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ORIGINAL ARTICLE

The Prevalence of Metabolic Syndrome and Its Related Factors in Dena County, Kohgiluyeh and Boyer-Ahmad Province, Iran: A Cohort Study

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ABSTRACT

Background: Metabolic syndrome (MetS) is a cluster of metabolic disorders that can increase the likelihood of developing diabetes and cardiovascular diseases. To address this condition in a population, its prevalence and associated lifestyle factors were determine in this cohort study.

Methods: In a cross-sectional study from Dena Persian cohort findings, demographic information, body mass index, alcohol consumption, physical activity, smoking status, and nutrient intake by a food frequency questionnaire were analyzed. The prevalence of MetS was determined, and the relevant factors were evaluated.

Results: Among 2706 enrolled subjects, 1002 were diagnosed with MetS with a prevalence rate of 37.02%. All dietary components were significantly higher in healthy individuals, except for saturated fatty acids. Furthermore, a statistically significant association was observed between smoking and physical activity with MetS; however, no significant correlation was found regarding alcohol consumption.

Conclusion: The findings indicated that embracing a healthy lifestyle, characterized by reduced smoking, increased physical activity, and a nutritious diet had the potential to decrease the prevalence of MetS. This approach can be effectively implemented by health policymakers within our community.

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Introduction

Metabolic syndrome (MetS) is a group of metabolic disorders that include central obesity, dyslipidemia, hyperglycemia, and high blood pressure. This group of metabolic disorders can raise the risk of diabetes and cardiovascular disease (1, 2). Risk factors for MetS are aging, limited mobility, obesity, diabetes mellitus, cardiovascular illnesses, and lipodystrophy (3, 4). People could have MetS if they exhibit three or more of the symptoms according to the Adult Treatment Panel 3 (ATP-III), which was presented by the American National Cholesterol Education Program. Symptoms include waist measurement to be greater than or equivalent to 102 cm for men and 88 cm for women; triglyceride (TG) level of 1.7 mmol/L or higher; a fall in high-

density lipoprotein (HDL) of 1.1 mmol/L or less in men and 1.3 mmol/L or less in women; an elevated systolic pressure of at least 130 mm Hg and diastolic pressure of at least 85 mm Hg, or use of blood pressure medication; a change in fasting blood sugar of more than or equal to 6.1 mmol/L or diabetic medication (5).

The rise in incidence of obesity which is a key contributor to MetS can parallel these trends, and underscore the urgency for targeted interventions. The National Health and Nutrition Examination Survey (NHANES) reported the prevalence of MetS among adults in US to be increased from 25.3% in 2003to 34.2% in 2012 (6). Therefore, reducing obesity as a major societal risk factor can lower the prevalence of MetS (7). According to the findings of a prospective cohort research, individuals with MetS had a greater rate of cardiovascular death than those without this syndrome (8). The Framingham prospective study's findings indicated that MetS alone can predict about 25% of all new instances of cardiovascular illnesses (9).

Diet plays a pivotal role in the development or management of MetS. Diets high in refined carbohydrates, sugars, unhealthy fats, and low in fiber are associated with increased mentioned risk factors; while conversely, diets rich in fruits, vegetables, whole grains, and healthy fats can mitigate them (10-12). Physical inactivity is another critical factor contributing to MetS. Regular physical activity helps maintain a healthy weight and improves insulin sensitivity (13, 14). Smoking is a major risk factor for many heart diseases and raises the chances of developing MetS. The harmful chemicals in cigarettes can damage blood vessels and increase insulin resistance (15, 16). On the other hand, moderate alcohol intake may have some protective effects against cardiovascular diseases, while excessive consumption is linked to obesity and other components of MetS (17).

Investigating the prevalence of MetS is crucial for multiple reasons. First, obtaining precise data on the prevalence of MetS can enable health authorities to allocate resources efficiently and develop public health interventions that are specifically tailored to various populations. Additionally, understanding the lifestyle factors that most significantly influence MetS can guide educational campaigns aimed at encouraging healthier behaviors. Furthermore, monitoring changes in MetS prevalence over time is vital for evaluating the effectiveness of public health initiatives and identifying emerging trends associated with lifestyle modifications. The development and prevalence of these conditions can be influenced by lifestyle choices, social determinants, environmental factors, and genetic diversity, which may vary across different geographical areas. So this research aimed to investigate the prevalence of MetS among adults participating in the Dena PERSIAN cohort study and to explore the correlation between MetS and life style regarding consumption of various nutrients, the extent of physical activity, cigarette smoking, alcohol consumption, etc.

