



Research Article

Prevalence, Trends, and Harm Perception Associated with E-Cigarettes and Vaping among Adolescents in Saudi Arabia

Bayan T. Rayes¹, Abdulaziz Alalwan², Nasser M. AbuDujain^{2*}, Ali Darraj³, Muath A Alammar³, Hoda Jradi¹

Abstract

Introduction: Younger generations are an important market for the tobacco products industry since most smokers try their first cigarette before the age of 18. Electronic cigarettes (e-cigarettes) are a common mode of smoking among teens, and the number of users is increasing exponentially.

Objective: This study aimed to estimate the current prevalence of e-cigarettes and vaping usage among adolescents between the ages of 15 and 19 in the city of Mecca, Saudi Arabia.

Methods: This study was conducted among 534 students at four high schools. They were asked to complete a 23-item questionnaire retrieved from the Global Youth Tobacco Survey. Descriptive statistics and regression analysis were conducted. The study was approved by the Ministry of Health Saudi Arabia Medical Research Center Institutional Review Board committee on October 10, 2018 (research number 18-506E).

Results: A total of 109 (20.6%) of the participants reported being smokers of e-cigarettes. Being a male (OR = 1.55; 95% CI: [1.01–2.37]), in the second year of high school (OR = 2.91; 95% CI: [1.61–5.24]), ever experimenting with regular tobacco cigarettes, being a current shisha smoker, living with a smoker, and believing that e-cigarettes are less addictive than traditional cigarettes are all factors independently associated with e-cigarette use in this sample of adolescents.

Conclusion: Among adolescent smokers, even minimal experience with smoking is correlated with pro-smoking attitudes. E-cigarette use is common in adolescents and related to the use of other combustible tobacco products. Tobacco control efforts at all levels should eliminate factors fostering future tobacco use to minimize the burden of disease and disability in vulnerable populations.

Introduction

Tobacco use and abuse are the most avoidable and preventable causes of morbidity and mortality [1]. Tobacco smoke is loaded with more than 7,000 toxic substances of a poisonous nature that can cause serious health issues [2]. An electronic cigarette (e-cigarette) is an electronic system that produces nicotine in an aerosol form and consists of a mouthpiece, an atomizer, a cartridge, and a battery [3]. The cartridge is a reservoir filled with a fluid composed of a mixture of propylene glycol, vegetable glycerin, nicotine, and flavors [4]. The atomizer heats the liquid ingredients into vapor, which is inhaled by the user [5]. E-cigarettes are considered common among teens and are now the most commonly used form of tobacco among youths in the United States [6]. The younger generation is an important market for the tobacco industry since most smokers try their

Affiliation:

¹King Saud Bin Abdulaziz University for Health Sciences, College of Public Health and Health Informatics, Department of Community and Environmental Health, Riyadh, Saudi Arabia

²University Family Medicine Center, Department of Family and Community Medicine, King Saud University Medical City, Riyadh, Saudi Arabia

³Department of Medicine, Collage of Medicine, Shaqra University, Shaqra 11961, Saudi Arabia

*Corresponding author:

Nasser M. AbuDujain, University Family Medicine Center, Department of Family and Community Medicine, King Saud University Medical City, Riyadh, Saudi Arabia.

