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The Prevalence of Electronic Cigarette Use Among College Students of Taibah University and Symptoms of Cardiovascular Disease

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Abstract

Background: Electronic cigarettes (e-cigarettes) have been increasing in popularity among young adults due to the misconception about the safety of e-cigarettes. Our study aims to identify the prevalence rate of e-cigarette use among college students, the reason behind their use, and the relationship between the use of electronic cigarettes and cardiovascular symptoms among college students.

Methods: An online questionnaire was sent to students of Taibah University between 2021 and 2022. Data from this survey were analyzed to obtain the prevalence of e-cigarette use among Taibah University students and to compare the demographic and health characteristics differences between e-cigarette users and non-users. The prevalence of cardiovascular symptoms was also compared between the two groups.

Results: A total of 519 students participated in this study. The prevalence rate of e-cigarette use was 24%. Compared to non-users, e-cigarette users were more likely to be male (71% vs. 40%, $p < 0.01$), overweight (44% vs. 32%, $p = 0.01$), and drug users (4% vs. 1%, $p = 0.01$). E-cigarette users were likelier to complain of cardiovascular symptoms, including chest pain (19% vs. 10%, $p = 0.01$), shortness of breath (14% vs. 7%, $p = 0.02$), and palpitation (12% vs. 6%, $p = 0.03$). The association between e-cigarette use and cardiovascular symptoms was significant even after adjusting for students' characteristics. Students' main reasons for e-cigarette use were to enjoy the flavors of e-cigarettes, quit tobacco smoking, and improve depression.

Conclusion: The prevalence rate of e-cigarette use among college students was 24%. The self-reported cardiovascular disease symptoms rate was doubled among e-cigarette users compared to non-users.

Keywords: Electronic cigarette, Vaping, College students, Cardiovascular symptoms

1. Introduction

Electronic cigarettes (e-cigarettes) are electronic devices that resemble traditional cigarettes in appearance, flavor, scent, and other characteristics. E-cigarettes produce nicotine and aromatic particles through an electronic heat generator, giving e-cigarette users the same physiological experience as smoking traditional cigarettes [1–3]. E-cigarette use leads to several biological changes, including

endothelial dysfunction, increased platelet activation, aggregation, oxidative stress, and inflammatory markers [4–10]. These biological changes are associated with an increased risk of cardiovascular disease.

Most e-cigarette users assume e-cigarettes are safer than combustible cigarettes, which is the primary reason for the widespread e-cigarette use [1–3]. According to the 2019 Saudi National Survey, the national prevalence of using e-cigarettes was 2.2%

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among adults [11]. However, adult smokers who want to reduce or quit combustible cigarettes increasingly turn to e-cigarettes. Moreover, e-cigarettes have been increasing in popularity among young adults who never smoked traditional cigarettes due to the misconception about the safety of e-cigarettes [12–14]. In Saudi Arabia, few studies showed a high prevalence of e-cigarette use among college students, ranging between 21% and 32% [14–16].

Although e-cigarettes are linked with various adverse health effects, including multiple pulmonary and cardiovascular diseases, the effects of e-cigarettes on college students have not been studied extensively [17]. Given the recent growth in the popularity of e-cigarettes among young adults, there is a crucial need for studies on the spread of e-cigarettes among college students to address the cardiovascular impact on this population.

Our study aims to identify significant knowledge gaps relevant to the prevalence rate of e-cigarette use among Taibah University students in Saudi Arabia, the reason behind their use, and the relationship between the use of electronic cigarettes and self-reported cardiovascular symptoms. Understanding the cardiovascular risks and harms would help spread awareness to decrease electronic cigarette usage and improve health education among college students.

2. Methods

This study was designed as a cross-sectional study using a convenience sampling technique. OpenEpi version 3 software was used to determine the sample size (402 students) based on an 80% study power, a 5% margin of error, a 95% confidence interval, and a 1.8 ratio of unexposed to exposed.

An online questionnaire was created on google forms and distributed between September 2021 and May 2022 to students of Taibah University to fill out. All students of Taibah University were eligible for this study without any exceptions. Thus, being a current student at Taibah University was the only inclusion criterion. There were no exclusion criteria. The online questionnaire was used to eliminate interviewer error (non-sampling error). The consent for this study was added to the first page of an online questionnaire. Students (n = 519) who participated in this study and answered the online questionnaire were included in the analysis of this study.