Materials and Methods

The Dena PERSIAN cohort study is a sub-cohort of the PERSIAN Cohort Study in Iran since 2018 (18). The study included individuals aged 35-70 years who lived in urban and rural areas of Dena County in Yasuj, Iran for more than one year, except those with physical or mental disabilities that prevented them to attend the interviews. Dena County comprises two cities of Pataveh and Sisakht. The county's administrative center was located in Sisakht. The selection of participants for this cohort study was based on the list of eligible individuals provided by the health centers in the region. To ensure that the participants were willing to participate, they were asked to sign a written consent form.

Data entry and validation occurred following the completion of each interviews. Any missing or erroneous data were addressed by reviewing the process and consulting with the respective interviewer. During the data entry process, the completeness and consistency were assessed. The study's quality control team consisted of two individuals at the national and university/executive levels. Furthermore, faculty members in the university from the epidemiology and laboratory science departments undertook the quality control. A pair of experts in epidemiology and laboratory science conducted field quality control throughout all data collection stages, encompassing interviews, invitations, censuses, samplings, conducting tests, while directly recorded the findings. In addition, checklists were utilized to oversee the procedural steps and the duration of the study. Subsequently, the collected data were compared with the outcomes of the electronic questionnaires. The data for this study was gathered from the cohort center and after discarding incomplete data, the final sample size reached 2706 subjects.

Demographic information were age, gender, and body mass index (BMI) that was determined by dividing weight in kilograms by the square of height in meters and waist circumference in centimeters. Participants' systolic and diastolic blood pressure were measured and recorded in millimeters per Hg (mmHg), and were recorded on

two separate occasions, specifically after 5 minutes of rest in a seated position, and again 15 minutes later, following the established protocols on the right arm. Laboratory data were total cholesterol (CHOL), triglycerides (TG), fasting blood sugar (FBS), and high-density lipoprotein (HDL) in milligrams per deciliter of blood (mg/dL). All blood samples were collected in tubes that contained either a clot activator or an anticoagulant. The collections took place in the morning following an overnight fasting period. The specimens were preserved in labeled tubes and containers. A cumulative volume of 25 mL of blood was collected, utilizing one 7 mL clot tube and three 6 mL EDTA tubes.

The participants were divided into two groups based on the ATP III criteria (5) as those with or without MetS. The prevalence of MetS in this population was then determined. Lifestyle factors, such as dietary intake and level of physical activity were assessed. The International Physical Activity Questionnaire (IPAQ) was used to estimate physical activity in the routine life (19). The physical activity index utilized is the MET (metabolic equivalent of tasks), which was computed over 24 hours of physical activities (MetS/hour/day). This research employed a validated Food Frequency Questionnaire (FFQ) consisting of 113 items, in addition to a separate 127-item FFQ specifically for indigenous foods. Participants were instructed to indicate the frequency and portion sizes of food items they consumed on a daily, weekly, monthly, and annual basis over the preceding year. All portion sizes or household quantities were standardized to grams per day. Subsequently, the energy and nutrient composition of the foods was determined using Nutritionist IV software (Version 7.0) (20). Yes/no questions were used to collect data on lifestyle variables such as smoking and alcohol usage. Smoking was defined as consuming at least 100 cigarettes in a lifetime. Alcohol consumption was described as approximately 200 mL of beer or 45 mL of alcohol once a week for a minimum of 6 months.

After receiving the code of ethics for this research work (IR.YUMETS.REC.1401.077) in August 2022 and collecting the required data from the Dena PERSIAN cohort study, the data was analyzed and interpreted. Data analysis was performed using SPSS software (Version 27, Chicago, IL, USA). Quantitative and qualitative variables were described using mean, standard deviation, frequency, and percentage. For quantitative variables that had a normal distribution, the independent sample t-test, and for variables that did not follow a normal distribution, the Mann-Whitney U test was used.

Table 1: Comparison of demographic, anthropometric, lifestyle, and biochemical characteristics between participants with and without metabolic syndrome (mean±SD).

