

Original Article

Association between qat chewing and dyslipidaemia among young males

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المخلص

أهداف البحث: بحثت هذه الدراسة العلاقة بين تناول القات وانتشار وأنماط اختلال دهون الدم بين الشباب اليمني.

طرق البحث: في هذه الدراسة المستعرضة، استخدمنا طريقة أخذ العينات العنقودية العشوائية متعددة المراحل. تم الحصول على البيانات باستخدام استبانة، والقياسات البشرية وعينات الدم في حالة الصيام. كما تم استخدام معايير البرنامج الوطني الأمريكي التعليمي للكوليسترول-برنامج معالجة البالغين ٣. كما تم تحليل عينات الدم لقياس مستويات الدهون بما في ذلك مستويات الكوليسترول الكلي، والدهون الثلاثية وكوليسترول البروتينات الدهنية منخفضة الكثافة، وكوليسترول البروتينات الدهنية عالية الكثافة.

النتائج: تم تسجيل ٣٦٠ من طلاب الجامعات اليمنية الذكور في الدراسة بمتوسط عمر ٢١.٤ ± ٣.٦ سنة. تم تقسيم الطلاب إلى مجموعتين؛ متناولي القات (ن = ٢٨٣) والمجموعة الضابطة (ن = ٧٧). كان معدل انتشار اختلال دهون الدم بشكل علم أعلى بشكل ملحوظ في فئة متناولي القات مقارنة مع غير متناولي القات (٨٩.٨٪ مقابل ٨٠.٥٪). كانت نسبة فرط كوليسترول الدم، وفرط الدهون الثلاثية في الدم، وفرط كوليسترول البروتينات الدهنية منخفضة الكثافة، وفرط الدهون المختلطة في الدم أقل عند متناولي القات مقارنة بغيرهم (١٦.٦٪، ٥٨.٣٪، ١٦.٣٪، ١٠.٦٪، على التوالي، مقابل ٢٠.٨٪، ٦٤.٩٪، ١٨.٢٪، ٢٠.٨٪، على التوالي). كما لوحظ ارتفاع شحوم الدم المنفرد بشكل طفيف عند متناولي القات منه في غيرهم (٤٧.٧٪ مقابل ٤٤.٢٪). من ناحية أخرى لوحظ زيادة انتشار انخفاض كوليسترول البروتينات الدهنية عالية الكثافة وانخفاض كوليسترول البروتينات الدهنية عالية الكثافة المنفرد وفرط كوليسترول الدم المنفرد عند فئة متناولي القات مقارنة مع فئة غير متناولي القات (٨٣٪، ٢٥.١٪، ٦٪، على التوالي، مقابل ٧٥.٣٪، ١٥.٦٪، و صفر ٪، على التوالي).

الاستنتاجات: أظهرت هذه الدراسة ارتفاع معدل انتشار اختلال دهون الدم بين متناولي القات من الشباب اليمنيين. وكذلك انخفاض كوليسترول البروتينات الدهنية

عالية الكثافة، ثم فرط دهون الدم الثلاثية كانا أكثر أنواع الاضطرابات الدهنية عند متناولي القات. قد يكون للعوامل الوراثية، ولظروف الحرب، وقلة الحركة، ولنوع الغذاء اليمني التقليدي قليل الدهون من العوامل المحددة لهذه النتيجة.

الكلمات المفتاحية: اختلال دهون الدم؛ المنظور الدهني؛ انتشار؛ تناول القات؛ اليمن

Abstract

Objectives: This study investigated the association between qat chewing and prevalence and patterns of dyslipidaemia among young Yemeni males.

Methods: In this cross-sectional study, we used a multi-stage random cluster sampling method. Data were obtained using a questionnaire. Additionally, anthropometric measurements and fasting blood samples were collected. We used Program-Adult Treatment Panel III. The blood samples were analysed for lipid profile measurements including levels of total cholesterol, triglycerides, low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C).

