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E-cigarette knowledge and use among undergraduate students in Oman: a cross-sectional study

Wafa Al Jabri[1], Ali Bani Oraba[2], Sultan Bani Oraba[2], Lui Al Nadhiri[2], Osama Al Jamoudi[2]
[1]Department of Community and Mental Health Nursing, College of Nursing, Sultan Qaboos University, Muscat, Oman
[2]Graduate of the College of Nursing, Sultan Qaboos University, Muscat, Oman

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ABSTRACT

The increasing prevalence of electronic cigarette (e-cigarette) uses among youth globally, including in Oman, raises significant public health concerns. Despite a ban on the sale and marketing of e-cigarettes in Oman since 2015, their use remains legal and has increased among university students. This study aims to assess e-cigarette knowledge among students at Sultan Qaboos University (SQU) and examine its association with e-cigarette use. It addresses a gap in the Omani literature, where evidence on e-cigarette knowledge and use among university students remains limited despite existing regulatory restrictions. A cross-sectional survey was conducted to gather data on students' knowledge, and use of e-cigarettes. Among 449 university students, overall knowledge of e-cigarettes was relatively high, with most participants acknowledging their potential health risks and supporting regulatory measures; however, some misconceptions still remained. Students from scientific colleges showed significantly higher knowledge levels than those from humanities colleges ($p < 0.05$). Although only 12.7% reported ever using e-cigarettes, there was a significant negative correlation between knowledge and use ($r = -0.245$, $p < 0.001$), indicating that higher knowledge was associated with lower likelihood of e-cigarette use. The findings suggest the importance of strengthening health education and regulatory efforts to improve e-cigarette awareness and reduce use among university students in Oman.

Corresponding Author:

Wafa Al Jabri
Department of Community and Mental Health Nursing, College of Nursing, Sultan Qaboos University
P.O. Box 66, Al-khod 123 Sultanate of Oman, Muscat, Oman
Email: wafah@squ.edu.om

1. INTRODUCTION

The use of electronic cigarettes (e-cigarettes or vapes) has rapidly increased worldwide, among all age groups including youth and university students. Initially introduced as a harm-reduction tool to support smoking cessation, e-cigarettes have since become widely used in an addictive manner, especially among younger populations. These devices function by heating a liquid, which contains nicotine, flavorings, and other chemicals, producing an aerosol that users inhale. This aerosol not only exposes users to potentially harmful substances, but may also pose risks to bystanders through secondhand inhalation [1].

Despite being widely marketed as a safer alternative to traditional combustible tobacco, growing scientific evidence suggests that e-cigarettes carry significant health risks and may be equally hazardous in the long term [2]. Concerns have also emerged regarding their role as a gateway to nicotine addiction and their appeal through flavored products. In addition, celebrity endorsements and online advertising may further contribute to the normalization of vaping behaviors among youth.

In response to these concerns, many countries have introduced regulatory measures, including restrictions or bans on e-cigarette sales, marketing, and use. For example, countries such as the United States and members of the European Union have implemented regulatory frameworks that include age restrictions, flavor limitations, and marketing regulations to reduce youth uptake [3], [4]. In contrast, strict regulatory approaches have been adopted in several Gulf countries, including Oman and Saudi Arabia, where sales and promotion are prohibited or tightly controlled [5]. In Oman, the Public Authority for Consumer Protection has responded to these concerns by instituting regulations banning the sale and promotion of e-cigarettes, starting in 2015 and reaffirmed under Decision No. 756/2023 [6]. Violators face fines of up to 1,000 Omani Riyals, with penalties doubled for repeat offenses [6]. Despite these prohibitions, anecdotal and observational reports indicate that e-cigarette use continues to rise, especially among young adults. However, there is a lack of empirical data on e-cigarette use and usage trends in Oman.

International studies have consistently demonstrated substantial knowledge gaps regarding the health risks of e-cigarettes among university students, including those enrolled in health-related fields. For example, Babjaková *et al.* [7] found that 13.5% of medical students in Slovakia used e-cigarettes and lacked adequate knowledge about their risks. Similar findings have been reported across Gulf countries. In Saudi Arabia, Almutham, Altami [8] reported that 10.6% of medical students had tried e-cigarettes, with a significant proportion misperceiving them as safe alternatives to conventional smoking. Aqeeli *et al.* [9] noted that 21% of university students in Jazan used e-cigarettes, while 70.2% acknowledged passive nicotine exposure risks. In Qatar, Kurdi *et al.* [10] reported that 78.6% of users believed vaping could reduce conventional cigarette use, but notable gaps in knowledge persisted. Further studies across the region have highlighted the influence of peer usage, misconceptions about regulatory approval, and widespread use of flavored e-cigarettes, particularly among male students aged 18–24 years [11]-[13]. Although tobacco control policies exist, they are largely designed for conventional cigarettes and may not adequately address the unique characteristics of e-cigarettes, including digital marketing, flavor availability, and social media influence. Furthermore, limited awareness campaigns specifically targeting e-cigarette harms may reduce the effectiveness of existing tobacco control strategies in curbing use among young adults.

