Ethical approval

This study was approved by the research ethics committee at the Faculty of Applied Medical Sciences, Umm Al-Qura University.

## Results

A total of 120 female students participated in this study with the Mean ± SD of age 20.7 ± 1.4 years, 55.5 ± 14.8 for body weight (Kg) and 156.4 ± 15.6 for height (cm), as shown in Table 2.

| Characteristics | Mean (± SD) |
|---|---|
| Age (years) | 20.7 ± 1.4 |
| Systolic Pressure (mmHg) | 120.2 ± 14.3 |
| Diastolic Pressure (mmHg) | 78.4 ± 9.1 |
| Fasting Blood Sugar (mg/dL) | 90.6 ± 8.9 |
| Wight (Kg) | 55.5 ± 14.8 |
| Height (cm) | 156.4 ± 15.6 |
| Body Mass Index (Kg/cm$^2$) | 22.6 ± 5.8 |
| Waist Circumference (cm) | 75.6 ± 12.2 |
| Triglyceride (mg/dL) | 84.1 ± 9.3 |
| Total Cholesterol (mg/dL) | 147.5 ± 10.9 |
| High-density lipoprotein (mg/dL) | 56.1 ± 5.2 |
| Low-density lipoprotein (mg/dL) | 89.2 ± 10.6 |

**Table 2:** General characteristics and descriptive analysis of metabolic syndrome.

### Blood pressure

Nineteen students (15.8%) had hypertension among whom 10% (n = 12) were exclusively systolic hypertensive (> 140 mmHg), 3.3% (n = 4) were solely diastolic hypertensive (> 90 mmHg) and the remaining 2.5% (n = 3) had simultaneous systolic and diastolic hypertension, as shown in Figure 1.

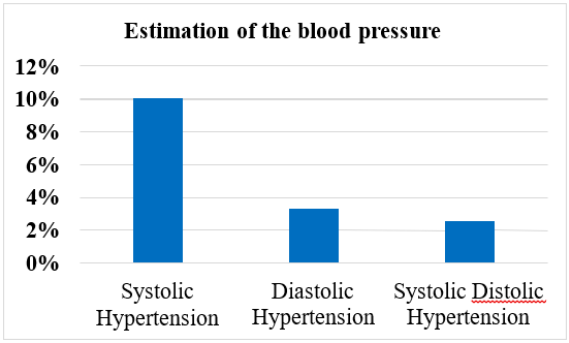


**Figure 1:** Estimation of the blood pressure.

### Fasting blood sugar

Nine of the students (7.5%) had high FBS (109.9 ± 7.6 mg/dL) and the glucose levels were significantly higher than those who were normoglycemic (89 ± 7 mg/dL; $P < 0.0001$). The majority

of the students with high FBS (n = 6; 5%) had normal BMI, were normotensive (n = 7; 5.8%) and had normal WC (n = 8; 6.7%) as well as all none of them had either low HDL or high TG levels, as shown in Table 3.

| Parameters | Prevalence % | n |
|---|---|---|
| Normal BMI | 5% | 6 |
| Normal BP | 5.8% | 7 |
| Normal WC | 6.7% | 8 |

**Table 3:** Correlation between BMI, BP and WC in the participants with high FBS (> 100mg/dl).

Keywords: Fasting blood sugar (FBS), Body mass index (BMI), Waist circumference (WC), and Number (n).

### Body composition

The majority of students (n = 63; 52.5%) were classified as normal weight according to their BMI, whereas 27 students (22.5%) were underweight, and the remaining 30 students were equally classified as overweight or obese [n=15 (12.5%)/group], as shown in Figure 2.

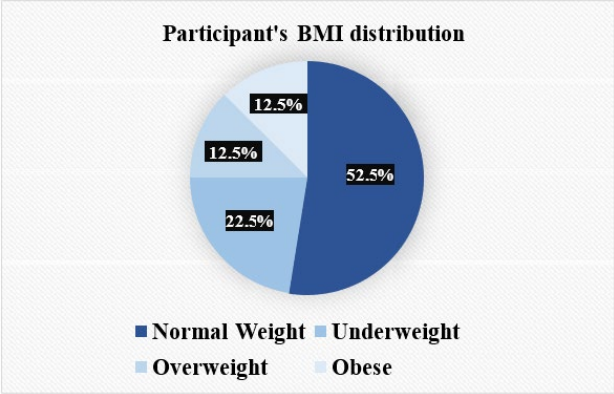


**Figure 2:** Participant's BMI distribution.

### Lipid profile

Nine of the students (7.5%) also had low serum concentrations of HDL (< 50 mg/dL). While there was no significant difference in the concentrations of TG between the low and normal HDL groups (86.4 ± 7.7 and 83.9 ± 9.4 mg/dL, respectively), the LDL (105.2 ± 20.8 vs. 87.9 ± 8.1 mg/dL; P = 0.02), total cholesterol (161.1 ± 23.1 vs. 146.4 ± 8.6 mg/dL; p = 0.03) and WC (97.4 ± 18.7 vs. 73.8 ± 9.7 cm; P = 0.005) were significantly higher in the low HDL group as shown in Figure 3.