Results: A total of 440 Yemeni male with mean age of 21.4 ± 3.6 years were enrolled. The students were divided into the following two groups—qat chewers (n = 283) and non-qat chewers (n = 77). The overall occurrence of dyslipidaemia was significantly higher in qat chewers than that in non-qat chewers (89.8% versus 80.5%) (*P* < 0.05). Hypercholesterolaemia, hypertriglyceridaemia, high LDL-C level, and mixed hyperlipidaemia were lower in qat chewers than in non-qat chewers (16.6%, 58.3%, 16.3%, and 10.6%, respectively, versus 20.8%, 64.9%, 18.2%, and 20.8%, respectively). Isolated hypertriglyceridaemia was slightly higher in qat chewers than in non-qat chewers (47.7% versus 44.2%). However, the

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incidence of low HDL-C level, isolated low HDL-C level, and isolated hypercholesterolaemia were generally higher in qat chewers than in non-qat chewers (83%, 25.1%, and 6%, respectively, versus 75.3%, 15.6%, and 0%, respectively).

Conclusion: This study showed high prevalence of dyslipidaemia among Yemeni male qat chewers. Low HDL-C level was the main lipid variable, followed by hypertriglyceridaemia. Genetic factors, war conditions, physical inactivity, and low-fat traditional Yemeni diet were considered the determinants of the study findings.

Key words: Dyslipidaemia; Lipid profile; Prevalence; Qat chewing; Yemen

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Introduction

The qat (*Catha edulis* Forsk.) belongs to the family *Celastraceae* and is known with many other names such as khat and miraa. The green soft leaves (Figure 1) of qat have an astringent taste and an aromatic odour and are consumed

through chewing.¹ In terms of distribution, qat is cultivated widely in several countries in Africa and Yemen (Figure 1). It is assumed that this plant originated in Ethiopia and subsequently was introduced to Yemen during the trade trips from Africa.² The habit of chewing qat is significantly increasing among different categories of people in Yemen and Africa. Hence, it becomes a social habit and is even being transferred to other surrounding countries where the chewers live.³ Young leaves of qat are rich in several chemical compounds mainly alkaloids, glycosides, flavonoids, sterols, terpenoids, tannins, and amino acids. Additionally, these leaves also contain other compounds such as vitamins and minerals.⁴ Among the chemical compounds found in qat, cathinone and cathine are the most important alkaloids due to their stimulating effects. The effects of cathinone and amphetamine in the body are relatively similar. The mechanism of qat action includes the activation and release of dopamine neurotransmitter from its storage (presynaptic).⁵ The process of consuming qat by chewing includes some specific steps and certain timing. Individuals chew fresh and young flushing leaves between 4 and 6 h commencing, in most cases, in the afternoon (1–2 pm).⁶ Qat consumers start chewing the young leaves and store them in either side of the cheeks and gradually fill that side of the mouth with qat. Subsequently, they slowly chew that mass, which results in the slow release of the active compounds of qat. These substances are mixed with the saliva and are swallowed.⁷ The absorption of these active chemicals occurs either sublingually or through the