Within this gap, no published studies to date have specifically assessed e-cigarette knowledge and usage patterns among university students in Oman. University students represent a vulnerable group due to their developmental stage, increased susceptibility to peer and media influences, and high exposure to targeted marketing, all of which may contribute to experimentation and adoption of such behaviors during a critical period of health behavior formation. Given the potential public health implications, particularly in the context of the country's regulatory stance and the apparent rise in informal use, it is therefore essential to investigate this issue. Therefore, the primary aim of this study is to assess the level of knowledge and the prevalence of e-cigarette use among students at Sultan Qaboos University in Oman. Understanding these patterns will help inform public health strategies and educational interventions aimed at reducing the harms associated with e-cigarette use among young adults in Oman.

– Theoretical framework

Social cognitive theory (SCT) was developed by Bandura [14], emphasizes that human behavior is the result of a dynamic and reciprocal interaction between personal, behavioral, and environmental influences. This reciprocal determinism suggests that individuals are not only shaped by their environment but also actively shape and modify it through their behaviors. Within this framework, personal factors include cognitive and psychological elements such as knowledge, beliefs, expectations, attitudes, and misconceptions; environmental factors encompass external social influences such as peer pressure, family behaviors, cultural norms, media exposure, and marketing strategies; while behavioral factors refer to the individual's actual actions and habits, which in turn reinforce or modify both personal and environmental conditions.

Grounded in social cognitive theory (SCT), this study explains e-cigarette use among Omani university students as the result of dynamic interactions between personal factors (knowledge and misconceptions) and environmental influences (advertising, peer, and family behaviors). Students with accurate knowledge are expected to be less likely to use e-cigarettes, while exposure to positive social modeling and marketing may increase use through observational learning and social reinforcement. Figure 1 (see in Appendix) presents the conceptual framework of the study, adapted from SCT theory.

2. METHOD

The proposed study aimed to assess the knowledge of e-cigarettes (vaping) use among university students in Oman. The research design, environment, sample selection, tools, data collecting methods, data management, and data analysis are all reviewed in this section. In order to guarantee sufficient scientific rigor

in answering the following research questions, a thorough explanation of the particular technique used to carry out the study will be helpful:

- What is the level of knowledge about e-cigarette among students at SQU in Oman?
- What is the correlation between students' knowledge levels and their actual use of e-cigarettes in Oman?

A cross-sectional descriptive study design was utilized to assess the knowledge of e-cigarette usage among university students. Participants were SQU students from different colleges whether they use e-cigarette or not. About 449 students have completed the questionnaire.

2.1. The study setting

This study was being conducted at SQU and involved students from nine colleges, including nursing, economics and political science, science, engineering, medicine and health sciences, education, arts and social sciences, agricultural and marine sciences, and law. The inclusion criteria for the study subjects are Omani students enrolled in the fall 2024 semester in any college of SQU from different academic years and of both genders. The exclusion criteria are students in foundation programs, students who have previously participated in a knowledge campaign about the risks of using electronic cigarettes, and non-Omani students.

2.2. Sample, sampling technique, and sample size

The study included both male and female undergraduate students from different academic years who were recruited using a convenience sampling technique from all colleges within the university. Although probability sampling was not applied, efforts were made to recruit students from diverse academic disciplines and academic levels. This approach was intended to enhance sample variability and improve the representativeness of the study population.

Several measures were implemented to minimize potential sources of bias. To reduce selection bias, recruitment was conducted across all colleges, ensuring participation from students with different academic backgrounds and years of study. Data were collected anonymously using a self-administered questionnaire to minimize social desirability bias, and a standardized validated instrument was used to reduce measurement bias and enhance data reliability.

