RISK OF METABOLIC SYNDROME LINKED TO TOBACCO SMOKING AND CAFFEINE CONSUMPTION AMONG PALESTINIAN UNIVERSITY STUDENTS

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SUMMARY

Objectives: The aim of the study was to determine the prevalence of metabolic syndrome (MetS) and its association with the use of tobacco smoking and caffeine consumption among Palestinian university students.

Methods: A cross-sectional study was conducted in 2020 among university students at An-Najah National University in the West Bank. MetS was diagnosed according to the National Cholesterol Education Programme. We employed adjusted multiple logistic regression models to address the association between MetS and tobacco smoking and caffeine consumption.

Results: The number of participants was 392. The findings revealed that 9.2% of the students met the diagnostic criteria for MetS, with a significantly higher prevalence in males (14.1%) than females (4.8%) ($p = 0.001$). The study highlighted various substance use rates among participants: 20.2% smoked cigarettes, 28.6% smoked waterpipes, 5.6% smoked e-cigarettes, and 39% consumed energy drinks. Coffee (83.9%) and black tea (84.7%) were also widely consumed. Mean values of triglyceride level ($p = 0.006$), systolic blood pressure ($p < 0.001$), and diastolic blood pressure ($p = 0.016$) were higher in cigarette smokers than nonsmokers. Energy drink consumers had higher levels of triglycerides than non-consumers ($p = 0.015$). Tea consumers had decreased mean values of fast blood sugar ($p = 0.020$) than non-users. The adjusted binary regression revealed that cigarette smokers were at greater risk of MetS (OR = 3.48, $p = 0.009$), and black tea consumers were less likely to have MetS (OR = 0.37, $p = 0.032$). Furthermore, increased BMI was associated with an increased risk of MetS (OR = 1.09, $p = 0.008$). Moreover, waterpipe smokers were at a higher risk of having high triglyceride levels (OR = 5.18, $p = 0.027$).

Conclusion: The study illustrates the health implications of tobacco and energy drink consumption on MetS among Palestinian university students, underlining waterpipe smoking as a pressing health concern linked to elevated triglycerides. These results clarify the MetS burden in Palestine and explore new risks and protective factors.

Key words: cigarette smoking, tobacco products, metabolic syndrome, waterpipe smoking, caffeine addiction

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INTRODUCTION

Non-communicable diseases, including cardiovascular disease and diabetes, have become the leading causes of mortality among Palestinians and have increased sharply in the West Bank in the last decades. University students are prone to use psychostimulants like tobacco, coffee, tea, and energy drinks (ED) to be physically, mentally, and socially active (1). These stimulants are widely used by university students worldwide (2). In recent years, increasing attention has been paid to the high rates of tobacco smoking and ED among Palestinians, especially university students (2, 3). Different alternative tobacco products (ATPs), including waterpipes and electronic cigarettes (e-cigarettes or vapes), are now available in addition to traditional cigarettes (2, 3). Moreover, the prevalence of ED consumption among Palestinians ranged from 60% to 80% in different age groups, with apparent male predominance (4). Many of the studies examining the prevalence of young adult tobacco smoking and ED consumption in Palestine have focused on factors associated with the increased risk of using these substances, including the initiation age, the frequency and the pattern of use, and the co-occurrence of other substances at the same time (2). The initiation age of ED (12 years) was younger than smoking, drinking alcohol, and using drugs (5). Peer pressure and coping with stress were associated

with these substances used by young adult Palestinians (2, 3). University students experience higher rates of stress and are more susceptible to anxiety disorders, and as a result, tend to smoke to cope with stress. Chronic psychological stress could significantly contribute to developing obesity, cardiovascular diseases, and, ultimately, metabolic syndrome (MetS) (6).

Metabolic syndrome (MetS) is associated with an increased risk of cardiovascular disease (atherosclerotic and non-atherosclerotic) as well as diabetes mellitus type 2 (7). Different studies have demonstrated that MetS and its abnormalities are highly prominent among Palestinians aged 6–68 years old in the West Bank (8, 9). The risk factors for MetS among Palestinians are related to obesity. Overweight and obesity, as well as their related diseases, are largely preventable (10). Many ED consumers believe that ED helps lose weight, but relevant data shows that heavy consumption can lead to weight gain and increased body mass index (BMI) (11).