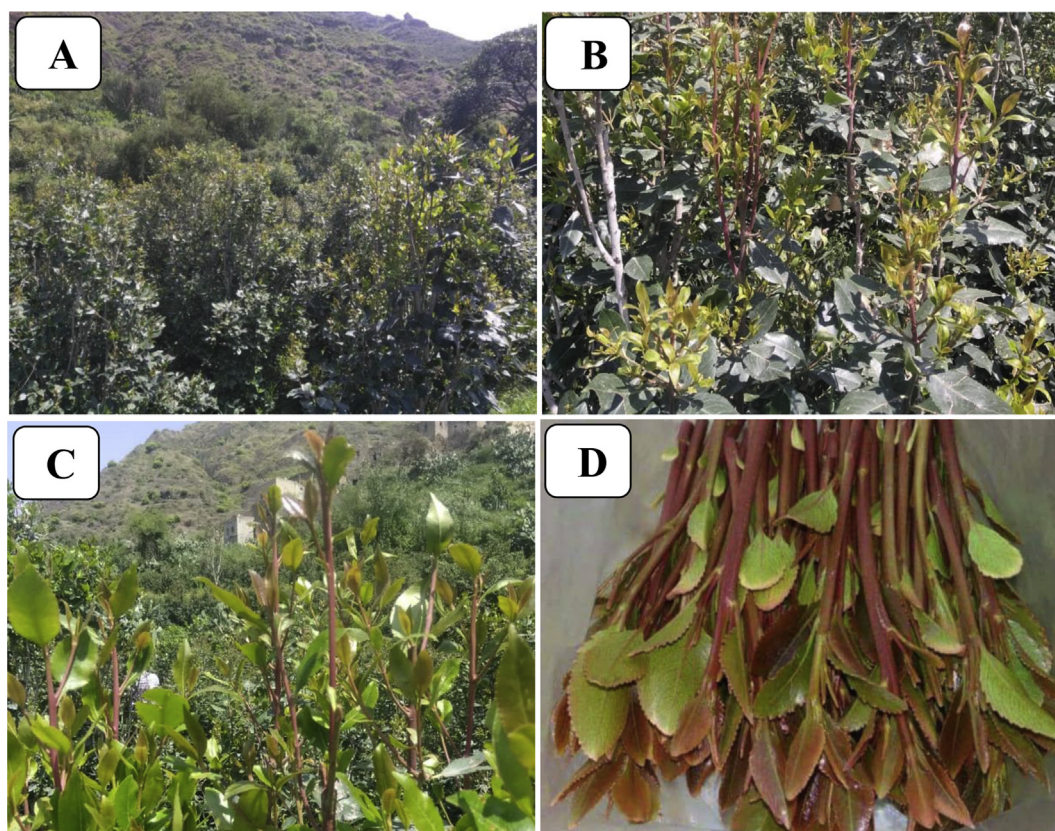


Figure 1: Colour images of qat (*Catha edulis*). A–C: Qat farms in Yemen with different magnifications, D: cultivated qat leaves for chewing purposes.

gastrointestinal tract, and the chewers start feeling active. Consumption of qat is not merely a social habit; it is also chewed for other reasons such as alleviation of depression and relief from fatigue. Some individuals chew qat to significantly stimulate their body. For instance, for students, they chew qat because it helps them to focus during exams, or for labourers doing handy jobs, it helps them specifically when requiring significant efforts and additional energy.⁸ In Yemen and some eastern African countries, some reported statistics showed that 80%–90% of adult males and 10%–60% of adult females consume qat on a daily basis.⁹ Among all the risk factors for cardiovascular diseases (CVD), dyslipidaemia is one of the most crucial factors that evidently lead to CVD worldwide. There is a high percentage of mortality due to CVD. In the recent report of the World Health Organization, death due to CVD is remarkably high with an estimation of 17.7 million deaths annually.¹⁰ On the contrary, the presence of dyslipidaemia during advanced age results in high risk of CVD with increasing age.¹¹ There are a reasonable number of studies regarding the physiological and biochemical effects of qat in humans. However, the influence of chewing qat on the lipid profile and dyslipidaemia is insufficiently investigated. Therefore, the present study aimed to investigate the association between qat chewing and prevalence and patterns of dyslipidaemia among Yemeni young males.

Materials and Methods

Study population

The present study was a cross-sectional study and was conducted in a 6-month duration (from April 1 to September 30, 2018). All subjects were selected from different faculties of Ibb University (Ibb, Yemen). Ibb University has ten faculties and nearly 14,000 students. The percentage of males constitutes approximately 60% of the total number of undergraduate students in this university. Sampling of the subjects was conducted following the multistage stratified random sampling method to ensure students from different faculties and various levels were included in the study (i.e. academic year). The faculty division (department) student lists of theoretical and practical classes were adapted as small groups. Each group consisted of 15–30 students. In each academic year, 1–2 clusters were randomly chosen. The fact that 87% of Yemeni university students had dyslipidaemia was taken into consideration when calculating the sample size according to a recent study.¹² Statistical significance of 0.05 was considered during the analyses, and the power of the study was 90%. After the necessary calculations, the sample size was estimated to be 200. Hence, a total of 440 Yemeni male students aged between 18 and 25 years were included in this study. Out of this number, 360 male students agreed in completing the study. The calculated response rate was 81.8%.

Data collection and measurements

First, the questionnaire forms were distributed among students. The questionnaire provides the necessary

demographic data (age, sex, faculty, and residence) and healthy and dietary habits (qat chewing, smoking tobacco, physical exercise, consumption of fast food and vegetable and fruit proportion in the meals). Moreover, only male qat chewers and non-qat chewer healthy students who had no chronic diseases (hypertension, diabetes mellitus, renal or liver diseases) and those who agreed to complete the study were included. Students who smoke and those taking prescribed medications affecting lipid profiles were excluded. A total of 440 Yemeni male students (18–25 years old) were included at this step of the study. Only 360 male students agreed to complete the study. Students were requested to fast for 10–12 h prior to collecting the blood samples. All measured data and collected blood samples were analysed at the outpatient department of the Al-Thawra Modern General Hospital, a public hospital in Ibb (Yemen). As a reliable tool in validating the data, subjects' body mass index (BMI), which involves the ratio between the weight in kilogram and squared value of height in metre, was recorded. After the blood samples were obtained, they were processed in a centrifuge and appropriately stored until further analyses. The blood samples were analysed for lipid profile measurements including levels of total cholesterol (TC), triglycerides (TGs), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C). For the tests, Spinreact diagnostic enzymatic reagents (Spain) and a spectrophotometer (Roche Cobas C311, Hitachi, Germany) were used.