Eligibility criteria included currently enrolled undergraduate students at Sultan Qaboos University who were willing to participate and provided informed consent. Student information for the year of 2023 was obtained from the Department of Statistics at Sultan Qaboos University, encompassing all students across various majors. The total number of students was 17,179, with 51.5% enrolled in humanities colleges and 48.5% in scientific colleges. Females constituted 49% of the total enrolled students [15]. The required sample size was calculated using Slovin's formula. To account for potential non-response or incomplete questionnaires, 10% was added, resulting in a final sample size of 440 students.

2.3. Description of study instruments

A validated self-administered questionnaire was used for data collection. The instrument was originally developed by Franks *et al.* [16] and subsequently translated into Arabic and culturally adapted by Aqeeli *et al.* [9] for use among university students in Saudi Arabia [9], [16]. The translated version demonstrated good reliability in the Saudi population (Cronbach's $\alpha > 0.80$). Permission to use the questionnaire was obtained from the study author. In the current study, the culturally appropriate Arabic version was adopted and pilot-tested among 20 university students, yielding acceptable internal consistency (Cronbach's $\alpha = 0.75$).

The questionnaire collected data on participants' demographic and socioeconomic characteristics, e-cigarette use, knowledge, and perceptions. Knowledge was assessed using seven dichotomous (Yes/No) items, with one point assigned for each correct response, resulting in a total score ranging from 0 to 7, where higher scores reflected greater knowledge about e-cigarettes. Knowledge scores were classified based on percentage cut-offs: poor (<50%; 0–3), sufficient (50–74%; 4–5), and good (≥75%; 6–7). These thresholds were used to facilitate interpretation and are consistent with classifications applied in previous health knowledge studies. Perceptions toward e-cigarette use were measured using 18 statements rated on a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5). E-cigarette use was assessed using three indicators: ever use, defined as having used an e-cigarette at least once; current use, defined as use on at least one day during the previous 30 days; and regular use, defined as use on 20 or more days during the previous 30 days.

2.4. Data collection procedure

In September 2024, we used social media applications such as WhatsApp and Instagram to disseminate the survey among SQU students. Additionally, we asked some university faculty members in different colleges to encourage their students to participate in the study, inform them about the study and

invited them to participate voluntarily through a Google survey link. To speed up the data collection process, a QR barcode was created for the Google survey. Faculty members were encouraged to explain the purpose of the project and display the barcode during their class time. We also visited the SQU library and presented the survey to the university students using the two methods: Google survey link and the QR barcode. The survey consisted of questions about the demographic characteristics of the participants, knowledge level about e-cigarettes, and use of e-cigarettes. To ensure credibility, only students with SQU email were allowed to access the survey, no private email was allowed. The total responses received through the Google survey were about 449 responses as of October 22, 2024.

2.5. Data management and analysis

Data collected via the Google Forms questionnaire were initially exported to Microsoft Excel for organization and preliminary processing. The data cleaning process—performed using both Excel and IBM SPSS Statistics Version 23—included the removal of duplicate entries, identification and handling of outlier values, exclusion of incomplete responses, correction of inconsistencies between questionnaire items and responses, and coding of qualitative responses into numerical values where appropriate to facilitate quantitative analysis.

Following data preparation, statistical analyses were conducted using IBM SPSS Version 23. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were employed to summarize and present the characteristics of the study population. Inferential statistical methods were used to explore relationships and draw conclusions about the broader student population. Specifically, independent-samples t-tests and one-way ANOVA were applied to assess differences between groups, while Pearson's correlation coefficient was used to examine associations between continuous variables. Statistical significance was determined using a two-tailed test with a p-value set at < 0.05.

3. RESULTS AND DISCUSSION

3.1. Results

3.1.1. Characteristics of the sample

An electronic survey was distributed to a group of university students at SQU, 449 students completed the survey. The majority of participants were male (62.1%), and most of them were from the scientific colleges (73.5%). Moreover, about 46.3% of the participating students were in their fifth year of study. The characteristics of the study sample are presented in Table 1.

Table 1. Sample characteristics

Characteristic		Number	%
Gender	Male	279	62.1
	Female	170	37.9
	total	449	100
Collage	Scientific colleges	330	73.5
	Humanities colleges	119	26.5
	Total	449	100
Academic year	First year	24	5.3
	Second year	67	15
	Third year	75	16.7
	Fourth year	75	16.7
	Fifth year	208	46.3
	total	449	100

3.1.2. Knowledge level

Out of 449 participants, 96.7% have heard about e-cigarettes, in which 84.1% of participants reported that they first heard about e-cigarettes from social media and friends. Most participants gave accurate answers to the bulk of the e-cigarette knowledge questions. Specifically, 77.5% correctly identified that e-cigarettes are reusable, and about 79.8% of participants disagreed that e-cigarettes are an effective method to quit smoking. Additionally, 84% of participants agreed that e-cigarettes might be detrimental to health, while 58.2% disagreed that the health effects of e-cigarettes are less severe than those of tobacco products. On the other hand, about 30.1% of participants agree that e-cigarettes are less addictive than regular cigarettes. In terms of adolescent appeal, 84.4% believed that attractive packaging and different flavors attract young users to e-cigarettes. Lastly, 73.8% disagreed with the idea that using e-cigarettes is a way to express oneself, and about 56.7% disagreed that e-cigarettes are a way to relieve stress.

