

Original Article :

A cross-sectional study comparing the use of e-cigarettes and traditional tobacco cigarettes among young Makkah people.

Mohammed Ayad Alruqi^{1,2}, Abdullah R. Alzahrani^{1,2}, Munira Muhammad Alrooqi³, Nahla Ayoub^{1,2}, Ibrahim Mufadhi M. Alanazi^{1,2}, Mohammad Tariqeh Imam⁴, Saeed Saeed Al-Ghamdi^{1,2}, Naiyer Shahzad^{1,2},

1. Department of Pharmacology and Toxicology, Faculty of Medicine, Umm Al-Qura University, Makkah, Saudi Arabia.

2. Saudi Society of Toxicology (STS), Faculty of Medicine, Umm Al-Qura University, Makkah, Saudi Arabia.

3. Department of Chemistry, Faculty of Science, Umm Al-Qura University, Makkah, Saudi Arabia

4. Department of Clinical Pharmacy, College of Pharmacy, Prince Sattam Bin Abdulaziz University, Al-Kharj, Saudi Arabia

Received on May 25, 2023, accepted for publication on Oct 18, 2023, dx.doi.org/10.5455/mjhs.2024.01.003

Corresponding Author:

Naiyer Shahzad, Department of Pharmacology and Toxicology, Faculty of Medicine, Umm Al-Qura University, Makkah, Saudi Arabia, (nsshahzad@uqu.edu.sa)

OPEN ACCESS

Distributed under Creative Commons CC BY-NC-ND 4.0



Abstract

Background and Aims:

Tobacco smoking has a significant role in health deterioration worldwide. The study was conducted to estimate the prevalence and awareness of smoking among young Makkah people.

Methods:

A cross-sectional study was conducted to estimate tobacco smoking's prevalence, characteristics, perception, and awareness using the GATS standardized questionnaire tool.

Results:

The sample size was 410, the prevalence of smoking among males was 22.92% (n = 94), and for females was 14.39% (n = 59). The gender difference is significant ($\chi^2 = 93.657$, $p < 0.001$). Most of the young are new users and have used it for less than one year with a frequency of ≤ 1 smoke per day. Females are more motivated to quit smoking by using e-cigarettes 56.8% (n = 233) than males 18.2% (n = 75) while after successful cessation of smoking a large percentage of females continued using e-cigarettes 53.9% (n = 221) than males 18.2% (n = 75). This study revealed that there is a significant positive strong association between smoking and gender ($\chi^2 = 90.834$, $p < 0.001$), marital status ($\chi^2 = 59.339$, $p < 0.001$), different age groups ($\chi^2 = 41.961$, $p < 0.001$), and income ($\chi^2 = 107.662$, $p < 0.001$).

Conclusions:

We found a strong relationship between e-cigarette use and gender, income, and marital status. The data show that females who used e-cigarettes as a quit aid used them for longer than males. The findings suggested that e-cigarettes could be used to quit smoking or as a substitute for other tobacco products.

Keywords:

Electronic cigarette, smoking, nicotine, ENDD.

Introduction

Cigarettes are tobacco products and over 1 billion people around the world smoke them as a leisure practice ^{1,2}. Tobacco use is a major risk factor for various chronic illnesses, including cancer, lung, and heart diseases ^{1, 3, 4}. Various nicotine replacement therapy (NRT) products are available to aid in smoking cessation, including nasal spray, gum, inhalers, and electronic nicotine delivery devices (ENDD)/e-cigarettes ⁵. Adults' and children's acceptance of e-cigarettes has steadily grown over the last few decades because of its flavors that may perhaps appeal to younger generations ⁶⁻¹³.

Nicotine in e-cigarette vapor/smokes produces a pleasant warm sensation in the upper respiratory system, which stimulates thermoreceptors and contributes to the pleasing properties of e-cigarettes ¹⁴, it stimulates nicotinic acetylcholine receptors, affect hormone shifts, and modulates the nervous system, resulting in tobacco addiction ¹⁵. Nicotine also affects hunger receptors, triggers serotonergic neurons, and enhances serotonin secretion in the brain, which induces satiety and decreases hunger for carbohydrate-rich foods ^{14, 16}.

Traditional cigarette/tobacco smokers are gradually turning to e-cigarettes as a quit-smoking aid ¹⁷⁻¹⁹. E-cigarette use has

been shown to be less harmful than traditional smoking ¹ and to be an effective smoking cessation aid ⁵, but there are concerns that e-cigarettes may serve as a gateway to smoking cigarettes among young people ^{20, 21}. The gateway hypothesis/catalyst model has sparked a lot of discussion among researchers and public health practitioners ^{3, 21-23}. The Arabian Center for Tobacco Control (2011) reported that tobacco use was responsible for 280, 000 premature deaths in ten years in Saudi Arabia during 2001-2012 ², tobacco-related mortality data in Saudi Arabia is close to those in some developed countries (e.g., the United States, France, and Germany, where tobacco use is responsible for 22–23 percent of premature deaths) ^{2,24}. Since the Kingdom of Saudi Arabia (KSA) is undergoing rapid transformation, societal and cultural traditional values linked to socializing in cafes and restaurants where e-cigarette smoking has become a practice are being challenged ²⁰.