Definition of variables

Regular qat chewer was defined as an individual who chews qat for 4 h or more daily or even occasionally for the past 1 year. Non-qat chewer was defined as an individual who does not chew qat daily or occasionally for the past 1 year. According to the National Cholesterol Education Program-Adult Treatment Panel III criteria,¹³ dyslipidaemia is defined if one or more of the following situations are noted: hypertriglyceridaemia (TG levels ≥ 150 mg/dl), hypercholesterolaemia (TC level ≥ 200 mg/dl), high LDL cholesterol (LDL cholesterol level ≥ 130 mg/dl), and low HDL cholesterol (HDL cholesterol level < 40 mg/dl in males). However, isolated hypercholesterolaemia was observed when the sample has a TC level of more than 200 mg/dl and TG level less than 150 mg/dl. Furthermore, isolated hypertriglyceridaemia was reported if the serum values of TGs were more than or equal to 150 mg/dl and TC less than 200 mg/dl. The isolated low HDL-C was considered if the subject had a HDL-C level less than or equal to 40 mg/dl in males with neither hypercholesterolaemia nor hypertriglyceridaemia; mixed hyperlipidaemia was reported if the subject had TGs more than or equal to 150 mg/dl and TC more than or equal to 200 mg/dl.

As previously stated, the BMI has been included as a valid measurement for lipid profile indication. The normal weight is known if the BMI is less than 25 kg per m² of the body. Overweight and obese bodies are those with BMI of 25–29.9 kg/m² and ≥ 30 kg/m², respectively.¹⁴ When the waist circumference is more than 120 cm in men, this is defined as central obesity.¹⁴ This case is associated with high blood pressure (hypertension) as the pressure is more than

140 mmHg (systolic) and more than 90 mmHg (diastolic).¹⁵ When estimating physical exercises, moderate activities for more than 30 min per day for 5 days at least a week was considered as regular physical activities.¹⁶ The frequency of fast-food consumption was defined if the subject eats fast food (pizza, fried chicken, and hamburger) at least three times a week.¹⁷

Statistical analysis

The data were analysed statistically using the software package of the Statistical Package for the Social Sciences (International Business Machines Corporation, version 20.0 for Windows). The data were entered, coded, and analysed accordingly. The data were analysed descriptively for mean, standard deviation, frequencies, and percentage values for qualitative (e.g. demographic variables) and quantitative variables (TC, TG, HDL, and levels LDL). Independent sample T-test was used to compare the means of anthropometric and lipid profile parameters among different groups of students. However, chi-squared test was conducted to determine the association between dyslipidaemia and the qualitative variables. The statistical tests were examined for significance at the level of $P = 0.05$. An Excel was used to generate Venn diagrams.

Results

A total of 440 Yemeni male university students aged between 18 and 25 years (21.4 ± 3.6) were enrolled in this study. Out of this, 360 students agreed and completed the

study. **Table 1** demonstrates the basic detailed data of the participating subjects. The non-qat chewers comprised 21.4% (77 students), while the qat chewers (283 students) accounted for 78.6% of all subjects. Subjects older than 20 years in both groups were 85.7% and 96.5%, respectively. The majority of qat chewers (89.9%) were students in medical and natural science faculties. A total of 57.2% of qat chewers were from rural areas. Regarding the BMI, 15.5% and 22.1% of the qat chewers and non-qat chewers were overweight, respectively. No obese students were noted in both the qat and non-qat chewer groups. A total of 73.9% and 8.4% of qat chewers and non-qat chewers did not practise any type of exercise, respectively. On the contrary, a total of 36.4% and 19.1% of non-qat chewers and qat chewers practised regular exercise, respectively. Moreover, 38.9% and 92.6% and 26% and 79.2% of qat chewers and non-qat chewers seldom consumed fruits and fishes, respectively. The descriptive data of the demographic variables of the subjects are summarised in **Table 2**. The blood pressure values were significantly ($P < 0.05$) higher in qat chewers than that in non-qat chewers, while waist circumference was significantly lower in qat chewers than that in non-qat chewers. BMI did not show any significant difference between the two studied groups. **Table 3** presents the average concentrations of lipid profile measurements between the subjects. The mean serum levels of TC and LDL-C increased in qat chewers by 2.8% ($P = 0.64$) and 13.2% ($P < 0.005$), respectively. In contrast, the mean serum level of TG was high significantly lower by 14.9% in qat chewers than that in non-qat chewers. Furthermore, the mean serum level of HDL-C

Table 1: Basic characteristics of participating subjects.