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first cigarette before the age 18 [7]. Adolescence is a critical period for establishing smoking behaviors; most smokers develop their smoking pattern during their teenage years [8]. Those who begin at a younger age are more likely to develop nicotine addiction and have trouble quitting smoking [9]. The World Health Organization (WHO) estimated smoking prevalence among those aged 15 years or older living in Saudi Arabia in 2015 as 25.2% for males and 1.9% for females for any tobacco products [10]. In the United States in 2015, an estimated 4.7 million adolescent students were using tobacco products, over 2.3 million of whom were current users of two or more tobacco products [11]. Particularly among middle- and high school students who are current tobacco users, 3.0 million used e-cigarettes, 1.6 million used cigarettes, 1.4 million used cigars, 1.2 million used hookahs, and 1.1 million used smokeless tobacco [11]. Although tobacco use by adolescents has dropped noticeably in the last 40 years, in 2016, nearly one in 20 high school seniors was a daily smoker [12]. If the existing trends in tobacco use among all age groups persist, smoking is most likely to kill one in six people in Saudi Arabia and around the globe [13]. Evidence from epidemiological and research studies around the world have emphasized the consequences of tobacco usage, specifically cigarette smoking, as the main cause of or significant factor in causing disease and deterioration due to many illnesses [14]. Smoking harms nearly every body organ, causing diseases and decreasing the overall health of smokers [15]. Those who smoke cigarettes are two to three times more likely to die from conditions related to heart disease and stroke [16]. Just as smoking harms adults by causing heart disease and stroke, studies have also indicated that early signs of these diseases can affect adolescents who smoke [17]. Moreover, smoking at a young age can lead to lower levels of lung functions and cause a reduction in the rate of lung growth compared with those who never smoked [18]. Additionally, heavy cigarette smoking throughout adolescence has been linked to a higher risk of agoraphobia, anxiety disorder, and panic disorder [19].

Addiction to nicotine and the risk of addiction related to other drug use are among the widely cited consequences of smoking among the younger generation [20]. E-cigarettes present a relatively new health risk behavior and a gateway to regular tobacco use [21]. Their use in Saudi Arabia is restricted where other types of smoking are restricted, which includes indoor public places and workplaces. Although there are no restrictions on advertising and promoting e-cigarettes and online sales, there is no legal way to buy e-cigarette devices or flavors [22]. Following the importance of this topic, our study aimed to estimate the current prevalence of e-cigarettes and vaping usage among adolescents between the ages of 15 and 19 in the city of Mecca, Saudi Arabia.

Methods

Sampling and data collection

E-cigarette use and associated factors were investigated

in a sample of high-school students in years 1 to 3 in four high schools (two for boys and two for girls) in Mecca, Saudi Arabia. The data was collected at the beginning of the 2018–2019 school year, from September to November, using a self-administered questionnaire. The questionnaire was in Arabic, and all questions were adopted from the valid and reliable Arabic version of the Global Youth Tobacco Survey (GYTS), which was used for the same purpose and among a similar group [23]. The questions' clarity, feasibility, comprehension, and time management were checked by administering the survey to 20 high-school students from the same age group, from different schools, and who were not included in the sample. There were no major difficulties reported. The instrument's reliability was also checked by administering it twice to the same group of high-school students ($n = 25$) with a one-week interval between the two administrations. There was a 95% agreement between them. The high schools were public and selected purposefully from Mecca as conveniently located and reached. Consent forms were sent to all parents of the students in all four high schools. A total of 730 students from the four high schools (383 female students and 350 male students) were asked to participate; 534 returned their consent forms signed by their parents and were included in the study, for an overall response rate of 73%. Of note, Saudi Arabia has three years of high-school education (first, second, and third secondary).

Instrument

Information was collected about age, gender, weight and height, grade level, daily monetary allowance, and a reported family income estimate. The high-school years were categorized into three classes: first secondary, second secondary, and third secondary. Smoking behavior was assessed by several questions regarding the student having ever experimented with all types of tobacco (cigarettes, smokeless tobacco, and shisha/water pipes). E-cigarette use was evaluated by asking members of this sample if they are current e-cigarette users. The survey included 23 core questions designed to gather data on the following constructs: six questions on demographic characteristics (age, height, weight, grade level, daily allowance, and family income) and the remaining 17 questions designed to collect data on smoking trends and patterns, knowledge and attitudes of young people regarding e-cigarette smoking and other tobacco products, prevalence of e-cigarette smoking and other tobacco use among young people, the role of the media and advertising on young people's use of e-cigarettes, and exposure to environmental tobacco smoke at home and in public.