Smoking is prevalent in Saudi Arabia, and it affects people of all ages ²⁵. In the area of smoking prevention and control, further research is needed ²⁵⁻²⁷.

In the Kingdom of Saudi Arabia, the use of e-cigarettes is on the rise among college and university students. The rising popularity of e-cigarettes among teenagers raises fears that it could act as a gateway

to conventional cigarette smoking for non-smokers or postpone smoking cessation for existing smokers²⁷⁻²⁹. While a few studies have looked into e-cigarette awareness and usage among Saudi Arabian young adults, there is a lack of data for understanding the factors that influence adult e-cigarette use and correlating factors with use/non-use of e-cigarette²⁸⁻³¹. This study explored e-cigarette awareness and examined the correlates of use in Makkah people.

Methods

Study design and study location

This study was an observational, descriptive cross-sectional survey that targeted the Makkah residents aged between 15-55 years during Dec 2020 - April 2021. In this study, the recruited participants were randomly selected having both non-smoker and smokers of traditional cigarette or e-cigarette from Makkah city, Saudi Arabia, to determine the prevalence and health hazards of smoking among them. The population of Makkah city according to the 2015 Census was 1.6 million residents. Residents of Eligibility of inclusion of participants in the present study were e-cigarettes/tobacco cigarette smokers whereas pregnant women and hookah/water pipe users were excluded.

Study participants

For the selection of the study, partici-

pants' standardization of study protocol was carried out. The study data collection tool was pretested on 20 subjects to see whether it fulfilled the study, objectives and required modification were made later on. Each participant was informed that the study for research purpose and the subjective information. The option of withdrawal at any stage of the study was always available to them. The study participant defined smoker as who have smoked for at least once in the past 30 days while never smokers were those who had never tried smoking in their lifetime. The study participants were assured about the confidentiality of the survey questionnaire and that the interview would not be disclosed. Biomedical and Ethics Committee of Umm Al-Qura University Medical College approved the study protocol before the start of the study with study approval no.: [HAPO-MSCUQU-43312].

Sample size calculation and sampling procedures

Sample size was calculated using Cochran formula of infinity population.

Sample size of infinite population

$$n_0 = \frac{Zpq^2}{e^2}$$

Where, e is the desired level of precision (i.e. the margin of error),

p is the (estimated) proportion of the population which has the attribute in question, q is $1 - p$.

So, for $p = 0.5$ Confidence interval (CI) of 95% at least 5 percent plus or minus precision. Z values of 1.96, per the normal tables, we get

$$n_0 = \frac{(1.96)^2 * (0.5) * (1 - 0.5)}{(0.05)^2}$$

$$n_0 = 385$$

So, a random sample of 385 in our target population were enough to give us the confidence levels we need.

The sample calculated to be 385 using a 95% confidence interval. The sample further inflated to 410. Stratified random sampling technique used for the selection of the samples. We divided geographically Makkah city ten geographical parts for the randomization, which were numbered from 1 to 10 and of these 5 regions were selected randomly using random number table and in each selected region, eligible participants were identified using one-to-one contact.

Data collection

This study's questionnaire in the present study was adapted from the GATS (Global Adults Tobacco Survey) ³². The questionnaire asked about the respondents' socio-demographic and general statistics, as well as their smoking status, smoking-related

factors, and awareness of the dangers and long-term effects of smoking. All questions were translated into Arabic, which was verified by a second bilingual speaker using back-translation. Experts review the translated questionnaire to ensure that it captures the intended concepts and is culturally appropriate. Comparing the responses to the translated questionnaire with a validated instrument or external criteria to assess its accuracy. Assessing the questionnaire's consistency through Cronbach's alpha test of reliability, which involves administering the same questions to the same respondents at two different time points and comparing their responses for consistency. The participants were interviewed and given a survey to fill out. The questionnaire included demographic data (age, sex, year of study, and academic performance), tobacco smoking, tobacco use pattern (the type of smoking and age of initiation), and passive smoking. A smoker was defined as someone who currently used at least one tobacco product. A passive smoker was described as who has a family member or a close friend who is a smoker.