Variables	Level	Non-qat chewers (n = 77) # (%)	Qat chewers (n = 283) # (%)	Chi-squared tests
Age	<20	11 (14.3)	10 (3.5)	0.001
	≥ 20	66 (85.7)	273 (96.5)	
BMI	Normal	60 (77.9)	239 (84.5)	0.120
	Overweight	17 (22.1)	44 (15.5)	
	Obese	0 (0)	(0)	
Faculty	Medicine	41 (53.2)	164 (58)	0.019
	Natural Sciences	19 (24.7)	90 (31.8)	
	Social Sciences	17 (22.1)	29 (10.2)	
Residence	Rural	37 (48.1)	162 (57.2)	0.095
	Urban	40 (51.9)	121 (42.8)	
Exercise	No	35 (45.5)	209 (73.8)	0.000
	Irregular	14 (18.2)	20 (7.1)	
	Regular	28 (36.3)	54 (19.1)	
Fast food	Seldom	40 (51.9)	95 (33.6)	0.012
	3 times a week	20 (26)	96 (33.9)	
	Daily	17 (22.1)	92 (32.5)	
Fruit and vegetables	Seldom	20 (26)	110 (38.9)	0.040
	3 times a week	39 (50.6)	134 (47.3)	
	Daily	18 (23.4)	39 (13.8)	
Fishes	Seldom	61 (79.2)	262 (92.6)	0.003
	3 times a week	15 (19.5)	19 (6.7)	
	Daily	1 (1.3)	2 (0.7)	

BMI, body mass index.

Table 2: Anthropometric parameters of the study groups.

Variable	Control (n = 77) mean±SD	Qat chewers (n = 283) mean±SD	Total (n = 360) mean±SD	P-value
BMI (kg/m ²)	21.2 ± 3.6	21.1 ± 3.5	21.01 ± 3.5	0.464
WC (cm)	78.4 ± 10.1	73.5 ± 7.0	74.5 ± 8.0	0.000
SBP (mmHg)	116.8 ± 3.5	121.7 ± 4.9	120.7 ± 5.0	0.001
DBP (mmHg)	77.5 ± 6.5	81.6 ± 5.1	80.7 ± 5.7	0.020

BMI, body mass index; WC, waist circumference; SBP, systolic blood pressure; DBP, diastolic blood pressure.

Table 3: Mean concentrations of lipid profile among study subjects.

Variables	Non-qat chewers (n = 77) mean±SD	Qat chewers (n = 283) mean±SD	Total (n = 360) mean±SD	P-value
TC (mg/dl)	157.8 ± 40.9	162.2 ± 42.9	160.9 ± 41.6	0.64
TG (mg/dl)	193.9 ± 76.3	165.0 ± 61.9	171.1 ± 65.4	0.001**
HDL-C (mg/dl)	34.8 ± 6.8	33.9 ± 7.4	34.4 ± 7.3	0.402
LDL-C (mg/dl)	84.6 ± 36.6	95.8 ± 40.1	93.6 ± 39.6	0.026*

TC, total cholesterol; TGs, triglycerides; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol.

was nonsignificantly lower by 2.6% in qat chewers than in non-qat chewers. **Table 4** illustrates the occurrence of dyslipidaemia in qat chewers and non-qat chewers. Hypercholesterolaemia, hypertriglyceridaemia, high LDL-C level, and mixed hyperlipidaemia were lower in qat chewers than in non-qat chewers (16.6%, 58.3%, 16.3%, and 10.6% respectively, versus 20.8%, 64.9%, 18.2%, and 20.8%, respectively). Isolated hypertriglyceridaemia was slightly higher in qat chewers than that in non-qat chewers (47.7% versus 44.2%). However, the incidence of low HDL-C, isolated low HDL-C, and isolated hypercholesterolaemia were generally higher in qat chewers than that in non-qat chewers (83%, 25.1%, and 6%, respectively, versus 75.3%, 15.6%, and 0%, respectively). The overall occurrence of dyslipidaemia was statistically