Variable	Metabolic syndrome (n=1002)	Without metabolic syndrome (n=1704)	*P* value
Age (year)	51.20±9.63	49.63±9.74	0.001
Men, n (%)	245 (24.5)	929 (54.5)	0.001
Women, n (%)	757 (75.5)	775 (45.5)	
FBS (mg/dL)	123.93±49.55	103.51±28.98	0.001
CHOL (mg/dL)	185.22±37.65	175.01±35.26	0.001
TG (mg/dL)	204.33±124.16	129.19±74.45	0.001
HDL-C (mg/dL)	45.93 ± 9.09	51.10±9.97	0.001
SBP (mmHg)	119.28±20.43	106.29±14.02	0.001
DBP (mmHg)	76.26±13.50	69.43±10.16	0.001
BMI (kg/m²)	30.03±4.68	26.69±4.85	0.001
Waist circumference (cm)	102.81±29.04	95.17±11.55	0.001
Physical activity (MetS-h/day)	39.42±4.62	40.51±5.82	0.001
Energy intake (Kcal/day)	2525.32±831.70	2730.87±968.11	0.001
Carbohydrate (g/day)	410.55±142.55	443.95±160.65	0.001
Total fat (g/day)	68.36±26.94	73.13±30.51	0.003
Protein (g/day)	80.13±29.47	87.28±37.03	0.001
Total n-3 fatty acids (g/day)	0.054±0.056	0.062±0.063	0.001
Total n-6 fatty acids (g/day)	4.60±3.14	5.07±3.40	0.001
Saturated fatty acids (g/day)	24.44±11.37	26.26±12.81	0.056
Trans fatty acids (g/day)	0.227±0.233	0.283±0.291	0.001
Vitamin D (IU/day)	56.74±50.83	66.47±61.72	0.001

MetS, metabolic syndrome; FBS, fasting blood sugar; CHOL, total cholesterol; TG, triglycerides; HDL-C, high-density lipoprotein cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index; MET, metabolic equivalent of task; n-3, omega-3 fatty acids; n-6, omega-6 fatty acids. Quantitative variables were compared using independent samples t-test or Mann–Whitney U test, as appropriate. Categorical variables were compared using χ^2 test. A p value<0.05 was considered statistically significant.

Table 2: Association of smoking and alcohol consumption with metabolic syndrome.

Variable	MetS (n=1002)	Without MetS (n=1704)	*P* value
Alcohol consumption			
Yes	31 (3.1)	143 (8.4)	0.561
No	971 (96.9)	1561 (91.6)	
Smoking			
Yes	244 (24.4)	432 (25.4)	0.001
No	758 (75.6)	1272 (74.6)	

MetS, metabolic syndrome. Data were presented as number (percentage). Categorical variables were compared using χ^2 test. A p value<0.05 was considered statistically significant.

χ2, Fisher's exact test and linear by-linear association were used to investigate the relationship between two qualitative variables. The significance level was considered to be $p<0.05$.

Results

Among 2706 participants included in the study, 1002 had MetS with a prevalence rate of 37.02%; while 43.4% were male and 56.6% were female with the age range of 35-70 years (SD=9.63) and an average age of 51.20 years. The percentage of alcohol consumers and smokers was 6.4% and 24.98%, respectively. Table 1 presents a summary of demographic, anthropometric, lifestyle, and biochemical characteristics of participants with MetS. Participants diagnosed with MetS were notably older and exhibited a higher BMI and waist circumference in comparison to their counterparts without the syndrome. Furthermore, levels of FBS, TG, total cholesterol, and blood pressure were significantly elevated, whereas HDL-C level decreased among those with MetS. In terms of lifestyle factors, individuals without MetS showed significantly greater level of physical activity and higher dietary energy and nutrient intake. There was no significant difference between the two groups regarding the intake of saturated fatty acids. As indicated in Table 2, a statistically significant correlation was found between smoking status and the occurrence of MetS ($p<0.001$). Conversely, alcohol consumption did not show a significant association with MetS ($p=0.561$).

Discussion

In this study, the researchers estimated that 37.02% of the adult population in Dena County had MetS suggesting that people of this area were more susceptible to MetS and necessitates prevention interventions in young population of this region. It was shown that smoking may contribute to an elevated risk of developing MetS; however, the level of alcohol consumption among the participants did not reveal any significant correlation. Analysis of the lifestyle-related data suggests that factors such as physical activity, dietary habits, energy and nutrient intake, and the types of consumed fats were crucial elements in fostering a healthy lifestyle within the population.