Although tobacco smoking and caffeine consumption are highly prevalent among Palestinian students (3), it remains unclear whether MetS is associated with tobacco smoking and caffeine consumption among them and, if so, whether this association is evident after controlling for the effects of other stimulants. A comprehensive understanding of MetS in the adult population may be essential for the specific direction of prevention strategies. This provides insight into the extent of the MetS burden in Palestine and explores new risk factors. Prevention, identification, and treatment of MetS have become a significant challenge for healthcare professionals in the West Bank in the presence of an epidemic of obesity, tobacco smoking, and ED consumption among young adult Palestinians (12). This study aimed to investigate the association between MetS and tobacco smoking, as well as caffeine consumption, among young adults aged 18 to 25 years at An-Najah National University (ANNU) in the West Bank. The specific objectives were to determine the prevalence of MetS and metabolic abnormalities among Palestinian university students, assess the prevalence of tobacco smoking (including cigarettes, waterpipes and e-cigarettes) and caffeine consumption (including coffee, energy drinks, and black tea), and examine the relationship between MetS and metabolic abnormalities in relation to tobacco smoking and caffeine consumption.

MATERIALS AND METHODS

Study Design and Setting

Palestinian students from An-Najah National University were recruited to participate in a cross-sectional study conducted in 2020. Students were recruited through social media and flyers. The research was conducted in two stages. In the first stage, informed consent was obtained, anthropogenic measurements were taken, and the questionnaire was filled out. In the second stage, the students were asked to fast for 10–12 hours if they were not fasting, and blood samples were taken on the second day. In phase one, 1,470 questionnaires were distributed, 1,158 subjects responded, and 43 questionnaires were discarded as they had incomplete information. One eligible student out of three was chosen to give a blood sample, 39 subjects refused to give blood samples, and 13 haemolysis blood samples were discarded. The participant was excluded if he/she has Cushing syndrome, hypo- or hyperthyroidism, epilepsy, or taking regular medications other than anti-diabetic or lipidemic medication as indicated by him/her. Moreover, the student was excluded if he/she has haemophilia, psychiatric, cognitive or developmental disorders, fever, flu, or any other acute disease to prevent any possible risk from blood withdrawal (12). Ethical approval was obtained from the Institutional Review Board at An-Najah National University in Palestine.

Study Tools and Validity

The self-administered questionnaire was used and validated in previous studies to assess the practice and the pattern of tobacco and caffeine products (13). Metabolic syndrome was diagnosed based on the National Cholesterol Education Programme (NCEP) III criterion (14). It was defined as the presence of three or more of the following criteria: fasting triglycerides (TG) $\geq$ 150 mg/dL, high-density lipoprotein (HDL) cholesterol < 40 mg/dL, waist circumference (WC) $\geq$ 102 cm for men and $\geq$ 88 cm for women, systolic blood pressure and/or diastolic blood pressure $\geq$ 130/85 mmHg, and fasting blood glucose (FBG) $\geq$ 100 mg/dL or treatment for elevated blood glucose levels. For all participants, weight and height were measured while they were dressed in light clothing and not wearing shoes. Weight was recorded to the nearest 0.1 kg, and height to the nearest 0.1 cm. WC was measured at the midpoint between the inferior margin of the thoracic cage and the superior border of the iliac crest during minimal inspiration. BMI was calculated by dividing weight (in kg) by the squared height (in m^2). Blood pressure was measured twice with the subject seated and the arm at heart level, after at least 5 minutes of rest. A standardized mercury sphygmomanometer (TXJ-10, China) was used to take these measurements to the nearest 1 mmHg, with an appropriate cuff size. The mean of these two readings was used to represent the individual's systolic and diastolic blood pressures. For laboratory measurements, blood samples were collected from all subjects early in the morning after a 12-hour overnight fast. At An-Najah Hospital Laboratory, 5 ml of venous blood was drawn from the antecubital vein while the subject was seated, specifically for fasting blood sugar (FBS) and lipid profile analysis. The fasting blood tests for triglycerides and HDL cholesterol were conducted using the Roche/Hitachi Chemistry Analyzer Cobas C 311, Cobas C501/502, which has detection limits of 0.3 mg/dL, 0.8 mg/dL, and 0.2 mg/dL, respectively. Anthropometrics and blood pressure measurements, venous blood collection and biochemical analysis, and measurement tools accuracy and precision assessment were used and published in the previous work (8).