significant and higher in qat chewers than that in non-qat chewers by approximately 9.3% (89.8% versus 80.5%) ($P < 0.05$). **Figure 2-A** depicts the association between the types of dyslipidaemia and non-qat chewers, while **Figure 2-B** highlights the association between the types of dyslipidaemia and qat chewers. **Table 5** shows the association between dyslipidaemia and anthropometric variables for qat chewers. Hypercholesterolaemia and hypertriglyceridaemia were significantly ($P < 0.05$) associated with age, faculty, and exercise, while these parameters were nonsignificantly ($P > 0.05$) associated with residence. Low HDL-C and high LDL-C levels were significantly different ($P < 0.001$) in relation to age, but nonsignificantly different with “faculty.” On the contrary, a significant association between low HDL-C and exercise

Table 4: Prevalence of dyslipidaemia among study groups.

Prevalence of	Non-qat chewers (n = 77) # (%)	Qat chewers (n = 283) # (%)	P-value
Hypercholesterolaemia	16 (20.8)	47 (16.6)	0.243
Hypertriglyceridaemia	50 (64.9)	165 (58.3)	0.179
Low HDL-C	58 (75.3)	235 (83)	0.087
High LDL-C	14 (18.2)	46 (16.3)	0.401
Isolated hypercholesterolaemia	0 (0)	17 (6)	0.015*
Isolated hypertriglyceridaemia	34 (44.2)	135 (47.7)	0.0336
Isolated low HDL-C	12 (15.6)	71 (25.1)	0.051
Mixed hyperlipidaemia	16 (20.8)	30 (10.6)	0.018*
Dyslipidaemia (at least one character affected)	62 (80.5)	254 (89.8)	0.027*

HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol.

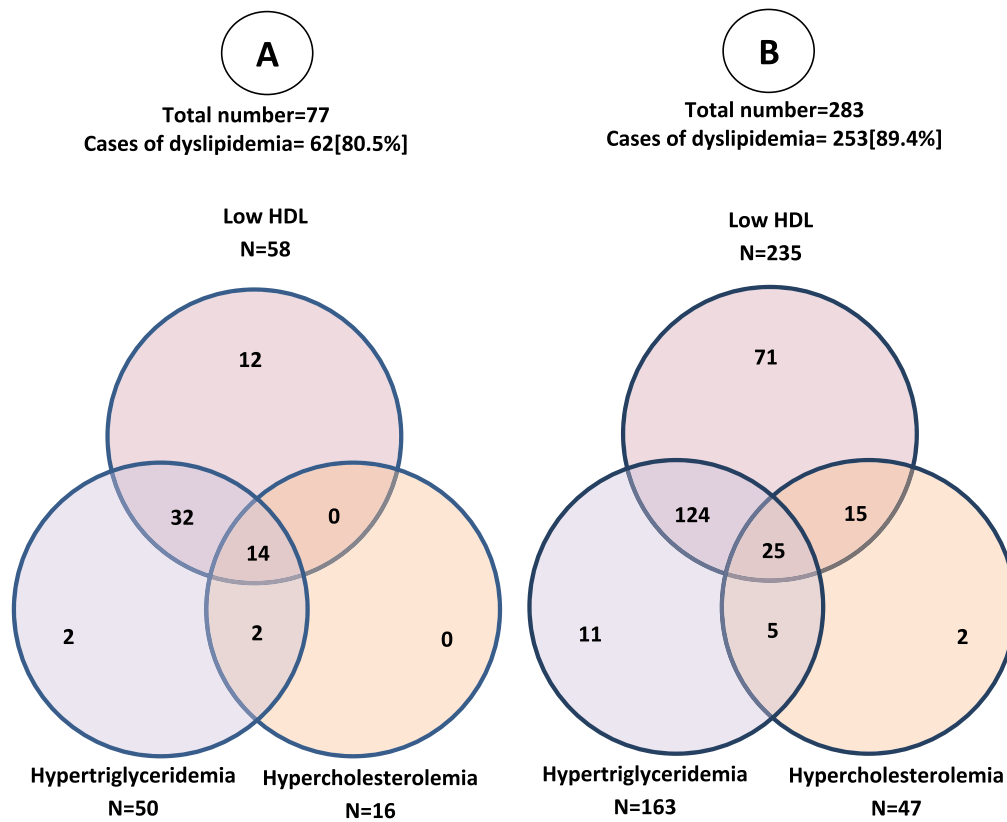


Figure 2: Venn diagram showing the association between dyslipidemia types in control (A) and Qat chewers (B). Three circles: green circle for hypercholesterolaemia, yellow circle for hypertriglyceridaemia, pink circles for low HDL-C.