Ethical considerations

All procedures performed in the study followed the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments

or comparable ethical standards. Informed consent was obtained from all participants. The study was approved by the Institutional Review Board at the Ministry of Health (serial number 18-506 E).

Statistical analysis

Analyses were performed using STATA statistical software (version 14; College Station, Texas, The differences in the categories of reported use of e-cigarettes across study variables (demographic characteristics, grade level, has ever experimented with tobacco products, and current tobacco use status) were assessed. USA). Descriptive statistics as the means and frequencies were calculated for all study variables where applicable. The chi-square test for categorical variables was used to examine significant differences in the parameters. Univariate and multivariate logistic regression analyses were conducted with reported e-cigarette use as the dependent variable to examine the simultaneous effects of the studied factors on the likelihood of high use versus no use. The odds ratios and 95% confidence intervals of using e-cigarettes among this group of youth compared with no use were calculated for a range of study variables. First, all demographic variables that showed significance in the chi-square analysis were assessed with logistic regression. All variables that showed significance in the univariate logistic regression were entered into the multivariate logistic model. Stepwise backward elimination of non-significant variables was applied to generate a final model for e-cigarette use in this sample of high-school students (significance level set at $p < 0.05$), with full data for all variables considered.

Results

The demographic characteristics of 534 participating students are detailed in table 1. Most students were between 16 and 17 years old (78.8%), with a mean age of 16.82 ± 0.85 (range between 16 and 19). Among the sample, students were distributed by grade and gender. Males and females represented 273 (44.3%) and 297 (55.6%) of the participants, respectively. According to their body mass index (BMI; weight in kilograms/height squared), 46.82% of the participants were classified as having normal weight, and 31.08% were classified as overweight or obese. The majority of the sample reported being from a high-income family (47.76%), with the remaining youths being between middle- and low-income families. A total of 109 (20.6%) of the participants reported being smokers of e-cigarettes, with an overall higher proportion of smokers among males (53.2%) compared with females (46.7%). A higher proportion of those in the second year of high school (51.3%) were smokers compared with those in the first or final years (15.6% and 33.0%, respectively). Almost 78.9% of the smokers reported living with a smoker (any type of tobacco smoker), and 37.6% claimed being tempted by a friend's offer of an e-cigarette.

The proportion of the students who reported encountering advertisements related to e-cigarettes through the internet was 26.6%. Regarding the perception of harm associated with e-cigarette smoking, users of this method had poor perceptions of the effects of this type of smoking, and 81.5% reported that there was no harm associated with it. Only 22.0% of smokers perceived e-cigarettes as equally addictive as regular tobacco cigarettes. Table 1 displays the results presented in this section. Bivariate analysis showed a significantly greater proportion of respondents were male smokers compared with female smokers (46.79% versus 53.21%; $p = 0.039$). The percentage of smokers was significantly higher in those who were in their second and third high-school years compared with the first year (84.41% versus 15.60%; $p < 0.001$). The students who reported their monthly family income was 9,000 Saudi riyals (SR; approximately 2,400 US dollars) or above also reported a higher frequency of e-cigarette use than those who claimed a family income of less than 9,000 SR (78.9% versus 21.1%; $p = 0.035$).