Statistical analysis

Data were analyzed to understand whether young people who never tried nicotine or have previously tried nicotine are

using e-cigarettes. All data analyses were performed using the Statistical Analysis System software package 23.0. Descriptive statistics are used to estimate smoking prevalence. The chi square test used to compare the smoking status of the studied adults by their sociodemographic characteristics. The level of statistical significance was defined as $p \leq 0.05$.

Results

Result of sociodemographic characteristics

This research included young male and female participants from Makkah city. A total of 410 participants included in this

study, 32.4% (133) were males and 67.6% (277) were females. The ages were categorized in the group of 15-55 years. 23.9% (98) singles and 76.1% (312) were married. Income ranges from less than 3000 Saudi Riyal (SR) monthly to more than 9000 SR. More participants are from high income grade 63.9% (262) while the least is between 3000-6000 SR 5.1% (21). Body mass index (kg/m²) was also recorded, and it was found that underweight 42.7% (175), normal 41.7% (171), overweight 8.3% (34), and obese were 7.3% (30). The majority of participants were below the normal weight (Table 1).

Table 1 Sociodemographic and frequency of respondents about e-cigarette, associated disease and clinical information (n = 410)

Survey measures	Categorical variables	Frequency	Percentage
Gender	Male	133	32.4
	Female	277	67.6
Age by Years	15-25	277	67.6
	26-35	100	24.4
	36-45	27	6.6
	46-55	6	1.5
Marital Status	Single	98	23.9
	Married	312	76.1
Income index	Less than 3000 SR	70	17.1
	Between than 3000-6000 SR	21	5.1
	Between than 6000-9000 SR	57	13.9
	More than 9000 SR	262	63.9
Body Mass Index (BMI) (kg/m ²)	Underweight	175	42.7
	Normal Weight	171	41.7
	Overweight	34	8.3
	Obese	30	7.3
Do you Suffer from any disease?	Yes	39	9.5
	No	371	90.5
Do you have difficulty in breathing?	Yes	42	10.2
	No	368	89.8

Survey measures	Categorical variables	Frequency	Percentage
Are you a diabetic?	Yes	15	3.7
	No	395	96.3
Do you suffer from hypertension?	Yes	27	6.6
	No	383	93.4

Results of disease and clinical information of participants

Participants' clinical history indicated that 9.5% (39) suffered from some disease and 90.5% (372) were free from any disease. Difficulty in breathing was reported by 10.2 % (42) while the majority of participants 89.8% (368) were free from any breathing problems or lung diseases. The record of chronic diseases among the smokers, 3.7% (15) and 6.6 % (27) suffered from diabetes and hypertension respectively while the remaining of them were healthy 96.3% (395) and 93.4% (383) were non-diabetic and non-hypertensive (Table 1).

Smoking trend, habits, and psychology/perception of tobacco users

Responses of research questions related to smoking habits and perceptions of smokers are presented in table 4. Out of 410 37.3% (153) were smokers. One quarter of the smokers 25.6% (105) use shisha, 24.6% (101) traditional tobacco cigarette, high number of them are e-cigarette users 35.9% (147) only 13.9% (57) in them are using multiple type of smoking materials. The majority of users are 71% (291)

started and using cigarette by less than one year, 14.4% (59) and 9.5% (39) are practicing smoking since 2-5, and 6-10 years respectively while long duration users 11-20 years are very less 5.1% (21) only. Frequency of smoking reported by majority of smokers were less than equal to one cigarette per day were 66.8% (274), moderate smokers are 2-5, and 6-10 in number per day were 14.9% (61) and 6.6% (27) respectively while heavy and chronic smokers who smoke 11-20 and 21-30 cigarettes per day were 9.8% (40) and 2% (8) respectively. More than half users 51.5% (211) tried to quit smoking while 48.5% (199) did not tried. Approximately half of them 49.8% (204) tried to quit smoking by using e-cigarette, rest of them used other means of quit aid such as nicotine tablets 14.9% (61), nicotine gum 9.8% (40) medications 5.9% (24), about 8.8% (36) tried to take consultation with clinical advice and 11.0% (45) tried other means. The smokers who used both e-cigarette and tobacco traditional cigarette always are 32.4% (133) whereas half of them 50% (205) use some time both while 17.6% (72) not at all, they use either of them. 61.7% (253) tried e-cig-

arettes and 38.3% (157) not tried. Two fifth 62.4% (256) of the respondents' opinion towards e-cigarette is helpful in quitting smoking while a large percentage has negative approach 37.6 (154). Three fourth 75.1% (308) a big no of participants succeeds in quitting smoking by the use of e-cigarette while 24.9% (102) failed. Even after a successful achievement 72.2% (296) still use e-cigarette and 52.0% (213) do not recommend e-cigarette as a quit aid or to cut down smoking.