Data Analysis

Data were analysed using IBM SPSS Statistics for Mac, version 22 (IBM Corp., Armonk, NY, USA). The association between MetS and substances was examined through independent t-test, ANOVA test, Pearson's chi-square test, and Fisher's exact test whenever appropriate. The p-value $\leq$ 0.05 was considered statistically significant. In addition, binary logistic regression analysis generated the odds ratios (OR) and 95% confidence intervals (CI) for risk factors. To assess the relationship between tobacco smoking and caffeine consumption with MetS (Model 1) or elevated triglycerides (Model 2), binary regression models were adjusted for age, BMI, and gender.

RESULTS

General Socio-demographic and Biomedical Characteristics of the Participants

This study's final number of participants was 392 (46.9% males and 53.1% females). Most participants were from the Faculty of Medicine and Health Sciences (64.5%) (Table 1). The overall prevalence of MetS according to NCEP criteria was 9.2% (14.1% in males vs. 4.8% in females, p = 0.001). Low HDL level was the most common MetS abnormality (40.8%) with no gender differences, followed by obesity – 28.6% (41% in males vs. 16.8% in females), high fast blood glucose (12.2%), increased diastolic blood pressure (11.0%), high LDL (6.6%), and high triglycerides (5.9%) with significant male predominance for all these abnormalities ($p < 0.05$). The prevalence of tobacco smoking and caffeine consumption in this study were as follows: cigarette smoking (20.2%), waterpipe smoking (28.6%), e-cigarette smoking (5.6%), and ED consumption (39%), with significant male predominance ($p < 0.05$). The most commonly used substances were coffee (83.9%) and tea (84.7%), with no differences between males and females observed in tea consumption ($p > 0.05$). The earliest initiation age was for coffee consumption, which occurs at an average of 14.9 years. This is followed by ED consumption at 16.8 years. Waterpipe smoking had an initiation age of 16.9 years, while cigarette smoking begins at an average age of 17.1 years. The latest initiation age is for e-cigarette smoking, which occurs at 18.3 years. Other information related to the mean initiation age for all substances is presented in Table 1.

Supplementary Material describes the pattern and frequency of the substances used among university students based on gender. Daily use for the tobacco smoking and caffeine consumption was as follows: cigarette smoking (54.4%), waterpipes smoking (17.8%), ED consumption (11.9%), and coffee consumption (43.1%). The daily tea consumption pattern was the most frequent in both genders (44.8% in males vs. 42.4% in females) (Supplementary Table 1).

Differences in Mean Values of Metabolic Abnormalities between Users and Non-users

Cigarette smokers had higher mean values of triglyceride level ($p = 0.006$), systolic blood pressure ($p < 0.001$), and diastolic blood pressure ($p = 0.016$) than nonsmokers. Energy drink consumers had higher levels of triglycerides than non-consumers ($p = 0.015$). Tea consumers had decreased mean values of fast blood sugar ($p = 0.020$) than non-users (Table 2).

Univariate Analysis of MetS and Association with Tobacco Smoking and Caffeine Consumption

Compared to nonsmokers, cigarette smokers showed a significantly increased risk of metabolic syndrome with an odds ratio (OR) of 4.84 ($p < 0.001$). Waterpipe smokers had an OR of 2.17 ($p = 0.027$), while e-cigarette users had an OR of 3.22 ($p = 0.024$). Additionally, males were found to have a higher risk of MetS compared to females (OR = 3.25, $p = 0.001$). Obese students, defined as having BMI 25 or greater, also had an increased risk (OR = 4.07, $p < 0.001$). In contrast, tea consumption was linked to a decreased risk of MetS (OR = 0.36, $p = 0.008$). No other significant associations were found between MetS and other substances (Table 3).

Adjusted Logistic Regression Models

The adjusted binary regression for the association of MetS and tobacco and caffeine use (Model 1) revealed that cigarette smokers have a higher risk of developing MetS with OR = 3.48 and $p = 0.009$ compared to nonsmokers. Conversely, tea consumers were at a significantly lower risk of MetS, with OR = 0.37 and $p = 0.032$ when compared to non-consumers. Additionally, an increased BMI was correlated with a higher risk of MetS, showing OR = 1.09 and $p = 0.008$ when compared to individuals with a normal weight (Table 4). Model 2 included adjusted binary regression results for the association of high triglycerides and tobacco smoking and caffeine consumption.