Gender ($p = 0.039$), grade level ($p = 0.001$), reported family income ($p = 0.035$), and daily allowance ($p = 0.018$) were all characteristics that varied significantly with e-cigarette use in this sample of adolescents. Regarding factors associated with e-cigarette usage, including being prone to temptation to try one when offered by a friend ($p < 0.001$), perceiving e-cigarettes as harmful or not ($p < 0.001$), believing e-cigarettes to be as addictive as regular tobacco cigarettes ($p < 0.001$), being exposed to this type of smoking in public or at home ($p < 0.001$), and showing curiosity about e-cigarettes ($p < 0.001$), there were also factors related to e-cigarette use in the bivariate analysis of this sample of high-school students. Regarding regular tobacco product use, having ever experimented with regular cigarettes and being a current cigarette smoker were found to be significantly associated with beginning e-cigarette users ($p < 0.001$). In addition, having ever experimented with shisha (water pipe) or smokeless tobacco products and currently being a shisha smoker were also significantly greater in e-cigarette smokers ($p < 0.001$). Among the students who smoke e-cigarettes, a higher percentage thought they were less addictive than regular cigarettes compared with those who reported that they are more or equally addictive (66.06% versus 22.11%; $p < 0.001$). Age and being exposed to e-cigarette advertisements on the internet were found not to be significantly associated with e-cigarette smoking. In univariate and multivariate logistic regression analyses, having reported ever experimenting with regular tobacco cigarettes (OR = 8.6, 95% CI: 5.45–13.85 and OR = 3.39, 95% CI: 1.54–7.47, respectively), experimenting with shisha (OR = 7.92, 95% CI: 3.52–17.83), currently being shisha smokers (OR = 9.25, 95% CI: 3.29–26.00), being in the second year of high school (OR = 2.9, 95% CI: 1.61–5.24), being a male (OR = 1.55, 95% CI: 1.01–2.37), living with a user of any

Table 1: Characteristics of participating students from four schools from Mecca Saudi Arabian (n=534).

Characteristics	n	%
Age		
16	230	43.1
17	191	35.8
18	92	17.2
19	21	3.93
Gender		
Female	297	55.6
Male	237	44.4
BMI*		
Underweight	118	22.1
Normal	250	46.8
Over Weight	90	16.9
Obese	76	14.2
Grade		
First secondary	154	28.9
Second secondary	211	39.6
Third secondary	168	31.5
Daily Allowance SR**		
<10	258	41.6
>10	362	58.4
Family Income **		
3000-5999 SR	97	18.9
6000-8999 SR	55	10.7
9000-12000 SR	116	22.6
>12000 SR	245	47.8
Ever experimenting with cigarettes		
Yes	146	27.3
No	388	72.6
Current cigarettes smoker		
Yes	472	88.4
No	71	11.6
Ever experimenting with smokeless tobacco products		
Yes		
No	54	10.1
	479	89.9
Current user of smokeless tobacco		
Yes	26	4.88
No	507	95.1
E-cigarettes user		
Yes	109	20.5
No	424	79.5
Ever experimenting with shisha		
Yes	122	22.9

No	412	77.2
Current shisha smoker		
Yes	450	84.3
No	84	15.7
- BMI*; < 18.5 underweight, 18.5–24.9 normal, 25.0–29.9 overweight and 30.0–39.9 obese		
- SR**; Saudi riyal		

tobacco product (OR = 2.13, 95% CI: 1.37–3.33), and perceiving e-cigarettes as less addictive than regular tobacco cigarettes (OR = 7.86, 95% CI: 4.20–14.73) were all factors associated with e-cigarette smoking among this group of participants. Results of the univariate and multivariate logistic regressions are displayed in (Table 3).