Table 5: Association between dyslipidaemia and demographic characteristics and exercise in qat chewers.

Demographic		High TC (n = 47))	High TG (n = 165)	Low HDL-C (n = 235))	High LDL-C (n = 46))
Age	<20	0	8	8	0
	≥20	47	157	227	46
	P-value	0.001	0.001	0.000	0.001
Faculty	Medicine	25	107	141	24
	Natural Science	17	40	71	17
	Social Science	5	18	23	5
	P-value	0.045	0.028	0.071	0.072
Residence	Rural	30	89	131	30
	Urban	17	76	104	16
	P-value	0.247	0.464	0.261	0.050
Exercise	No	33	119	175	33
	Irregular	3	13	16	3
	Regular	11	33	44	10
	P-value	0.021	0.007	0.003	0.110

TC, total cholesterol; TGs, triglycerides; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol.

was observed ($P = 0.003$), whereas high LDL-C was not significantly associated with exercise ($P = 0.110$).

Discussion

Qat chewing has been a common habit in Yemeni society in the recent decades, which in turn has led to health problems such as body fat imbalance, specifically among young male people. In addition to euphoria and increased alertness obtained by qat chewing, chewers believe that qat gives them

the sense of excitement and energy.^{2,3} Local qat farmers and sellers reported that factors such as high demand, ease of cultivation, sale, and the huge profits are playing major roles in increasing qat prevalence.

The current results showed that systolic blood pressure and diastolic blood pressure increased more in qat chewers than that in non-qat chewers. This is consistent with other results.¹⁸ An interesting finding in this study was the high occurrence of dyslipidaemia with the absence of obesity among Yemeni qat chewers. This result is consistent with

the results of the other previous studies conducted in Yemen.¹² On the contrary, this result was inconsistent with the results of the other regional and international studies reporting that obesity is one of the most risk factors of dyslipidaemia.^{19,20} Qat results in anorexia after qat consumption due to the inhibitory effects of cathinone and cathine on the appetite centre in the hypothalamus.²¹ However, obesity was also not observed in non-qat chewers, suggesting that obesity was not noted among Yemeni qat and non-qat chewers. This could be related to the type of Yemeni traditional food, which is poor in fats and calories.¹² In Yemen, lunch is the main meal of the day. Asida and saltah are the important national dishes during lunch time. Asida consists of wheat groats or wheat flour that is cooked and then eaten with soup, while saltah includes several ingredients such as the traditional Yemeni soup (maraq), potatoes, vegetables, and sahawi (mixture of garlic, tomatoes, and chilli peppers). Saltah is eaten with bread. Furthermore, we believe that the widespread poverty in Yemen, specifically during the last 4 years of war, plays an important role. It was reported by the Food and Agriculture Organization of the United Nations that in Yemen, in late 2018, approximately 57.6% of the total population (15.9 million people) are in need for food, healthy nutrition, and humanitarian assistance.²² Our study showed that 73.9% of qat chewers did not practise any type of exercise. This result is consistent with real-life scenario because qat session generally starts at 1–2 pm for non-students and 3–4 pm for university students for at least 7–9 h daily. Yemeni students think that qat helps them in relieving fatigue, improving memory, achieving tasks, and clear thinking.²³ The current results show that 92.6% of qat chewers and 79.2% of non-qat chewers had consumed fish rarely. This could be related to the war conditions in the west coast of the country, which is the main source of fish for middle and northern cities in Yemen. The levels of TGs showed significant difference between the two studied groups, and it is evidently lower in qat chewers (14.9%) than in non-qat chewers. This finding is consistent with that of the other related studies.²⁴ The contributory effect of qat in reducing the level of TGs could be attributed to the amphetamine-like effect of cathinone, which stimulates β -adrenergic receptors and enhances lipolysis.⁴ Additionally, the presence of tannins in qat leaves could lower the intestinal absorption of TGs. It was reported that tannins lower the intestinal absorption of lipids.²⁵ Al-Alimi et al. reported that 1 g of qat extracts contained 254 mg of condensed tannins.²⁶ The levels of TC and LDL-C were nonsignificantly higher in qat chewers than that in non-qat chewers. This result is inconsistent with that of the other previous studies.²⁷