2.1. Independent variable

Students who answered “No” or “I used it previously” to “Do you use electronic cigarettes?” were

classified as “non-users.” The students who answered “Yes, daily,” “Yes, every other day,” or “Yes, sometimes” were classified as “users.”

2.2. Dependent variable

Self-reported cardiovascular disease symptoms, including shortness of breath, chest pain, and palpitation, were the clinical outcomes of this study. These data were obtained by asking students, “Do you complain of ... ” Their responses were cardiovascular disease symptoms. The students were allowed to select more than one symptom.

2.3. Demographic and clinical covariates

The online questionnaire contained questions about demographics, lifestyle, and health characteristics. The demographic factors were sex, age, and college. These data were obtained by asking the students, “Sex?” “Age?” And “College?” For the college question, the students were given a choice between medical/health science colleges and other colleges. The lifestyle factors were exercise, eating a healthy diet, smoking tobacco, alcohol abuse, and IV drug abuse. These data were obtained by asking the students, “Select from the following statements what you usually do,” and responses were “I do regular sports activities,” “I eat a healthy diet,” “I use alcohol,” and “I use one of the prohibited drugs.” The students were allowed to select more than one option. The students were also asked, “Do you use regular cigarettes?” The students who answered “Yes, daily,” “Yes, every other day,” or “Yes, sometimes” were classified as “Smokers.” The students who answered “No” or “I used it previously” were classified as “Non-smokers.”

The health characteristics were body mass index, diabetes, hypertension, anxiety, depression, and irritable bowel syndrome. The body mass index was calculated based on the student's height and weight. The height and weight were obtained by asking the students about their “Height?” And “Weight?” We assessed the diagnosis of diabetes, hypertension, anxiety, depression, and irritable bowel syndrome by asking the students, “Have you been diagnosed with any diseases ... ” and responses were the name of the diseases. Students were allowed to select more than one disease.

2.4. Statistical analyses

All students included in the analysis were divided into two groups, e-cigarette users and non-users. The demographic, lifestyle, and health characteristics

were compared between the two groups. Chi-square and Wilcoxon rank-sum tests were used to compare binary and continuous variables.

The chi-square test was also used to examine the differences in cardiovascular symptoms, including chest pain, dyspnea, and palpation, separately between the two groups. A logistic regression model was used to calculate the odds ratio of cardiovascular symptoms separately after adjusting for the significant difference in demographics, lifestyle, and health characteristics, which include sex, age, being overweight, eating a healthy diet, tobacco smoking, and drug abuse. The statistical analyses were performed using STATA 16 to analyze the data. All tests were conducted using an $\alpha = 0.05$ probability for a Type I error.

2.5. Ethical approval

The Ethics Review Committee of Taibah University approved this study (Prof. Abdulmohsen Al-Zalabani, Professor of Community Medicine Head, Department of Family and Community Medicine Chair of CM-REC), Study ID: STU-21-014.

3. Results

3.1. Baseline characteristics

The total number of students who participated in this study between 2021 and 2022 was 519. The average age of the students in this study was 20 years old. Out of 519 students, 48% of students were male, and 24% of students reported using e-cigarettes. 50% and 36% of students report exercising regularly and eating healthy diets. 13%, 1.2%, and 1.5% of students were smoking tobacco, drinking alcohol, and abusing drugs, respectively. The total percentage of overweight, diabetes, hypertension, anxiety, depression, and irritable bowel syndrome were 34%, 0.8%, 0.2%, 3.5%, 1.9%, and 4.1%, respectively.

Table 1 compares the demographics and lifestyle characteristics between e-cigarette users and non-users. Compared to non-users, e-cigarette users were more likely to be male (71% vs. 40%, $p < 0.01$) and overweight (BMI >25) (44% vs. 32%, $p = 0.01$). E-cigarette users were more likely to be currently tobacco smokers (31% vs. 8%, $p < 0.01$) and drug users (4% vs. 1%, $p = 0.01$). Interestingly, there were no differences in the rate of e-cigarette use between students who studied in medical/health science colleges versus other colleges.

Table 2 outlines the comparisons in the prevalence rate of health characteristics and self-reported cardiovascular disease symptoms between e-

Table 1. Demographic and lifestyle characteristics for students who use electronic cigarettes versus those who do not.