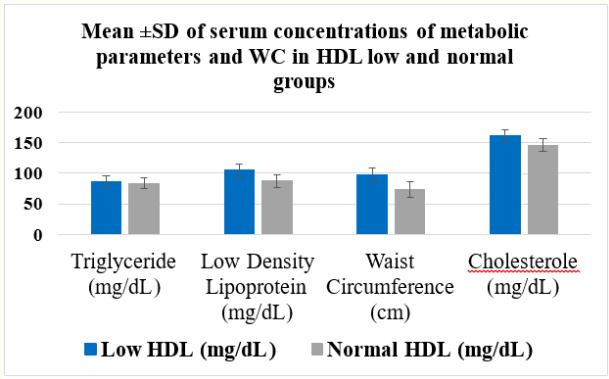


**Figure 3:** Mean ± SD of serum concentrations of metabolic parameters and WC in HDL low and normal groups.

### Overall prevalence of metabolic syndrome

The prevalence of MetS was low among the targeted population and only three female students (2.5%) had three or more of the NCPE-ATP III criteria.

## Discussion

### Metabolic syndrome association factors

Since the oil discovery in the last century, the financial state of Saudi Arabia has flourished significantly [10]. As a result of this development, the citizen's socioeconomic status has been improved as well as food availability [11]. Moreover, these changes have been reflected on people's lifestyle, their food preferences, and their dietary patterns [12]. For instance, people have become physically inactive and prefer to consume fast food (i.e. pizza, fried food, and sweets) instead of fruits and vegetables. In order to mitigate this shift, Saudi Arabia has developed a 2030 vision, which aims to improve healthcare services and increase public health awareness regarding their way of living [13]. Therefore, this study aimed to determine the prevalence of MetS component among female aged between 18-25 years who is attending at Umm Al-Qura University to prevent metabolic disease complications.

The range of MetS cases across the world is varied from less than 10% to nearly up to 84% [14,15]. For example, the prevalence of MetS among adult women in Nepal was 22.5%, Brazilian university students were 1.7%, the UAE was 6.8% [16-18]. This variation may result from different factors such as people's characteristics (i.e. age, gender, and ethnicity) as well as their living environment [14,15]. Moreover, the prevalence of MetS in this study was low among the target population, and only three females with a percentage of 2.5 had three or more of the NCEP-ATP III criteria. The result of this study agreed with those of Abolfotouh, Al-Alwan., *et al*. (2012), which was conducted in Riyadh city in Saudi Arabia, in terms of sample size, participant's age, as well as the prevalence of MetS was nearly 1.7% [19]. However, the prevalence of MetS in King Saud University (KSU) in Riyadh city was high, which was approximately 39% compared to our study [20].

This study indicates the most common factors of MetS which are arranged as the following: high BMI (25%), hypertension (15.8%), low HDL (7.5%), and high FBS (7.5%). However, the most popular aspect in Jakarta was central obesity (84.1%), and in Brazil was high TAG (23%) [17,21]. The majority of the participants, which were approximately 84%, had normal BP. Meanwhile, only 16% of them were diagnosed with hypertension. However, most of the participants had systolic hypertension (3.3%). Furthermore, our study highlights that there is a significant association between HDL, total cholesterol, LDL, TG, WC levels, and MetS. On the other hand, the participants who had normal HDL levels had lower levels of total cholesterol, LDL, TG, and WC.

## Metabolic syndrome from gene prospective

Considerable improvement has been made over the last decade in recognition of hereditary risk factors that are related to several traits of MetS [22]. According to the Genome-Wide Association Study (GWAS), there is a relationship between genetic variants and MetS components [23]. As a result, numerous mutations have been discovered for particular traits [22]. In addition, genetic studies, which include family and twin studies, were afforded the initial proof for the heritability and co-occurrence of the metabolic characters. Moreover, the heritability of each MetS trait may exceed 50% [22].

The Superoxide Dismutase 2 (SOD2) (rs4880) gene is found on chromosome 6q25, and the most common Single Nucleotide Polymorphism (SNP) was in Ala16Val [24]. This changes the amino acid at position 16 from valine (Val) to alanine (Ala) and may develop CVD in diabetic women [24]. Also, another study shows that in the SOD2 gene, the polymorphism of Ala16Val may be a risk factor for diabetes among Japanese Americans [24,25]. Moreover, one locus was found in the intron region of C5orf67 (rs3936511) protein that closely correlated to T2DM, HDL, and TG levels [26]. In addition, the SNPs in the transcription factor 7-like 2 (TCF7L2) (rs7903146) gene showed the strongest relation to T2DM among the Saudi adult population [27].