In the univariate analysis, all those who are in third-secondary school (OR = 2.14, 95% CI: 1.18–4.13), reported a monthly family income of 9,000 SR and above (OR = 2.97, 95% CI: 1.40–6.29), receive a daily allowance of 10 SR and above (OR = 1.57, 95% CI: 1.37–2.42), believe that e-cigarettes are not harmful (OR = 0.18, 95% CI: 0.11–0.31), and are exposed to e-cigarettes in public and in households (OR = 2.29, 95% CI: 1.70–3.07 and OR = 6.76, 95% CI: 4.09–11.15, respectively) also showed to have significant associations with e-cigarette use. Additionally, participants who are current smokers of regular cigarettes (OR = 9.7, 95% CI: 5.46–17.25), reported having ever experimented with smokeless tobacco products (OR = 6.32, 95% CI: 3.51–11.40), are current users of smokeless tobacco products (OR = 7.12%, 95% CI: 3.13–16.19), and think all tobacco products are not harmful also showed significant associations with e-cigarette use before adjusting for all other variables. In the final model for multivariate logistic regression analysis, those who ever experimented with regular cigarettes were 3.39 (95% CI: 1.54–7.47) times more likely to be e-cigarette smokers compared with those who never tried regular cigarettes in their lifetime. Those who reported experimenting with shisha and currently smoking shisha products were 7.92 and 9.25 times more likely to be e-cigarette smokers than participants who never experimented with nor are currently smoking shisha (95% CI: 3.52–17.83 and 95% CI: 3.29–26.00, respectively). Students who live with a smoker in their household were 3.62 times more likely to be e-cigarette users than those who do not live with a smoker at home (95% CI: 1.13–4.54). These same e-cigarette smokers who believed that e-cigarettes are less addictive than regular cigarettes were 3.63 times more likely to currently use e-cigarettes compared to those who believed that e-cigarettes are more addictive than or equally addictive as regular cigarettes (CI 95%: 1.53–8.60). Furthermore, in this sample, those in the second grade of secondary school were four times more likely to be e-cigarette smokers compared with those in first- and third-secondary grades (95% CI: 1.57–10.22). Finally, e-cigarette smokers were 2.34 times more likely to be male

Table 2: Respondent’s characteristics according to electronic cigarettes’ smoking status.

Variable	Total n (%)	%	Non-smoker (n=424)	Smoker (n=109)	P-value	
Age						
16	230 (43.70)	43.1	191 (45.05)	39 (35.78)		
17	191 (35.77)	35.8	149 (35.14)	42 (38.53)	0.065	
18	92 (17.23)	17.2	65 (15.33)	26 (23.85)		
19	21 (3.93)	3.93	19 (4.48)	2 (1.83)		
Gender						
Female	297	55.6	245 (57.78)	51 (46.79)		
Male	237	44.4	179 (42.22)	58 (53.21)	0.039	
BMI*						
Underweight	118	22.1	98 (23.11)	19 (17.43)		
Normal	250	46.8	198 (46.70)	52 (47.71)	0.05	
Over Weight	90	16.9	63 (14.86)	27 (24.77)		
Obese	76	14.2	65 (15.33)	11 (10.09)		
Grade						
First secondary	154	28.9	137 (32.39)	17 (15.60)		
Second secondary	211	39.6	155 (36.64)	56 (51.38)	0.001	
Third secondary	168	31.5	131 (30.79)	36 (33.03)		
Family income						
3000-5999SR	97	18.9	86 (21.34)	11 (10.09)		
6000-8999 SR	55	10.7	43 (10.67)	12 (11.01)	0.035	
9000-12000 SR	11	22.6	84 (20.84)	32 (29.36)		
>12000 SR	245	47.8	190 (47.15)	54 (49.54)		
Daily Allowance (SR)**						
<10 SR	258	41.6	215 (50.71)	43 (39.45)	0.036	
>10 SR	362	58.4	209 (49.29)	66 (60.55)		
Factor associated with E-cigarettes						
Temptations (offered by a friend)						
Yes	167	31.3	126 (29.72)	41 (37.61)	<0.001	
No	366	68.5	298 (70.28)	68 (62.39)		
Harm perception of e-cigarettes						
No harm	284	250	53.2	194 (45.75)	89 (81.56)	<0.001
Very harmful			46.8	230 (54.25)	20 (18.35)	
Exposure in public						
Never	341	64	302 (71.23)	39 (35.78)		
Sometimes	139	26	85 (20.05)	54 (49.54)	<0.001	
Frequently	53	9.92	37 (8.73)	16 (14.68)		
Exposure in home						
Living with a smoker	237	44.4	151(35.61)	86 (78.90)	<0.001	
Living with non-smoker	296	55.4	273 (64.39)	23 (21.10)		
Exposure in home with e-cigarettes smoker						