The participants reported awareness of e-cigarettes by watching website advertisements 25.9% (106), 38% (159) by interacting with friends, 12.7% (52) by seeing relatives and 22.7% (93) by interacting with social media. About the health benefits more than 50% have the perception that none of the smoking activity is good for health, while 7.1% (29), 25.9% (106), 6.8% (28) responded that tobacco cigarette, e-cigarette, shisha is better for health respectively.

It is reported that there is variance in the time of use during day/night. Some of them prefer to smoke 0.7% (3) before a meal while 14.6% (60) after a meal. Very

few and similar percentage 0.7% (3) prefer smoking before and after sleep. While a large number of smokers prefer smoking during some activities like during taking tea/coffee 3.7% (15), playing cards 1.5% (6), during reading and solving problems 0.7% (3), and majority they like during watching TV 62.4% (256), while 14.9% (61) at free time.

In reply to question when they feel to smoke, they responded the situation/state 0.5% (2) depressed, 3.2% (13) happy, 5.1% (21) sad, 2.9% (12) upset, 8.3% (34) angry, 7.3% (30) while free, 8.3% (34) stressed while majority answered 64.4% (264) in all the situation.

When they smoke a high number express regret 63.9% (262), while 16.1% (66) feel satisfaction, 11% (45) are happy, 2.9% (12), 4.6% (19), and 1.5% (6) are sad, upset, and angry respectively. If they don't use cigarettes for a long time vast number of users reported nervous status 65.4% (268); 7.6% (31) and 2.2% (9) are satisfied and happy. Very rare 0.7% (3) are sad 2.2% (9) happy whereas 8% (33) and 4.4% (18) upset and anger (Table 2).

Table2 Frequency table of smoking trend, habits, and psychology of tobacco users (n = 410)

Survey measures	Categorical variables	Frequency	Percentage
Do you smoke?	Yes	153	37.3
	No	257	62.7
What type of cigarettes do you smoke?	Tobacco Cigarettes	101	24.6
	Electronic Cigarettes	147	35.9

Survey measures	Categorical variables	Frequency	Percentage
What type of cigarettes do you smoke?	Shisha	105	25.6
	All of the above	57	13.9
How many years you have been smoking?	≤1	291	71.0
	2-5	59	14.4
	6-10	39	9.5
	11-20	21	5.1
How many times or cigarettes do you smoke in a day?	≤1	274	66.8
	2-5	61	14.9
	6-10	27	6.6
	11-20	40	9.8
	21-30	8	2.0
Did you try to quit smoking?	Yes	211	51.5
	No	199	48.5
How did you try to quit smoking?	Electronic Cigarettes	204	49.8
	Nicotine Tablets	61	14.9
	Nicotine Gum	40	9.8
	Medications	24	5.9
	Quitting Smoking Clinic	36	8.8
	Other	45	11.0
Do you think E-cigarettes will be helpful to quit smoking?	Yes	256	62.4
	No	154	37.6
How did you know about E-cigarettes?	Websites	106	25.9
	Friends	159	38.8
	Relatives	52	12.7
	Social Media	93	22.7

Association of gender with smoking cigarettes and e-cigarettes

A chi-squared test of independence was performed to examine the correlation between gender and smokers. Thirty seven percent of participants were smokers in which 22.92 % (94) were males and 14.39% (59) were females. Findings revealed a significant correlation between gender and smoking; $\chi^2 (2, n=410) = 93.657, p < 0.001$. Level of significance ($p < 0.001$) suggested smoking and gender relation are moderately associated. Fe-

males 56.82% (233) are more successful to stop smoking through e-cigarettes than males 18.29 (75), the Chi-squared tests revealed there was a significant correlation between gender and smoking cessation $\chi^2 (2, n=410) = 36.957, p < 0.001$. Even after quitting the smoking successfully female in large number 53% (221) continues using e-cigarettes than males 18% (75). Continuation of e-cigarette use among the Makkah people also have an association $\chi^2 (2, n=410) = 24.495, p < 0.001$ (Table 3).

Table 3 Association of gender with smoking cigarettes and e-cigarettes (n = 410)

	Gender	Yes	No	χ^2	$p <$
Do you smoke?	Male	94	39	93.657	0.001
	Female	59	218		
Did you succeed in quitting smoking through using of e-cigarettes?	Male	75	58	36.957	0.001
	Female	233	44		
Do you still using e-cigarettes even when you succeed in quitting smoking?	Male	75	58	24.495	0.001
	Female	221	56		

Association of smoking cigarettes/e-cigarettes status in years with gender, marital status, age grade, and income grade