Waterpipe smokers were at a higher risk of having high triglyceride levels (OR = 5.18, $p = 0.027$) than non smokers. Males were at higher risk of having high triglyceride levels (OR = 9.645, $p = 0.005$) than females. In addition, increased BMI was also associated with an increased risk of high triglycerides (OR = 1.16, $p = 0.001$) (Table 5).

DISCUSSION

This study revealed that metabolic syndrome and its abnormalities are highly prevalent and associated with tobacco and caffeine products among university students. According to NCEP criteria, the total prevalence of MetS among students was 9.2%, with a significant male predominance. This high prevalence of MetS in both genders is alarming as it is higher than in international university students (15, 16).

It was demonstrated in previous local studies that MetS was more predominant in males than females in overweight and obese university students (12), refugee children (9, 17), and adults (8, 18), with no significant differences. In this study, the prevalence of Mets in males was approximately threefold more significant than in females. Males were also at higher risk of increased obesity and ultimately MetS than females. In agreement with previous local studies (12), the most prevalent component of MetS among study participants was low HDL-cholesterol (40.8%), followed by central obesity (22.2%), high blood pressure (13%), high FBS (12.2%), high LDL-cholesterol (6.6%), and high triglycerides (5.9%). These metabolic abnormalities were significantly more predominant in males than females, except for low HDL levels.

In this study, MetS was more prevalent in cigarette smokers than nonsmokers (OR = 3.8, $p = 0.009$). Male students have a higher prevalence of consumption of all tobacco products than females. Cigarette smoking was approximately six times, and waterpipe smoking was 1.5 times more common in males than in females. These gender differences in tobacco product smoking were also observed in previous studies involving Palestinian university students (2, 3). These differences also extend to the pattern of smoking. Male cigarette smokers had a considerably higher daily smoking prevalence (67.2%) than female smokers (20.0%). However, a narrower gender gap was observed in daily waterpipe smoking (20.3% of males and 15.6% of females). Moreover, smoking of ATP was highly prevalent among students. Waterpipe

Table 1. *General socio-demographic and biomedical characteristics of the participants*

		Total n (%)	Males n (%)	Females n (%)	p-value
General characteristics					
Residency	City	203 (51.8)	99 (53.8)	104 (50.0)	
	Village	179 (45.7)	78 (42.4)	101 (48.6)	
	Camp	10 (2.6)	7 (3.8)	3 (1.4)	
Marital status	Single	384 (98.0)	182 (98.9)	202 (97.1)	
	Not single	8 (2.0)	2 (1.1)	6 (2.9)	
Faculty	Medical and health sciences students	242 (64.5)	106 (43.8)	136 (56.2)	
	Non-medical students	133 (35.5)	71 (53.4)	62 (46.6)	
Metabolic syndrome and biomedical analysis					
Metabolic syndrome	Yes	36 (9.2)	26 (14.1)	10 (4.8)	0.001*
Body mass index	≥ 25	112 (28.6)	77 (41.8)	35 (16.8)	< 0.001*
	< 25	280 (71.4)	107 (58.2)	173 (83.2)	
Diastolic blood pressure	High	43 (11.0)	34 (18.7)	9 (4.3)	< 0.001*
Systolic blood pressure	High	29 (7.4)	25 (13.7)	4 (1.9)	< 0.001*
Systolic or diastolic blood pressure	High	51 (13.0)	42 (22.8)	9 (4.3)	< 0.001*
Low-density lipoprotein level	High	26 (6.6)	17 (9.3)	9 (4.3)	0.049*
Glucose blood level	High	48 (12.2)	31 (16.8)	17 (8.2)	0.009*
Triglyceride blood level	High	23 (5.9)	21 (11.4)	2 (1.0)	< 0.001*
High-density lipoprotein level	Low	160 (40.8)	78 (42.4)	82 (39.4)	0.551
Waist circumferences	High	13 (3.3)	3 (1.6)	10 (4.8)	0.080
Tobacco smoking and caffeine consumption					
Cigarettes	Yes	79 (20.2)	67 (36.4)	12 (5.8)	< 0.001*
Cigarettes/water pipes	Both of them	46 (11.7)	37 (20.1)	9 (4.3)	< 0.001*
	One of them	99 (25.3)	57 (31.0)	42 (20.2)	
Waterpipe	Yes	112 (28.6)	64 (34.8)	48 (23.1)	0.010*
E-cigarettes	Yes	22 (5.6)	16 (8.7)	6 (2.9)	0.013*
Energy drinks	Yes	153 (39.0)	90 (48.9)	63 (30.3)	< 0.001*
Coffee	Yes	329 (83.9)	154 (83.7)	175 (84.1)	0.906
Energy drinks/coffee	Both of them	146 (37.2)	85 (46.2)	61 (29.3)	0.001*
	One of them	246 (62.8)	99 (53.8)	147 (70.7)	
Tea	Yes	331 (84.7)	154 (83.7)	177 (85.5)	0.620
Initiation age in years, mean (SD)	Cigarette smoking	17.1 (2.5)	17.1 (2.6)	16.7 (1.8)	0.417
	Waterpipe smoking	16.9 (2.5)	16.7 (2.8)	17.4 (1.8)	0.001*
	E-cigarette smoking	18.3 (1.5)	18.6 (1.7)	17.71 (1.0)	0.776
	Energy drink consumption	16.8 (9.4)	16.8 (11.4)	16.80 (2.8)	< 0.001*
	Coffee consumption	14.9 (2.9)	14.84 (2.9)	15.00 (2.9)	0.049*
	Tea consumption	9.2 (3.8)	8.93 (3.5)	9.37 (4.06)	0.366