Yes					
No	26	4.87	97 (19.13)	12(46.15)	0.001
	508	95.1	410 (80.87)	14 (53.84)	
Curiosity about E-cigarettes					
Yes	115	21.5	28 (25.69)	81 (74.31)	<0.001
no	419	78.5	390 (91.98)	34 (8.02)	
Ever experimenting with cigarettes					
Yes	146	27.3	75 (17.69)	71 (65.14)	<0.001
No	388	72.6	349 (82.31)	38 (34.61)	
Current smoker of cigarettes					
Yes	472	88.4	23 (5.42)	39 (35.78)	<0.001
No	71	11.6	401 (94.58)	70 (64.22)	
Ever Experimenting with shisha					
Yes	122	22.9	41 (9.67)	81 (74.31)	<0.001
No	412	77.2	383 (90.33)	28 (25.69)	
Current smoker of shisha					
Yes	450	84.3	20 (4.72)	63 (57.80)	<0.001
No	84	15.7	404 (95.28)	46 (42.20)	
Ever Experimenting with smokeless tobacco products					
Yes			24 (5.66)	30 (27.52)	<0.001
No	54	10.1	400 (94.34)	79 (72.48)	
	479	89.9			
Current user of smokeless tobacco					
Yes	26	4.88	24 (5.66)	30 (27.52)	<0.001
No	507	95.1	400 (94.34)	79 (72.48)	
Tobacco products are generally harmful					
Agree	399	74.7	337 (63.10)	62 (11.61)	<0.001
Disagree	134	25.1	87 (16.29)	47 (8.80)	
Smoking E-cigarette in class					
No one smokes	209	39.1	192 (45.28)	17 (15.60)	
Less than half of the class	175	32.8	129 (30.42)	46 (42.20)	<0.001
More than half of the class	149	27.9	103 (24.29)	46 (42.20)	
Addiction properties					
Less addictive	219	41	145 (34.20)	72 (66.06)	
More or equally addictive	218	40.8	73 (17.22)	24 (22.02)	<0.001
Don't know	97	18.2	206 (48.58)	13 (11.93)	
Exposure to internet ads regarding e-cigarettes					
Rarely	403	75.5	323 (76.18)	80 (73.39)	0.546
Often	130	24.3	101 (23.82)	29 (26.61)	

than female (CI 95% CI: 1.21–4.49). The results of the Hosmer-Lemeshow goodness-of-fit test showed that the final model was a significantly good fit ($P > 0.05$).

Discussion

We studied the prevalence and correlation of e-cigarette use frequency and dependence in a sample of high-school students in Mecca, Saudi Arabia. E-cigarette use among this population of adolescents was mostly associated with having ever experimented with cigarettes (even one or two puffs) or shisha (even once), being current smokers of shisha, being exposed to any type of tobacco use in the household, claiming that e-cigarettes are less addictive than regular cigarettes, being in the second year of high school, and being male. The results suggest that the prevalence of e-cigarette use is high and may be increasing. We found that e-cigarette usage was 20.41%, which was higher than reported in another study conducted in the United States [24]. Similarly, a study from Poland reported that e-cigarette use among youth has been increasing since 2011 [25]. In this sample, current smokers of e-cigarettes among females and males were 46.79% and 53.2%, respectively. These results are consistent with those for US adolescents, with a higher proportion of males than females [26]. The reasons for this variation may be linked to the fact that males are socially encouraged to spend free time with peers and are not as supervised as females. In addition, Arab youths may think that smoking helps to increase their masculine image and perception of maturity among peers [27]. In 2014, a cohort study conducted in Sweden reported a clear difference between males and females in trying tobacco products [28], with males more likely to experiment than females [28]; however, later in life, females were more likely to experiment with cigarettes or become regular smokers to a greater extent [28]. Similar to adults, the use of both e-cigarettes and conventional cigarettes are high among adolescents and rising rapidly. Teenagers who have experimented with cigarettes and used e-cigarettes were more likely to be current smokers than those who never used e-cigarettes [29]. These results suggest that e-cigarettes aggravate tobacco use and abuse among adolescents [30] [31]. A US study indicated that the use of e-cigarettes was associated with higher odds of current cigarette smoking, higher odds of established smoking habits, and lower odds of limiting conventional cigarettes [32]. Regarding the harm perception associated with e-cigarettes, one study characterized the amounts of certain toxicants in e-cigarette aerosols to be between nine and 450 times less than the amounts in regular tobacco cigarette smoke [33]. One particular carcinogen (formaldehyde) present in e-cigarettes can equal the level in regular tobacco smoke if the liquid in the e-cigarette is heated using higher-voltage batteries [33]. Our results showed that among the students who smoke e-cigarettes, higher percentages thought they were less addictive than regular cigarettes compared with those who