A chi-squared test of independence was performed to examine the correlation between practicing smoking in years and gender, marital status, age, and income grades. Users using less than one year are more in females than males while the chronic users in between 11-20 years are more in number in males so there is a strong association between chronic use and occasional use in genders $\chi^2 (3, n=410) = 90.834, p < 0.001$. Marital status also has an association is new users (less than one year) and chronic users, married are more in num-

ber who just started smoking less than a year while singles are chronic users $\chi^2 (3, n=410) = 59.339, p < 0.001$. Youngers age between 15-25 years are smoking in large numbers than higher age groups, youngsters are less chronic user than middle age groups so there is significant association in age group and duration of smoking $\chi^2 (9, n=410) = 41.961, p < 0.001$. Similarly, a significant association is observed in low income grade and high income grade with smoking status in years. Frequency of new users in less income grade less than high income grade while the chronic users are more in less income grade $\chi^2 (9, n=410) = 107.662, p < 0.001$ (table 4).

Table 4 Association of duration (how long time) of smoking cigarettes and e-cigarette users with gender, marital status, income, and frequency of smoking per day (n = 410)

Measures	How many years do you smoke?						χ^2	$p <$
	Variables	≤ 1	2-5	6-10	11-20			
Gender	Male (n=133)	56	33	24	20	90.834	0.001	
	Female (n=277)	235	26	15	1			
Marital Status	Single	51	12	17	18	59.339	0.001	
	Married	240	47	22	3			
Age by Years	15-25	213	36	26	2	41.961	0.001	
	26-35	58	17	10	15			
	36-45	17	4	2	4			
	46-55	3	2	1	0			

Measures	How many years do you smoke?						
	Variables	≤1	2-5	6-10	11-20	χ^2	p <
Monthly Income	Less than 3000 SR	39	13	9	9	107.662	0.001
	Between than 3000-6000 SR	8	3	0	10		
	Between than 6000-9000 SR	40	8	7	2		
	More than 6000 SR	204	35	23	0		

Discussion

The results of this community based study showed a high prevalence of smoking in Saudi Arabia and that age, gender, marital status, and income grade were important demographic factors predicting the likelihood of tobacco consumption. Since 2013, there has been a marked growth in regular use of e-cigarettes among Saudi population. E-cigarettes is now most common than shisha and traditional tobacco cigarette. The reported prevalence of current smoking was 37.5% overall (22.9% among men and 14.3% among women), which is higher than the prevalence of 12.9% (24.7% among men and 1.4% among women) reported previously for Saudi Arabia which is almost double of the previously reported ³³. This difference could be attributed to a large extent to the lower rate of smoking reported among females in that study. Worldwide, the prevalence of smoking is much higher in men than in women ³⁴. The obtained results were consistent with this, although the difference between the sexes was small

in our study (men were 1.5 times more likely to be smokers than women), which could be attributed to the social stigma attached to women being smokers in Saudi Arabia. However, it is also possible that the current study underestimated the rate of female smokers, as there may have been under-reporting in spite of assurances to participants about the confidentiality of the data. The validity of self-reporting in determining the rate of smoking is often questioned ³⁵. A study in New England in the United States compared self-reported smoking behavior by men and women and showed credibility in the use of self-reports of smoking in both sexes ³⁶. The situation may be different in a more socially conservative community, however, and this needs to be addressed in further research. Generally, younger people have a greater tendency to be smokers than older people³⁷.

In this study the prevalence of smoking in different age groups showed same trends in men and women, as we found the highest rate of smoking in men among the

younger groups and the lowest rate among the older ages, while in women the lowest rate was in the younger group, and it increased as they got older. However, it may be difficult to generalize from these data for women because the reported cases were from one region that might has unique cultural habits. It is found that smoking was more common among younger people, frequency of smoking is less than 2 per day, most of the participants using less than one years. It is also found that smoking habit is more in low income or high income grade people than medium grade which may be due to social anxiety, friends influence or unsatisfactory income in high income grade. This could be explained by the influence of the promotion through social media, family, friends, television, website, and social media. A study conducted in Hong Kong (put the year of the study here) has shown that one of the strongest risk factors for smoking by youths was their perception of cigarette advertisements as attractive ³⁶. Smoking initiation in young people and the factors contributing to it are well established ³⁸ and constitute one of the main challenges for tobacco control program ^{38,39}. Similar to other studies ^{40,41}, our findings revealed that smoking tended to be more prevalent low and high income grade, young's and this can be explained by stressful working environments ⁴¹ and

peer influences in some occupations ³⁸. These are factors which needed to be addressed in order to focus on an effective strategy for smoking cessation and prevention in these groups. In this study new smokers are more prevalent, chronic/active smokers gradually decreased by age similar pattern is seen in the duration smoking old smokers are less in number.