A significant majority of respondents (82.2%) believe that e-cigarettes must be banned, and 81.8% of them agree that advertising of e-cigarette products should be restricted in all media. Similarly, 76.6 % of participants agree that the relevant authorities, such as the food and drug authority, should regulate e-cigarettes selling in the same manner as tobacco products. Furthermore, about 76% of participants support the idea that e-cigarette companies must disclose all the ingredients in their products.

Male and female knowledge levels do not appear to differ significantly, according to the findings of the independent t-test. ($t = 1.589$, $p > 0.050$). Nonetheless, a statistically significant variation exists in the knowledge levels between scientific college students and humanities college students. The scientific college students have better knowledge levels than humanities college students ($t = 2.000$, $p < 0.05$). Moreover, based on the ANOVA results, there is no significant difference in the knowledge levels among students from different years of study at SQU ($f = .155$, $p > 0.05$).

3.1.3. Uses of e-cigarettes

Among the participants, 12.7% reported having used e-cigarettes at some point, whereas 89.9% indicated they had not used e-cigarettes within the past 12 months. Notably, only 6.2% reported using e-cigarettes as a method to quit smoking. Furthermore, 73.9% of respondents stated that they had never been exposed to someone smoking e-cigarettes in their presence. Based on the independent samples t-test, there is no significant difference in the use of e-cigarettes between males and females ($t=1.746$, $p > 0.05$), nor between scientific college students and humanities college students ($t=-1.65$, $p > 0.05$). Additionally, the findings of the ANOVA test indicate no discernible variation in e-cigarette use throughout the several research years at SQU ($t=.351$, $p > 0.05$).

3.1.4. Correlation between knowledge level and use of e -cigarettes

There is a significant negative correlation ($r = -0.245$, $p < 0.05$) between the level of knowledge about e-cigarettes and the actual use of e-cigarettes among SQU students. This means that higher knowledge about e-cigarettes was associated with lower use among students. Table 2 presents the correlation between knowledge of e-cigarettes and their use among SQU students.

Table 2. Pearson correlation between knowledge of e-cigarettes and actual use (N = 449)

Variables	r	p-value
Knowledge & use	-0.245**	< 0.001

Note: r = Pearson correlation coefficient.
p < 0.05 indicates statistical significance.

3.2. Discussion

To the best of our knowledge, this is the first study to assess both knowledge and use of electronic e-cigarettes among students at SQU in Oman. The findings reveal a high level of general awareness, with nearly all participants (96.7%) reporting that they had heard of e-cigarettes. This widespread awareness is consistent with similar studies conducted in the Gulf region, such as those by Aqeeli *et al.* [9] and Habib *et al.* [17], which also found good knowledge levels among university students.

Importantly, students enrolled in scientific colleges demonstrated significantly higher knowledge scores compared to their peers in humanities colleges. This pattern mirrors previous research, including Al-Sawalha *et al.* [13], which found that students in non-health-related fields often exhibited lower knowledge levels about e-cigarette risks. Similar findings have also been reported in studies among university students in Saudi Arabia and the wider Gulf region, where health science students consistently showed better awareness of tobacco-related harms compared to non-health disciplines Aqeeli *et al.* [9]. These findings underscore the need for targeted educational interventions beyond health sciences to ensure equitable awareness across disciplines.

Despite the generally high knowledge scores, several critical misconceptions persist. About one-third of respondents believed e-cigarettes to be less addictive than traditional cigarettes. This belief parallels earlier findings by Almutham *et al.* [8] and Aqeeli *et al.* [9], where similar misconceptions were prevalent. Comparable perceptions have also been documented internationally, including studies among young adults in Europe and the United States, which highlight persistent misunderstandings regarding nicotine dependence and the perceived safety of vaping products [18], [19]. Such misconceptions may stem from aggressive marketing strategies, the smoother sensory experience of vapor inhalation, and the widespread portrayal of e-cigarettes as smoking cessation aids, all of which can mask their addictive potential.