reported they are more or equally addictive. Overall, of all adolescents who thought e-cigarettes were not harmful, the majority were current e-cigarette users. While e-cigarettes have a possible role in creating a nicotine addiction and as a getaway to conventional cigarettes for youths, the nicotine itself harms adolescent brain development [34].

The findings of this study also highlighted the different motivations that may affect an adolescent's willingness to smoke e-cigarettes. Those whose main reason for trying e-cigarettes was goal-oriented were a lower proportion than those who tried e-cigarettes for non-goal-oriented reasons such as curiosity or the influence of a friend or family member. Indeed, the results indicated that almost three-fourths of the smokers first initiated e-cigarette smoking out of curiosity. However, it has been reported in the literature that current smokers who had tried e-cigarettes out of curiosity were unlikely to have continued use [35]. This finding may be due to the lack of resemblance between e-cigarettes and regular tobacco cigarettes and the fact that e-cigarettes do not reduce cigarette cravings or that smokers just wanted to try them [35]. E-cigarette users also often mentioned the influence of friends or family as a reason for trying the product. Social connections encourage the flow of most innovations throughout a population [36]. Moreover, e-cigarettes are promoted through youth-dominated channels such as celebrities on social media [37]. They are offered in flavors such as berries, chocolate, and mixed fruits that may appeal to young people [29].

Moreover, the results demonstrated that more than a third of the current e-cigarette-smoking students were tempted to try an e-cigarette when offered by a friend. One of the possible reasons for this is that smoking behaviors, in particular, increase through social connections, partly because similar people meet in social or family groups [37][38]. Additionally, the link between friends' offers of e-cigarettes and the use of e-cigarettes is consistent with other studies. For instance, 31.27% of adolescents reported they would try an e-cigarette if a friend offered it to them since those friends who use e-cigarettes may perceive greater social approval and a greater prevalence of e-cigarette usage, both of which increase adolescents' likelihood of use [39] [40] [41]. In this study's sample of teenagers, most had experimented with shisha products and a third with smokeless tobacco. Consistent with these results, a cohort study revealed that among teenagers who did not smoke, experimentation with alternative tobacco products was associated with a higher risk of conventional smoking six months later [42]. Another study reported that adolescents who started tobacco use with any form of tobacco products other than regular cigarettes were more likely to have smoked cigarettes one year later than were adolescents who had never used tobacco products [43]. Moreover, among participants who use e-cigarettes, more than half are also current users of shisha products. This may