*Significant level < 0.05; SD – standard deviation

smoking was the most common tobacco product used, with a prevalence of 28.6%, followed by cigarette smoking (20.2%) and e-cigarettes (5%). Moreover, it was determined previously that waterpipe smoking among university students could be associated with unhealthy food behaviours for weight loss (19).

In contrast to other studies, waterpipe smoking was not significantly associated with an increased risk of MetS (20, 21). However, in agreement with a local survey of adolescent students (17), waterpipe smoking was associated with high triglycerides, indicating that the waterpipe is an independent risk factor for increased triglycerides. Thus, Palestinian students are at higher risk of cardiovascular diseases at an early age. The lipid profile, markedly linked to cardiovascular diseases and dyslipidaemia, is associated with atherosclerosis, obesity, and diabetes (22). Therefore, cigarette smoking is likely to play a crucial role in increasing MetS rates in males more than females, resulting in a wide gender gap in MetS prevalence. This association between tobacco smoking and MetS is consistent with the results of previous studies

Table 2. *Mean differences in metabolic abnormalities between substance users and non-users*

		Cigarette			Water pipe			Energy drink		
		Mean	**SE**	**p-value**	**Mean**	**SE**	**p-value**	**Mean**	**SE**	**p-value**
FBS	Yes	91.84	1.24	0.502	90.52	1.14	0.416	90.26	0.91	0.148
	No	91.01	0.48		91.35	0.46		91.61	0.48	
Triglycerides	Yes	96.27	6.79	0.006*	83.29	3.61	0.859	87.35	3.56	0.015*
	No	80.14	2.14		82.42	2.55		80.15	2.61	
HDL	Yes	81.47	4.13	0.480	79.24	3.10	0.933	82.66	2.75	0.074
	No	78.58	1.58		78.96	1.68		77.12	1.72	
LDL	Yes	57.31	3.73	0.330	59.05	2.99	0.590	59.27	2.41	0.580
	No	60.80	1.370		60.67	1.41		60.78	1.51	
Average systolic BP	Yes	123.43	1.37	< 0.001*	118.36	1.40	0.418	119.15	1.041	0.171
	No	116.93	0.702		117.80	0.72		117.31	0.81	
Average diastolic BP	Yes	77.72	0.814	0.016*	75.97	0.85	0.706	75.89	0.68	0.392
	No	74.97	0.463		75.20	0.47		75.14	0.52	
		Coffee			**Black tea**			**Chocolate**		
		Mean	**SE**	**p-value**	**Mean**	**SE**	**p-value**	**Mean**	**SE**	**p-value**
FBS	Yes	90.96	0.49	0.367	90.71	0.48	0.020	91.04	0.46	0.20
	No	92.05	1.075		93.61	1.120		92.57	1.83	
Triglycerides	Yes	82.78	2.290	0.881	83.07	2.28	0.620	81.94	2.15	0.620
	No	81.92	5.46		80.13	5.63		92.87	10.03	
HDL	Yes	79.02	1.60	0.990	78.22	1.59	0.191	78.35	1.52	0.191
	No	79.07	3.82		83.64	3.93		88.98	5.90	
LDL	Yes	60.65	1.42	0.491	60.86	1.41	0.271	60.59	1.29	0.271
	No	58.24	3.20		56.86	3.20		55.35	7.30	
Systolic BP	Yes	117.67	0.72	0.329	117.74	0.70	0.458	117.29	0.66	0.458
	No	119.38	1.31		119.04	1.56		126.69	2.16	
Diastolic BP	Yes	75.26	0.46	0.444	75.22	0.46	0.318	75.05	0.43	0.318
	No	76.13	0.94		76.36	0.93		80.00	1.28	