The research focused on awareness of e-cigarettes, the factors associated with initial and continuing use of e-cigarettes, and reasons for using e-cigarettes among Makkah people. Awareness of e-cigarettes included seeing, hearing, or watching e-cigarette advertising, and receiving or sharing information about e-cigarettes from friends, newspapers, magazines, family, social media, and television. Seeing, hearing, or watching e-cigarette advertising is associated with e-cigarette use among Makkah people. However, double of participants who has not used e-cigarettes reported watching e-cigarette advertising on TV and seeing e-cigarette advertising in magazines or newspapers. High e-cigarette awareness among non-users indicated exposure to e-cigarette advertising among the people. In our study there is a signification gender association found. E-cigarettes are aggressively marketed to young adolescents and adults through social media. In support of efforts to prevent

e-cigarette use among youth, it is urgent that e-cigarette advertising be restricted or banned. Elders and family members may play important role in disseminating information about e cigarettes and using them⁴²⁻⁴⁵. Smoking cessation clinics should educate on e-cigarette use and the potential harms on exposure to nicotine and other e-cigarettes toxins^{43, 46}.

In this study 75% of people reported considering using e-cigarettes in quit smoking, which is large number of participants aware about the health hazards, While females three times that of male continued e-cigarette even after successful cessation of smoking. Females' use of e -cigarettes and conventional cigarettes to deal with stress, sadness or while depressed was indicated in other studies⁴⁷. E-cigarettes have been advertised as healthy and as a safe alternative to smoking and have been promoted by a few celebrities.

Conclusions

E-cigarette users and non-users both reported seeing, hearing, and watching e-cigarette ads, as well as receiving information about e-cigarettes. Since more people (young/adults) are becoming aware of e-cigarettes as a smoking cessation aid. The findings revealed a significant link between e-cigarette use and gender, income, and marital status. The results suggest-

ed that e-cigarettes could be used to stop smoking or as an alternative to other tobacco products, such as conventional cigarettes, shisha, and tobacco smoking, since they were marketed as a healthy smoking cessation method. According to the findings, many people considered a variety of tobacco products, including e-cigarettes. The implications of these results revealed that tobacco-related codes of conduct and national restrictions on e-cigarettes could be implemented strictly. According to the results, females who used e-cigarettes for quit aid used them for longer than males. These results indicate that females' use of e-cigarettes for smoking cessation could be linked to e-cigarette advertisements, implying that e-cigarettes are potentially harmless.

Funding

None

Conflicts of Interest

The authors declare no conflict of interest.

The author's contribution

ARA, SSA, and NS conceived the idea of this experimental study, and MAA performed the study. MAA and MMA wrote the manuscript. ARA, NA, and IMMA supervised the experiment. Data analysis was done by NS and MTI. NS, MTI, and ARA proofread the document for scientific

ic editing and language. The entire team approved the submission of the final manuscript. All authors have read and agreed to the published version of the manuscript.

References

1. Barrett, S. P., The effects of nicotine, denicotinized tobacco, and nicotine-containing tobacco on cigarette craving, withdrawal, and self-administration in male and female smokers. *Behavioural pharmacology* 2010, 21 (2), 144-52.
2. Almutairi, K. M., Trends in Current Tobacco Use, Smoking Rates and Quit Attempts among Saudi Population during Periods of 17 Years (1996-2012): Narrative Review Article. *Iranian journal of public health* 2015, 44 (2), 170-5.
3. Etter, J. F. J. A., Gateway effects and electronic cigarettes. 2018, 113 (10), 1776-1783.
4. Etter, J. F.; Stapleton, J. A., Nicotine replacement therapy for long-term smoking cessation: a meta-analysis. *Tobacco control* 2006, 15 (4), 280-5.
5. Dar, R.; Frenk, H., Hooked on the nicotine addiction thesis: a response to Di-Franza. *Harm Reduction Journal* 2013, 10 (1), 31.
6. Bao, W.; Xu, G.; Lu, J.; Snetselaar, L. G.; Wallace, R. B., Changes in Electronic Cigarette Use Among Adults in the United States, 2014-2016. *JAMA* 2018, 319 (19), 2039-2041.
7. Zhu, S.-H.; Zhuang, Y.-L.; Wong, S.; Cummins, S. E.; Tedeschi, G. J., E-cigarette use and associated changes in population smoking cessation: evidence from US current population surveys. 2017, 358, j3262.
8. King, A. C.; Smith, L. J.; Fridberg, D. J.; Matthews, A. K.; McNamara, P. J.; Cao, D., Exposure to electronic nicotine delivery systems (ENDS) visual imagery increases smoking urge and desire. *Psychology of addictive behaviors : journal of the Society of Psychologists in Addictive Behaviors* 2016, 30 (1), 106-12.
9. Arrazola, R. A.; Singh, T.; Corey, C. G.; Husten, C. G.; Neff, L. J.; Apelberg, B. J.; Bunnell, R. E.; Choiniere, C. J.; King, B. A.; Cox, S.; McAfee, T.; Caraballo, R. S., Tobacco use among middle and high school students - United States, 2011-2014. *MMWR. Morbidity and mortality weekly report* 2015, 64 (14), 381-5.
10. Schoenborn, C. A.; Stommel, M.; Lucas, J. W., Examining the high rate of cigarette smoking among adults with a GED. *Addictive behaviors* 2018, 77, 275-286.