Several studies have been conducted to determine the prevalence of MetS and related factors in specific communities to create health promotion programs. In 2013, Sadrbafoghi *et al.* estimated that the prevalence of MetS in a population of 1110 people from Yazd was 32.1% (21). Similarly, in another study conducted in Yazd by Mozaffari-Khosravi *et al.*, the prevalence of MetS was calculated to be 33.3% in subjects older than 50 years; while there was no significant difference in the prevalence of MetS between smokers and non-smokers (22). Gharipour *et al.* demonstrated that the percentage of MetS was higher in non-smokers in comparison to smokers (23). Navayinia *et al.* involved 200 patients with rheumatoid arthritis and found the prevalence of MetS was higher in non-smokers when compared to smokers suggesting that smoking could potentially have a protective effect against MetS in individuals with rheumatoid arthritis (24). In a study conducted by Chen *et al.*, it was found that smoking increased the risk of MetS (25). In a 2012 meta-analysis study investigating the risk of developing MetS among active smokers, the results revealed that the risk of developing MetS was higher in these individuals compared to non-smokers or former smokers (26).

Although this study did not find any significant relationship between MetS and alcohol consumption, some studies did, like one conducted in South Korea to examine the health status of alcoholics and non-alcoholics after a 4-year follow-up period of 3,833 study participants. The results revealed a statistically significant relationship between heavy alcohol consumption and MetS (27). Based on a 2008 meta-analysis study, a correlation was seen between alcohol consumption and the prevalence of MetS. The study found that a reduction in alcohol consumption could significantly decrease the prevalence of MetS. Additionally, it was shown that alcohol may exacerbate the condition (28). Our study revealed that healthy individuals consumed greater amounts of

macronutrients and micronutrients with a statistically significant difference across these nutrients, except the total saturated fat intake suggesting that consumption of saturated fats was lower among healthy individuals than those affected by MetS. A meta-analyses exhibited a contradiction on the prevailing notion that high saturated fat intake contributed to an increased risk of cardiovascular diseases (29). It was shown that excessive consumption of saturated fat was associated with an elevated LDL cholesterol level. Therefore, it is advisable to reduce the intake of saturated fats as a preventive measure against cardiovascular diseases (30-33).

Our study had strengths like employing a prospective approach with a substantial sample size that facilitated more precise comparisons of diseases and their risk factors. Participants were selected from both urban and rural regions, which could enhance the diversity of the sample. Comprehensive data were gathered through clinical, demographic, genetic, and laboratory variables, rendering the study a valuable resource for future investigations into the connections between different diseases and their related factors. However, one of the strengths of this study was that its large number of participants enabled a more comprehensive investigation of the effect of various factors on this syndrome.

This study had also certain limitations, including the insufficient information supplied by some participants, which resulted in their exclusion and a decrease in the overall number of participants involved in the research. Additionally, since the recording of information, such as the frequency of smoking and alcohol consumption was dependent on participants' memory, the obtained statistics may differ from reality. The research presents certain limitations regarding its generalizability too. The sample population was drawn from Dena County, which predominantly consists of individuals of Lur ethnicity. Other confounding factors may also influence the overall accuracy of the collected data. In addition to variations in nutritional intake among individuals, differing levels of stress may impact their physical condition or the way they report their health status. Furthermore, the participants represented a diverse age range, with varying levels of health literacy and access to healthcare facilities.

Conclusion

This study revealed a high prevalence of MetS (37.02%) among adults in Dena County. It is strongly linked with controllable risk factors such as smoking, increased BMI, expanded waist circumference, and abnormal blood markers like FBS, total cholesterol, and TG. Smoking was linked to a higher risk of MetS, while alcohol consumption did not show a significant association. These findings underscore the importance of early interventions such as adopting healthier diets, quitting smoking, and engaging in regular physical activity to lower the risk of developing MetS. Further research is necessary to investigate the mechanisms behind these associations and to create targeted prevention strategies.

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Authors' Contribution

MR: Conception, design, data curation, writing original draft preparation, analysis and interpretation of data, drafting the manuscript, and visualization. FA: Conception, design and data curation. EP: Data acquisition and management. AP: Conception and design. JM: Conception and design. SBP: Conception, design, analysis and interpretation of data, and revising manuscript for intellectual content.

Conflict of Interest

The authors have no conflict of interest.

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