Furthermore, 11.1% of students perceived e-cigarettes as safer than traditional cigarettes, while 40% were neutral or agreed that secondhand exposure from e-cigarettes was less harmful. Similar misperceptions

were reported in studies from Jordan and Qatar, where large proportions of students underestimated the harm of e-cigarette use and exposure [10], [13]. These perceptions are concerning in light of accumulating evidence indicating that e-cigarettes are not harmless and may contribute to adverse respiratory health outcomes. Existing research has demonstrated that e-cigarette use is associated with harmful effects on the respiratory system [20]. In addition, evidence suggests that youth who vape may be at increased risk of later transitioning to conventional cigarette smoking [21], [22]. These results highlight the need for corrective educational interventions that clearly communicate the health risks of vaping.

An important finding of this study is that 84.4% of students believed flavored products and attractive packaging play a major role in attracting youth to e-cigarettes. This observation is supported by earlier studies showing that flavors enhance the appeal of vaping products, particularly among adolescents and young adults [9], [10]. A systematic review further confirmed that flavored e-cigarettes increase product attractiveness, willingness to try, and initiation among youth [23]. In addition, experimental studies in the United States and Europe have demonstrated that branded and visually appealing packaging increases adolescents' intention to try e-cigarettes, while plain packaging reduces product appeal [24], [25]. Overall, these findings highlight the critical role of flavors and product design in increasing the attractiveness of e-cigarettes among youth, underscoring the need for stricter regulatory controls on flavorings and marketing strategies targeting young populations.

Additionally, 44.3% of respondents either agreed or were ambivalent about the idea that e-cigarettes help relieve stress. Although nicotine may offer temporary stress relief, evidence indicates that its chronic use contributes to dependence and may worsen stress and anxiety in the long run. Similar misconceptions about stress relief have been reported in regional studies [8], [9], reinforcing the importance of addressing psychological motivations behind e-cigarette use.

In terms of prevalence, 12.7% of SQU students reported current e-cigarette use. This figure aligns closely with rates reported in Al Faisal University (12.2%) and is somewhat lower than those reported in Qatar (14%) and Jazan (21%) [9], [10]. Differences in regulatory environments, cultural norms, and the scope of anti-smoking campaigns may account for this variation.

In Oman's cultural and regulatory context, the findings are particularly relevant. Despite existing regulations prohibiting the sale and promotion of e-cigarettes, continued use among students suggests a gap between policy and enforcement. Cultural norms, along with social media and peer influence, may contribute to the normalization of vaping among young adults. This underscores the need for stronger enforcement and culturally tailored health education for Omani youth. Interestingly, our study identified a negative correlation between knowledge and e-cigarette use, indicating that higher knowledge levels were associated with slightly lower usage rates. This aligns with findings by Jaafar *et al.* [26], and suggests that while knowledge may influence behavior, it is not always sufficient to prevent use. Psychosocial factors, peer influence, and accessibility may play mediating roles, limiting the protective effect of knowledge alone.

4. CONCLUSION

This study shows that e-cigarette use among university students in Oman is influenced by knowledge, misconceptions, and environmental factors such as peers and marketing. Despite generally good awareness, important misconceptions remain, highlighting the need for stronger education and enforcement of existing regulations. Future research should use longitudinal and multi-university designs to improve generalizability and examine causal relationships, as well as qualitative approaches to better understand the social and behavioral drivers of e-cigarette use.

This study has several limitations that should be considered when interpreting the findings. The cross-sectional design limits the ability to establish causal relationships between knowledge, perceptions, and e-cigarette use. In addition, the study was conducted at a single university, which may limit the generalizability of the findings to all university students in Oman. Finally, the reliance on self-reported data may lead to underreporting or overreporting of e-cigarette use and related behaviors.

Universities, in collaboration with health authorities in Oman, should strengthen targeted awareness campaigns on the health risks of e-cigarette use and address misconceptions regarding vaping as a safe alternative to smoking or a cessation aid. Although national regulations prohibit the sale and promotion of e-cigarettes, stronger enforcement is needed to reduce informal use and bridge the gap between policy and practice among young adults. Policy initiatives in Oman should further reinforce existing regulations by enhancing monitoring of illicit sales, tightening enforcement of age restrictions, regulating digital marketing, and considering the restriction or banning of flavored e-cigarettes, given their strong influence on youth initiation and product appeal. Universities should also adopt comprehensive tobacco-free campus policies that explicitly include e-cigarettes. In addition, multidisciplinary educational programs led by health professionals from nursing, medicine, and public health should be integrated into university health promotion

strategies to improve awareness of nicotine addiction and long-term health risks. Interactive workshops and student engagement activities should be prioritized to support behavioral change and strengthen preventive efforts among university students.