Characteristics	Electronic Cigarette Use		p-value
	Non-Users % (n)	Users % (n)	
Students	76.3 (396)	23.7 (123)	
Demographics Characteristics			
Male	40.2 (158)	71.3 (87)	<0.01
Age (\pm SD), year	20 (\pm 2)	21 (\pm 3)	0.02
Medical/Health Science Students	15.3 (53)	14.3 (16)	0.79
Lifestyle Characteristics			
Practicing Exercise	49.8 (197)	52.0 (64)	0.66
Eating Healthy Diet	39.9 (158)	24.4 (30)	<0.01
Tobacco Smoking			
Never	86.3 (341)	49.6 (61)	<0.01
Former	5.8 (23)	19.5 (24)	
Current	7.9 (31)	30.9 (38)	
Alcohol Abuse	0.8 (3)	2.4 (3)	0.13
Drug Abuse	0.8 (3)	4.1 (5)	0.01
Health Characteristics			
Overweight (BMI >25)	31.6 (125)	43.9 (54)	0.01
Diabetes Mellitus	0.5 (2)	1.6 (2)	0.21
Hypertension	0.3 (1)	0 (0)	0.58
Anxiety	3.0 (12)	4.9 (6)	0.33
Depression	1.5 (6)	3.3 (4)	0.22
Irritable Bowel Syndrome	3.3 (13)	6.5 (8)	0.11

cigarette users and non-users. E-cigarette users were more likely to complain of chest pain (19% vs. 10%, $p = 0.01$), shortness of breath (14% vs. 7%, $p = 0.02$), and palpitation (12% vs. 6%, $p = 0.03$). Logistic regression models showed that the odds ratio of having chest pain (OR = 2.0, 95% CI (1.0–3.8), $p = 0.04$), shortness of breath (OR = 2.4, 95% CI (1.1–5.2), $p = 0.03$), and palpitation (OR = 1.3, 95% CI (1.1–6.9), $p = 0.02$) were significantly higher among e-cigarette users than non-users after adjusting for the differences in demographic and health characteristics, which include sex, age, being overweight, eating a healthy diet, tobacco smoking, and drug abuse.

Table 3 lists students' reasons for using e-cigarettes. The main reasons for using e-cigarettes were to enjoy the flavors of e-cigarettes (51%), quit tobacco smoking (49%), and improve depression (18%). Interestingly, 71.1% of e-cigarette users believed that e-cigarette is safe or less dangerous than tobacco smoking.

4. Discussion

Our study revealed that the prevalence rate of e-cigarette use among college students was 24%. College students who used e-cigarettes had an approximately two-fold increase in the rate of self-reported cardiovascular symptoms compared to

Table 2. Health characteristics and clinical manifestation for students who use electronic cigarettes versus those who do not.

Characteristics	Electronic Cigarette Use		p-value	Adjusted ^a OR (95% CI)	Adjusted ^a p-value
	Non-Users % (n)	Users % (n)			
Students	76.3 (396)	23.7 (123)			
Clinical manifestation					
Chest pain	10.1 (40)	18.7 (23)	0.01	2.0 (1.0–3.8)	0.04
Shortness of breath	7.1 (28)	13.8 (17)	0.02	2.4 (1.1–5.2)	0.03
Palpitation	6.3 (25)	12.2 (15)	0.03	1.3 (1.1–6.9)	0.02

^a Logistic regression model was used to adjust for the differences in demographics and health characteristics, which include sex, age, being overweight, eating a healthy diet, tobacco smoking, and drug abuse.

non-users. The association between e-cigarette and cardiovascular symptoms were significant even after adjusting for the differences in the students' demographic and health characteristics. Most e-cigarette users report their motivations for using e-cigarettes were to enjoy the flavors of e-cigarettes, quit tobacco smoking, and improve depression.

The 2019 Saudi National Survey reported that e-cigarette use was 2.2% among adults [5]. However, our study showed that the prevalence rate of e-cigarette use was approximately eleven times higher compared to the national survey. The possible explanation for the differences is that our study focused on young adults (20 ± 2 years old), while the majority of participants in the national survey were above 30 years old [12]. Similar to our research, Qanash et al. found in a survey conducted in 2017 that the prevalence of e-cigarette use was 28% among health sciences college students in Jeddah [15]. Similarly, Alshanberi et al. found in a survey conducted in 2020 a high prevalence of e-cigarette use among medical students at Umm al-Qura University, reaching up to 32% [16]. Aqeeli et al. also found that the prevalence rate of e-cigarette use was 21% among students of Jazan University [14]. In the United States, the 2021 National Health Interview Survey showed that the rate of e-cigarette use

among young adults between the age of 18–24 was 33.21%.