11. Loukas, A.; Marti, C. N.; Cooper, M.; Pasch, K. E.; Perry, C. L., Exclusive e-cigarette use predicts cigarette initiation among college students. *Addictive behaviors* 2018, 76, 343-347.
12. Thrul, J.; Gubner, N. R.; Tice, C. L.; Lisha, N. E.; Ling, P. M., Young adults report increased pleasure from using e-cigarettes and smoking tobacco cigarettes when drinking alcohol. *Addictive behaviors* 2019, 93, 135-140.
13. Qanash, S.; Alemam, S.; Mahdi, E.; Softah, J.; Touman, A. A.; Alsulami, A., Electronic cigarette among health science students in Saudi Arabia. *Annals of thoracic medicine* 2019, 14 (1), 56-62.
14. Gilpin, D. F.; McGown, K.-A.; Gallagher, K.; Bengoechea, J.; Dumigan, A.; Einarsson, G.; Elborn, J. S.; Tunney, M. M., Electronic cigarette vapour increases virulence and inflammatory potential of respiratory pathogens. *Respiratory Research* 2019, 20 (1), 267.
15. Brunzell, D. H.; Stafford, A. M.; Dixon, C. I., Nicotinic receptor contributions to smoking: insights from human studies and animal models. *Curr Addict Rep* 2015, 2 (1), 33-46.
16. Cooper, S. Y.; Henderson, B. J., The Impact of Electronic Nicotine Delivery System (ENDS) Flavors on Nicotinic Acetylcholine Receptors and Nicotine Addiction-Related Behaviors. *Molecules* (Basel, Switzerland) 2020, 25 (18).
17. Cobb, C. O.; Hendricks, P. S.; Eissenberg, T., Electronic cigarettes and nicotine dependence: evolving products, evolving problems. *BMC medicine* 2015, 13, 119.
18. Tan, A. S.; Bigman, C. A., E-cigarette awareness and perceived harmfulness: prevalence and associations with smoking-cessation outcomes. *American journal of preventive medicine* 2014, 47 (2), 141-9.
19. Young-Wolff, K. C.; Adams, S. R.; Tan, A. S. L.; Adams, A. S.; Klebaner, D.; Campbell, C. I.; Satre, D. D.; Salloom, R. G.; Carter-Harris, L.; Prochaska, J. J., Disparities in knowledge and use of tobacco treatment among smokers in California following healthcare reform. *Preventive Medicine Reports* 2019, 14, 100847.
20. Glantz, S. A.; Bareham, D. W., E-Cigarettes: Use, Effects on Smoking, Risks, and Policy Implications. *Annual review of public health* 2018, 39, 215-235.
21. Khouja, J. N.; Suddell, S. F.; Peters, S. E.; Taylor, A. E.; Munafò, M. R., Is

- e-cigarette use in non-smoking young adults associated with later smoking? A systematic review and meta-analysis. *Tobacco control* 2021, 30 (1), 8.
22. Li, J.; Hajek, P.; Pesola, F.; Wu, Q.; Phillips-Waller, A.; Przulj, D.; Myers Smith, K.; Bisal, N.; Sasieni, P.; Dawkins, L.; Ross, L.; Goniewicz, M. L.; McRobbie, H.; Parrott, S., Cost-effectiveness of e-cigarettes compared with nicotine replacement therapy in stop smoking services in England (TEC study): a randomized controlled trial. *Addiction (Abingdon, England)* 2020, 115 (3), 507-517.
23. Eastwood, B.; Dockrell, M. J.; Arnott, D.; Britton, J.; Cheeseman, H.; Jarvis, M. J.; McNeill, A., Electronic cigarette use in young people in Great Britain 2013-2014. *Public health* 2015, 129 (9), 1150-6.
24. Ganguly, K.; Nordström, A.; Thimraj, T. A.; Rahman, M.; Ramström, M.; Sompa, S. I.; Lin, E. Z.; O'Brien, F.; Koelmel, J.; Ernstgård, L.; Johanson, G.; Pollitt, K. J. G.; Palmberg, L.; Upadhyay, S., Addressing the challenges of E-cigarette safety profiling by assessment of pulmonary toxicological response in bronchial and alveolar mucosa models. *Scientific reports* 2020, 10 (1), 20460.
25. Barrington-Trimis, J. L.; Urman, R.; Leventhal, A. M.; Gauderman, W. J.; Cruz, T. B.; Gilreath, T. D.; Howland, S.; Unger, J. B.; Berhane, K.; Samet, J. M.; McConnell, R., E-cigarettes, Cigarettes, and the Prevalence of Adolescent Tobacco Use. *Pediatrics* 2016, 138 (2).
26. Almas, K.; al-Amri, M.; al-Eid, A.; al-Shahrani, S., Oral hygiene, dietary pattern and smoking habits of Bedouin (nomadic Arabs) population in Saudi Arabia. *Odonto-stomatologie tropicale = Tropical dental journal* 2003, 26 (103), 19-23.
27. Camenga, D. R.; Kong, G.; Cavallo, D. A.; Liss, A.; Hyland, A.; Delmerico, J.; Cummings, K. M.; Krishnan-Sarin, S., Alternate tobacco product and drug use among adolescents who use electronic cigarettes, cigarettes only, and never smokers. *The Journal of adolescent health : official publication of the Society for Adolescent Medicine* 2014, 55 (4), 588-91.
28. Al-Turki, Y. A., Smoking habits among medical students in Central Saudi Arabia. *Saudi medical journal* 2006, 27 (5), 700-3.
29. Abolfotouh, M. A.; Abdel Aziz, M.; Alakija, W.; Al-Safy, A.; Khattab, M. S.; Mirdad, S.; Al-Juhani, A.; Al-Hu-