It has been published that plasma cholesterol decreased in rats after treatment with qat.²⁴ Our current results showed that dyslipidaemia was observed more in qat chewers (89.8%) than in non-qat chewers (80.5%). This high prevalence was associated with the increasing incidence of low values of HDL-C by 83% and 75.3% in both qat chewers and non-qat chewers, respectively. Our finding is one of the highest reported findings in Yemen and Middle East countries. For instance, one recent study conducted in KSA reported a 78% prevalence of dyslipidaemia, which is

lower than our figures.²⁸ Furthermore, other regional and international studies conducted in Egypt, Turkey, and the United States estimated the prevalence of dyslipidaemia, that is, 63.8%, 78.7%, and 65%, respectively.^{17,20,29} On the contrary, our results are similar to that of an Iranian study that reported a prevalence rate of 83.4% for dyslipidaemia.³⁰

Our study demonstrates high prevalence of low HDL-C in both qat and non-qat chewers. Our figures are higher than those in other reports. For instance, Abujbara et al. reported 59.5% low HDL-C levels among Jordanians.³¹ However, our result is almost similar to the result of one study conducted in Uganda that reported 71.3% of low HDL-C.³² Moreover, Yemeni male qat chewers and non-qat chewers have high risk for developing CVD because of the following reasons. First, our study was conducted under stressful conditions due to the current war. The effect of pressure and stress as risk factors disrupting the lipid metabolism and profile had been estimated elsewhere.³³ Second, the Yemeni traditional diet is a low-fat diet, hence probably reducing the HDL-C levels.³⁴ Third, the variation in the serum HDL-C levels might be associated with unpredictable genetic attributes.³² Prevalence of hypertriglyceridaemia among qat chewers was 58.3%, much higher than that in Iranian (28.0%), Egyptian (29.7%), and Jordanian (41.9%) studies.^{30,17,31} The current results revealed hypercholesterolaemia in only 16.6% of qat chewers. This result is lower than that of the other reports from KSA, Turkey, and Jordan.^{28,20,31} However, our present findings were consistent with the results from Oman on a group of university students.³⁵ The present study showed significantly high association between dyslipidaemia in the form of hypertriglyceridaemia and low HDL-C and regular physical exercises in qat chewers. This finding is consistent with that of other reports.^{16,36} Thus, improving the level of physical activity among Yemeni qat and non-qat chewers can be one of the most important strategies to prevent dyslipidaemia. One of the advantages of this study is that it was conducted during difficult war conditions. Second, the present study findings provide valuable baseline data on lipid abnormalities among qat chewers in Yemen. Finally, conducting this study only on healthy male youth minimises the effects on the lipid profile results. The effect of smoking was not included in this study, and this can be considered as a limitation. However, this provides interesting point to be addressed in the future studies to determine the synergetic effect of chewing qat and smoking on human lipid profile. The second limitation was the non-inclusion of females in the study because majority of qat-consuming individuals are males and to eliminate the interference of female's hormones on the parameters under study to obtain the most affected parameter by qat consumption alone. Moreover, qat chewing habit, specifically among young females, is unacceptable and uncommon. The third limitation is that the present study includes a specific group of subjects (university male students) who may not accurately represent the real variation in the lipid profile of the Yemeni population.

Conclusion

This study demonstrates one of the highest incidences of dyslipidaemia in Yemen and in the region. Low HDL-C was

the main lipid variable followed by hypertriglyceridaemia among Yemeni male young qat chewers. Genetic factors, war conditions, physical inactivity, and low-fat traditional Yemeni diet are considered the determinants of such findings. Qat chewing is considered a significant economic and health problem in Yemen that needs specialised programmes to help Yemeni people to stop and/or reduce the habit of qat chewing.

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Conflict of interest

The authors have no conflict of interest to declare.

Ethical approval

The entire study and experiments followed the ethical standards of the Helsinki Declaration. A written informed consent was obtained from each subject. The study has the approval from the ethical committee (Ibb University, Yemen).

Authors contributions

MA conceptualized the study and prepared the primary draft of the article. YA collected and analysed the data. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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