The predominance of fatness has been developed promptly all over the world [22]. Also, the total body mass of fat is determined by calories from the consumption of nutrients and energy expenses, which in turn are linked with genetic aspects [22]. As a result, recognizing the obesity-responsible genes will play a crucial role in MetS.

The link between Leptin (LEP) gene, which is produced by fatty cells, and its receptor (LEPR) leads to the inhibition of the appetite [28]. However, the presence of any mutation in LEP and its receptor may directly link with the occurrence of obesity [22]. Furthermore, changes in the Lipoprotein Lipase (LPL) gene not only directly elevate TG level but also lead to an increase in the potential risk of developing CVD [29].

Fat mass- and obesity-associated gene (FTO) promotes food intake [28]. In addition, Melanocortin 4 Receptor gene (MC4R) is bound with the alpha-melanocyte-stimulating hormone that leading to stimulates appetite [28]. However, FTO (rs3751812) and MC4R (rs571213) genes are the key SNPs correlated to the risk of obesity among the UAE population [30]. Moreover, another study shows that FTO (rs9939609 and rs17817449) gene polymorphisms have a strong association with fatness among the Brazilian population [30]. Also, the FTO (rs1558902 and rs1421085) gene and Secretogranin III (SCG3) (rs3764220) gene are related to subcutaneous fat and obesity [31]. On the other hand, the myotubularin-related protein 9 (MTMR9*)* (rs2293855) gene was associated with high BP and obesity [32].

In Saudi Arabia, one study shows that there are six genetic variants correlated with increasing the risk of hypertension [33]. However, statistically, approximately four of them are related

to hypertension. In Taiwan, there is a study conducted in 2017 shows that Actin Filament Associated Protein 1 like 2 (AFAP1L2) (rs1106475) gene associated with Systolic Blood Pressure (SBP) [34].

## Recommendation

Firstly, it is recommended to increase the participants' number as well as include both genders. Also, the research should include participants from the 13 managerial regions of Saudi Arabia to provide relevant data about MetS. This will help to increase the internal and external validity of the study. Finally, it is recommended to perform health promotion sessions to the entire population to emphasize the importance of having a healthy lifestyle on their health.

## Conclusion

To conclude this study, the prevalence of MetS is extremely low among the targeted population. According to NCEP-ATPIII criteria, only three students (2.5%) had three or more of the following risk factors: abdominal obesity, hypertension, hyperglycemia, and abnormal lipid profile (i.e. high LDL, TG, and Low HDL levels). Consequently, the diagnosed students may have significant risks of developing CVD and T2DM, which in turn may lead to stroke.


A link containing the questionnaire of this study:

https://drive.google.com/open?id=1Ulc_wKm2n46IqrwxFCYH-8vNivnieisakPV HcdWHsDQQ

## Bibliography

1. O'neill S and L O'driscoll. "Metabolic syndrome: a closer look at the growing epidemic and its associated pathologies". *Obesity Reviews* 16.1 (2015): 1-12.v

2. National Heart L and Blood Institute. Metabolic Syndrome. D. o. H. a. H. Services (2019).

3. Kylin E. "Studien ueber das Hypertonie-Hyperglyka" mie-Hyperurika" miesyndrom". *Zentralblatt für innere Medizin* 44 (1923): 105-127.

4. Reaven G M. "Role of insulin resistance in human disease". *Diabetes* 37.12 (1988): 1595-1607.

5. Bayameen M., *et al*. "Prevalence of Metabolic Syndrome among Primary Health Care Attendees in King Fahad Armed Forces Hospital in Jeddah". *Archives of Medicine* 10.2 (2018): 9.

6. Al-Rubeaan K., *et al*. "Prevalence of metabolic syndrome in Saudi Arabia-a cross sectional study". *BMC Endocrine Disorders* 18.1 (2018): 16.

7. Shin S and H Jee. "Prevalence of metabolic syndrome in the Gulf Cooperation Council countries: meta-analysis of cross-sectional studies". *Journal of Exercise Rehabilitation* 16.1 (2020): 27.

8. Alabdullatif G S S., *et al*. "Prevalence of Metabolic Disorder in Adolescent Residing in Al-dawadmi and Shaqra Regions of Saudi Arabia". *Journal of Advances in Medical and Pharmaceutical Sciences* (2019): 1-5.

9. Al-Daghri N M., *et al*. "Selected dietary nutrients and the prevalence of metabolic syndrome in adult males and females in Saudi Arabia: a pilot study". *Nutrients* 5.11 (2013): 4587-4604.

10. Ng SW., *et al*. "The prevalence and trends of overweight, obesity and nutrition-related non-communicable diseases in the Arabian Gulf States". *Obesity Reviews* 12.1 (2011): 1-13.