be because e-cigarettes, like shisha-flavored tobacco, come in different colors and flavors (such as cola, cherry, and peach), which make them particularly attractive to adolescents [42]. The current findings further indicated that about 73% of the students who smoked e-cigarettes reported some exposure to e-cigarette advertisements over the internet. While many existing studies on e-cigarette advertisement exposure have emphasized its association with adolescents' e-cigarette usage [44], this current research did not find a significant association between the frequency of e-cigarette advertisement exposure and the likelihood of smoking e-cigarettes. However, parental smoking status is a known strong predictor of adolescent smoking, and smoking is more prevalent among parents with low socioeconomic status (SES) [45]. Nonetheless, in this study, students who claimed their monthly family income was 9,000 SR (approximately 200 USD) or above also reported a higher frequency of e-cigarette use than those with a family income of less than 9,000 SR. This is in contrast to a study in Argentina that reported that smoking prevalence, the probability of purchasing single cigarettes, susceptibility to smoking, and secondhand smoke exposure were higher among students attending schools with lower SES, measured by convergent poverty in the area where the school was located and/or the school having received social assistance [46]. It has also been found that the Family Smoking Prevention and Tobacco Control Act of 2009, clean indoor air policies, cigarette taxes, and antismoking populations were linked to increased levels of e-cigarette searches and use [46]. The clean air policy, which prohibits using conventional tobacco products in indoor public places such as worksites and restaurants [22], raised e-cigarette use and did not necessarily address emissions from these products. Thus, the public must be protected from both secondhand smoke and secondhand aerosol. Clean air policies should be updated to include e-cigarette use [48][49].

Finally, according to the Saudi customs officials' website, e-cigarettes are considered illegal, and the Ministry of Health declares them as harmful as other tobacco products [50] [22]. Hence, there are no legal ways to obtain a vape module, vape liquid, or other equipment needed for e-cigarette devices. This

makes it clear that not only is the adolescent population at risk of harm associated with e-cigarettes (including becoming regular tobacco users, but they can also become targets for illegal vendors of all types of addictive products.

Study limitations

Several limitations should be considered to allow an interpretation of the described findings. First, the cross-sectional design of this study prevents exporting of causal inferences about the results since it can only indicate associations among the studied characteristics but not causality. Secondly, this study needs more information on the smoking behavior of non-responders, particularly among adolescents outside the schools. Non-respondents may have a higher smoking prevalence than those surveyed, which may have caused an underestimation of this smoking rate in the study. Thirdly, the self-reported assessment could introduce a reporting bias, and adolescents' smoking behavior in Mecca may differ from those living in the capital city of Riyadh or the more traditional suburban Saudi towns. Lastly, findings may not be generalizable to populations outside the sample's geographical areas or to other regions or countries.

Conclusion and Recommendations

In conclusion, even minimal smoking experience is correlated with pro-smoking attitudes among adolescent smokers. Thus, tobacco control efforts should attend to low-rate smokers, given their significant risk for chronic use, and capitalize on their motivation to quit with focused prevention strategies that arrest the progression from nondaily to daily smoking. To prevent the initiation of e-cigarette use, particularly among adolescents not susceptible to smoking cigarettes, educational campaigns should target harm perceptions associated with e-cigarettes. In addition, guidelines that limit adolescents' exposure to e-cigarettes in public places may decrease e-cigarette use by non-susceptible adolescents. Because e-cigarette use is common in adolescents and young adults, further research is needed to establish whether it will increase population use rates of cigarettes and other combustible tobacco products and their associated disease burden. Moreover, members

Table 3: Results of multivariate analysis for factors significantly associated with e-cigarettes smoking among high school students (multivariate) (n=534).

Variable	Reference	P-value	OR	95% CI
Ever Experimenting with cigarettes	Never experimented	0.002	3.39	1.54-7.47
Ever Experimenting with shisha	Never experimented	<0.001	7.92	3.52-11.83
Current shisha smoker	Not shisha smoker	<0.001	9.25	3.29-16.00
living with a smoker	Not living with a smoker	0.021	2.26	1.13-4.54
Perceiving e-cigarettes as less addictive	More addictive	0.003	3.63	1.53-8.60
Second year of high school	First year	0.004	4.01	1.57-10.22
Male	Female	0.011	2.34	1.21-4.49

of the young generation usually start smoking for reasons of social self-growth or to be treated as an adult in society. Thus, in antismoking educational campaigns for adolescents, rather than simply forcing the social norm that adolescents should not smoke, it is better to explain the harmful effects of smoking on physical growth and mental safety.

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