*Significant level < 0.05, FBS – fast blood sugar; HDL – high-density lipoprotein; LDL – low-density lipoprotein; BP – blood pressure

(20, 21). However, with the increased rate of tobacco smoking, especially waterpipes among females, Palestinian females could be at high risk of MetS in the future.

Further studies are required to address the comorbidity of increased waterpipe smoking among Palestinian females. Given that MetS prevalence was high among students and that MetS has catastrophic consequences on health, we recommend urgently creating effective screening protocols for university students, focusing on male and female students since they were predominantly affected. There is a critical need to address students' smoking and high BMI issues by raising health awareness and creating smoking cessation programmes. Smoking cessation and weight loss can reduce the risk of developing MetS and improve concurrent MetS components in patients (23). More efforts are needed to prevent smoking among young adults and, ultimately, the increased risk of mortality and comorbidity of metabolic syndrome.

Cigarette smoking in university students often occurs in the context of other psychostimulant use, such as coffee and ED (4, 13). In agreement with previous studies, ED consumption was highly prevalent among students with male predominance (4, 13). The relationship between ED consumption and MetS somehow remains ambiguous and needs more analysis and research (24). In contrast to results in children (17), ED consumption was not associated with an increased risk of MetS or abnormalities. However, these results are consistent with other studies (24). Despite the lack of association with MetS in our study, the triglyceride levels were higher in ED consumers than in non-consumers. Moreover, it is known that caffeine exhibited a stimulatory effect (25), resulting in increased heart rate, blood pressure, serum glucose, and bronchodilation (26). Based on the early initiation age and comparing previous adolescents' results (17), we recommend conducting more studies targeting different age groups to investigate the effect of ED on MetS and lipid profile. Comparing the results between other age groups will give the medical community a more detailed insight into the aetiology of MetS.

In this study, black tea consumption was highly prevalent and significantly associated with a decreased risk of metabolic syndrome. Black tea consumers also had low fasting blood sugar levels and systolic and diastolic blood pressure. These findings add to the current evidence about such beneficial effects of tea against MetS (27). This protective effect of tea is thought to be excreted via its anti-oxidant activity, weight loss inducing ef-

Table 3. *Univariate analysis of associated metabolic syndrome and cognitive enhancers and psychostimulants*

Factors		Having metabolic syndrome	Not having metabolic syndrome	OR	95% CI	p-value
Cigarettes	Yes	18 (22.8)	61 (77.2)	4.84	2.38–9.83	< 0.001*
	No	18 (5.8)	295 (94.2)			
Waterpipe	Yes	16 (14.3)	96 (85.7)	2.17	1.08–4.35	0.027*
	No	20 (7.1)	260 (92.9)			
E-cigarettes	Yes	5 (22.7)	17 (77.3)	3.22	1.11–9.31	0.024*
	No	31 (8.4)	339 (91.6)			
Coffee	Yes	28 (8.5)	301 (91.5)	0.64	0.28–1.48	0.292
	No	8 (12.7)	55 (87.3)			
Energy drink	Yes	19 (12.4)	134 (87.6)	1.85	0.93–3.69	0.076
	No	17 (7.1)	222 (92.9)			
Black tea	Yes	25 (7.6)	306 (92.4)	0.36	0.17–0.79	0.008*
	No	11 (18.3)	49 (81.7)			
Gender	Male	26 (14.1)	158 (85.9)	3.258	1.526–6.988	0.001*
	Female	10 (4.8)	198 (95.2)			
Body mass index	≥ 25	21 (18.8)	91 (81.3)	4.077	2.016–8.244	< 0.001*
	< 25	15 (5.4)	265 (94.6)			