ETHICAL APPROVAL

Ethical approval was obtained from the College of Nursing Research and Ethics Committee prior to the study (CON/GP/2024/6). All participants were given informed consent before they could participate in the study, which was entirely voluntary. The study's purpose, methods, confidentiality of response, and unrestricted ability for students to discontinue participation at any time were fully disclosed to them.

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APPENDIX

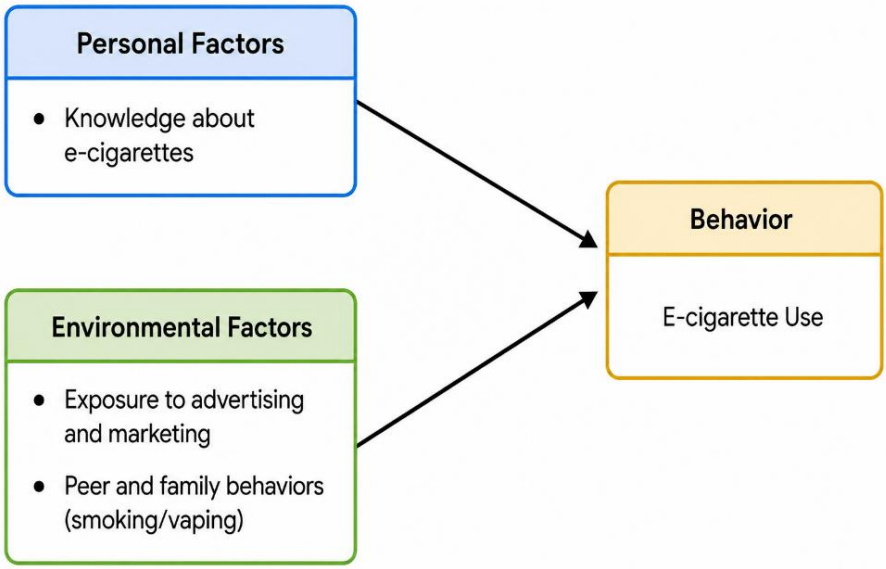
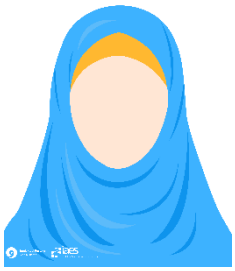


Figure 1. Conceptual framework of the study

BIOGRAPHIES OF AUTHORS



Wafa Al Jabri is affiliated with the College of Nursing at Sultan Qaboos University, Oman. Her academic and research interests focus on community health nursing, health promotion, and student health behaviors. She has contributed to research addressing public health issues among youth and university populations, with a particular interest in behavioral risk factors and family health. She is also involved in academic teaching and curriculum development in nursing education. Her scholarly work emphasizes evidence-based practice and improving health awareness among young adults. She contributed to the conceptualization, data interpretation, and manuscript development of the current study. She can be contacted at email: wafah@squ.edu.om.

Ali Bani Oraba is a graduate nursing student at the College of Nursing, Sultan Qaboos University, Oman. His academic interests include community health nursing, health risk behaviors, and preventive health among young populations. He contributed to data collection, analysis, and manuscript preparation for the present study. He can be contacted at email: ali.banioraba13@gmail.com.

Sultan Bani Oraba is a graduate nursing student at the College of Nursing, Sultan Qaboos University, Oman. His research interests include community health, adolescent and young adult health behaviors, and public health promotion. He contributed to data collection, statistical analysis, and manuscript writing in the current study. He can be contacted at email: baniorabasultan@gmail.com.

Lui Al Nadhiri is a graduate nursing student at the College of Nursing, Sultan Qaboos University, Oman. His academic interests include community health nursing, health promotion, and behavioral risk factors among youth. He contributed to data collection, literature review, and manuscript preparation for this study. He can be contacted at email: lwynasr1@gmail.com.

Osama Al Jamoudi is a graduate nursing student at the College of Nursing, Sultan Qaboos University, Oman. His academic interests include community health nursing, health promotion, and risk behaviors among adolescents and young adults. He contributed to data collection, statistical analysis, and manuscript preparation for the current study. He can be contacted at email: rko24884@gmail.com.