11. Pieters H and J Swinnen. "Food Security Policy at the Extreme of the Water-Energy-Food Nexus: The Kingdom of Saudi Arabia". Food Security in a Food Abundant World (Frontiers of Economics and Globalization, Volume 16), Emerald Group Publishing Limited (2016).

12. Alazzeh A Y., *et al*. "Some socioeconomic factors and lifestyle habits influencing the prevalence of obesity among adolescent male students in the hail region of Saudi Arabia". *Children* 5.3 (2018): 39.

13. Vision 2030 G. "Government of Saudi Arabia". Saudi Government (2016).

14. Desroches S and B Lamarche. "The evolving definitions and increasing prevalence of the metabolic syndrome". *Applied Physiology, Nutrition, and Metabolism* 32.1 (2007): 23-32.

15. Kolovou G D., *et al*. "The prevalence of metabolic syndrome in various populations". *The American Journal of the Medical Sciences* 333.6 (2007): 362-371.

16. Sharma S K., *et al*. "Prevalence of hypertension, obesity, diabetes, and metabolic syndrome in Nepal". *International Journal of Hypertension* (2011).

17. F de Freitas Jr R W., *et al*. "Prevalence of the metabolic syndrome and its individual components in Brazilian college students". *Journal of Clinical Nursing* 22.9-10 (2013): 1291-1298.

18. Al Dhaheri A S., *et al*. "A cross-sectional study of the prevalence of metabolic syndrome among young female Emirati adults". *PLoS One* 11.7 (2016).

19. Abolfotouh M A., *et al*. "Prevalence of metabolic abnormalities and association with obesity among Saudi college students". *International Journal of Hypertension* (2012).

20. Daghri NM., *et al*. "Decreasing prevalence of the full metabolic syndrome but a persistently high prevalence of dyslipidemia among adult Arabs". *PloS One* 5.8 (2010).

21. Soewondo P., *et al*. "Prevalence of metabolic syndrome using NCEP/ATP III criteria in Jakarta, Indonesia: the Jakarta primary non- communicable disease risk factors surveillance 2006". *Acta Medica Indonesiana* 42.4 (2010): 199-203.

22. Ziki MDA and A Mani. "Metabolic syndrome: genetic insights into disease pathogenesis". *Current Opinion in Lipidology* 27.2 (2016): 162.

23. Stančáková A and M Laakso. "Genetics of metabolic syndrome". *Reviews in Endocrine and Metabolic Disorders* 15.4 (2014): 243-252.

24. Pourvali K., *et al*. "Role of superoxide dismutase 2 gene Ala16Val polymorphism and total antioxidant capacity in diabetes and its complications". *Avicenna Journal of Medical Biotechnology* 8.2 (2016): 48.

25. Nakanishi S., *et al*. "Manganese superoxide dismutase Ala16Val polymorphism is associated with the development of type 2 diabetes in Japanese-Americans". *Diabetes Research and Clinical Practice* 81.3 (2008): 381-385.

26. Lind L. "Genetic Determinants of Clustering of Cardiometabolic Risk Factors in UK Biobank". *Metabolic Syndrome and Related Disorders* (2020).

27. Al-Daghri N M., *et al*. "Assessing the contribution of 38 genetic loci to the risk of type 2 diabetes in the Saudi Arabian Population". *Clinical Endocrinology* 80.4 (2014): 532-537.

28. Centers for Disease Control, a. P. Genes and Obesity. G. a. P. Health (2013).

29. Ference B A., *et al*. "Association of triglyceride-lowering LPL variants and LDL-C–lowering LDLR variants with risk of coronary heart disease". *Jama* 321.4 (2019): 364-373.

30. Chehadeh S E H., *et al*. "Implication of Genetic Variants in Overweight and Obesity susceptibility among the Young Arab Population of the United Arab Emirates". *Gene* (2020): 144509.

31. Fonseca A C P d., *et al*. "Genetic variants in the fat mass and obesity-associated (FTO) gene confer risk for extreme obesity and modulate adiposity in a Brazilian population". *Genetics and Molecular Biology* 43.1 (2020).

32. Hotta K., *et al*. "Association of variations in the FTO, SCG3 and MTMR9 genes with metabolic syndrome in a Japanese population". *Journal of Human Genetics* 56.9 (2011): 647-651.

33. Gosadi I M. "Assessment of the environmental and genetic factors influencing prevalence of metabolic syndrome in Saudi Arabia". *Saudi Medical Journal* 37.1 (2016): 12.

34. Lin E., *et al*. "Detection of susceptibility loci on APOA5 and COLEC12 associated with metabolic syndrome using a genome-wide association study in a Taiwanese population". *Oncotarget* 8.55 (2017): 93349.