*Significant level < 0.05; OR – odds ratio; CI – confidence interval

Table 4. *Adjusted binary logistic regression for association between metabolic syndrome and tobacco smoking and caffeine consumption*

Category	Reference group	OR	95% CI	p-value
Cigarette smoking (yes)	No	3.48	1.37–8.86	0.009*
Water pipe smoking (yes)	No	1.23	0.52–2.93	0.641
Electronic cigarette (yes)	No	0.83	0.23–3.02	0.773
Energy drinks consumption (yes)	No	1.11	0.47–2.63	0.820
Black tea (yes)	No	0.37	0.15–0.92	0.032*
Coffee consumption (yes)	No	0.58	0.22–1.52	0.266
Age		1.03	0.84–1.25	0.797
Gender (male)	Female	1.70	0.70–4.10	0.239
Body mass index (≥ 25)	< 25	1.09	1.02–1.17	0.008*

Dependent variable: metabolic syndrome; *significant level < 0.05; OR – odds ratio; CI – confidence interval

Table 5. *Adjusted binary logistic regression for association between increased triglycerides levels and tobacco smoking and caffeine consumption*

Category	Reference group	OR	95% CI	p-value
Cigarette smoking (yes)	No	1.85	0.61–5.63	0.279
Water pipe smoking (yes)	No	5.18	1.20–22.2	0.027*
Electronic cigarette (yes)	No	1.87	0.352–9.96	0.462
Energy drinks consumption (yes)	No	1.325	0.456–3.85	0.605
Black tea (yes)	No	0.398	0.120–1.32	0.132
Coffee consumption (yes)	No	0.525	0.159–1.733	0.290
Chocolate (yes)	No	2.478	0.414–14.84	0.321
Gender (male)	Female	9.645	2.02–46.15	0.005*
Body mass index		1.125	1.03–1.23	0.012*
Age		0.983	0.7649–1.329	0.904

Dependent variable: elevated triglyceride levels; *significant level < 0.05; OR – odds ratio; CI – confidence interval

fect, blood pressure, glucose-lowering effect, and improvement of dysfunctional lipid metabolism (28). In agreement with other studies, chocolate consumers' mean average systolic and diastolic blood pressure levels were lower than in non-consumers (29). Therefore, we recommend raising awareness about the benefits of tea consumption, including the protective effect against MetS and its components and the danger of ED consumption. We also recommend implying restrictions on ED availability on campuses in Palestine due to its very high prevalence among students and its catastrophic side effects profile.

This study includes some limitations. First, this study had a self-administered questionnaire, which made it prone to recall bias. Second, no temporal directionality between MetS and the substance consumed could be drawn. Finally, this study did not include quantitative data regarding substances consumed by students. Despite these limitations, this study was the first study to identify some common psychoactive substances and their association with prevalent metabolic abnormalities among Palestinian students and young adults.

CONCLUSION

This study showed an alarming prevalence of MetS among both genders and cigarette smokers, requiring unique treatment and prevention strategies. Moreover, black tea consumption was associated with a significantly decreased risk of MetS. Our findings highlight waterpipe smoking as a significant health problem in students with increased triglycerides. The waterpipe gender gap in university students was narrow compared to the previous results, prompting the focus on female smoking in future studies. We recommend conducting further research to investigate the risk of cigarette and waterpipe smoking in different age groups based on initiation age results. More attention should be given to children and young adults to reduce the risk of metabolic syndrome and associated morbidity and mortality and increase awareness about smoking problems, cigarettes, waterpipes, and the benefits of black tea.

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Conflicts of Interest

None declared

Adherence to Ethical Standards

Ethical approval was obtained from the Institutional Review Board (IRB) at An-Najah National University (ANNU) in Palestine. The study followed the ethical standards of the Declarations of Helsinki. All participants were assured of respect, privacy, and confidentiality. Consent from all participants was signed and obtained before participation. Furthermore, all participants were assured that all data would be confidential and available to the researcher only.

Electronic Supplementary Materials

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