The self-reported cardiovascular disease symptoms, including chest pain, shortness of breath, and palpitation, were significantly higher among e-cigarette use than non-users. These symptoms could be caused by gastrointestinal disease, musculoskeletal disease, or anxiety. However, these symptoms were still significantly high among e-cigarette use even after adjusting for baseline characteristics, which include sex, age, being overweight, eating a healthy diet, tobacco smoking, and drug abuse. Moreover, 58% of e-cigarette users, who report any cardiovascular disease symptoms, report no symptoms when they stop using e-cigarettes. Similarly, Wang et al. found that e-cigarette users had a significantly higher prevalence of chest pain, shortness of breath, and palpitation [18]. These symptoms were expected because of the biological changes associated with e-cigarette use. E-cigarette use affects endothelial function [19,20], which decreases the abilities of blood vessels to compensate for the increase in cardiac function. E-cigarette use increases inflammatory markers and platelet activation and aggregation [6–8], which leads to atherosclerotic cardiovascular disease [4,5,9,10,21], and increases the risk of myocardial infarction [22–25]. E-cigarette use has also been associated with atrial and ventricular arrhythmia due to the effect of nicotine, which explains the increased rate of palpitation in e-cigarette use [26,27]. Lowe et al. reported a case of a healthy adolescent male who developed atrial fibrillation after using an e-cigarette 40 times a day for two to three months [28].

Most of our students reported that they started to use e-cigarettes to enjoy the flavor of e-cigarettes, quit tobacco smoking, and improve depression. Interestingly, few students reported that e-cigarette was recommended to them by a physician. Moreover, most e-cigarette users (71.1%) thought e-cigarettes were safe or less dangerous than tobacco smoking. All of these facts likely contributed to the e-cigarette use among our students. Similarly, Other

Table 3. The reasons lead e-cigarette users to start and use electronic cigarettes.

Characteristics	Electronic Cigarette Use
	Users %
Students used electronic cigarettes for the following reasons:	
1- To enjoy flavor of electronic cigarettes	51.2%
2- To quit smoking tobacco	48.8%
3- To improve depression	17.9%
4- Because it was recommended by friends	8.9%
5- Because it was recommended by physicians	2.4%

studies showed similar factors contributing to the widespread e-cigarette use in the Kingdom of Saudi Arabia [16, 29]. Therefore, we should raise public awareness of the risks associated with e-cigarette use, especially among young adults. We should offer individuals who smoke tobacco a safe treatment to quit smoking to prevent them from using e-cigarettes as a way to quit smoking. We should screen for depression among young adults and treat it to reduce the use of e-cigarettes.

This study has some limitations. This study was designed as a cross-sectional study to identify the prevalence rate of e-cigarette use among our students and the association between e-cigarette use and self-reported cardiovascular symptoms. There were differences between the characteristics of e-cigarette users and non-users, which could bias the relationship between e-cigarette use and self-reported cardiovascular symptoms. Therefore, a logistic regression model was used in the analysis to adjust for the difference in demographic and health characteristics. The cross-sectional nature of this study could permit unknown confounding factors to bias the results. However, the results of our study are supported by biological studies, which showed that e-cigarettes cause changes in the cardiovascular system. The sampling technique used in this study was convenient, which might introduce participation bias based on e-cig usage status.

5. Conclusions

The prevalence of e-cigarette use was high among young adults and was associated with self-reported cardiovascular symptoms, including chest pain, shortness of breath, and palpitation. There was a misconception about the safety of e-cigarette use, which contributed to its widespread use. A nationwide campaign is necessary to increase public awareness about the health risk of e-cigarettes would likely reduce their use, especially among young adults.

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Authors contribution

TA, MA, AA, FA, AA, BA had full access to all the study data and take responsibility for the integrity of the data and the accuracy of the data analysis. All authors contributed to the study concept and design. All authors contributed to the analysis and

interpretation of data and the critical revision of the manuscript for important intellectual content.

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Conflict of interest

There are no conflicts of interest.

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