- maidi, M., Smoking habits of King Saud University students in Abha, Saudi Arabia. *Annals of Saudi medicine* 1998, 18 (3), 212-6.
30. Al-Turki, Y. A.; Al-Rowais, N. A., Prevalence of smoking among female medical students in the College of Medicine, Riyadh, Saudi Arabia. *Saudi medical journal* 2008, 29 (2), 311-2.
31. Tahir, M., Smoking and its risks in Saudi Arabia: Literature review. 2019, 12 (4), 152-157.
32. World Health, O.; Centers for Disease, C., Tobacco questions for surveys: a subset of key questions from the Global Adult Tobacco Survey (GATS): global tobacco surveillance system. World Health Organization: Geneva, 2011.
33. Al-Turki, K.; Al-Baghli, N.; Al-Ghamdi, A.; El-Zubaier, A.; Al-Ghamdi, R.; Alameer, M., Prevalence of current smoking in Eastern province, Saudi Arabia. *Eastern Mediterranean health journal = La revue de sante de la Mediterranee orientale = al-Majallah al-sihhiyah li-sharq al-mutawassit* 2010, 16, 671-6.
34. Grunberg, N. E.; Winders, S. E.; Wewers, M. E., Gender differences in tobacco use. *Health psychology : official journal of the Division of Health Psychology, American Psychological Association* 1991, 10 (2), 143-53.
35. Patrick, D. L.; Cheadle, A.; Thompson, D. C.; Diehr, P.; Koepsell, T.; Kinne, S., The validity of self-reported smoking: a review and meta-analysis. *American journal of public health* 1994, 84 (7), 1086-93.
36. Annlouise, A.; Parker, D.; Lapane, K.; McKenney, J.; Carleton, R., Are There Gender Differences in Self-Reported Smoking Practices? Correlation with Thiocyanate and Cotinine Levels in Smokers and Nonsmokers from the Pawtucket Heart Health Program. *Journal of women's health (2002)* 2003, 11, 899-906.
37. Siddiqui, S.; Ogbeide, D. O.; Al Khalifa, I., Smoking in a Saudi community: prevalence, influencing factors, and risk perception. *Family medicine* 2001, 33 (5), 367-70.
38. Gritz, E. R.; Prokhorov, A. V.; Hudson, K. S.; Mullin Jones, M.; Rosenblum, C.; Chang, C. C.; Chamberlain, R. M.; Taylor, W. C.; Johnston, D.; de Moor, C., Predictors of susceptibility to smoking and ever smoking: a longitudinal study in a triethnic sample of adolescents. *Nicotine & tobacco research : official journal of the Society for Research on Nicotine and Tobacco* 2003,

- 5 (4), 493-506.
39. Kuppens, S.; Moore, S. C.; Gross, V.; Lowthian, E.; Siddaway, A. P., The Enduring Effects of Parental Alcohol, Tobacco, and Drug Use on Child Well-being: A Multilevel Meta-Analysis. *Development and psychopathology* 2020, 32 (2), 765-778.
40. Patterson, J. M.; Eberly, L. E.; Ding, Y.; Hargreaves, M., Associations of smoking prevalence with individual and area level social cohesion. *Journal of epidemiology and community health* 2004, 58 (8), 692-7.
41. Shohaimi, S.; Luben, R.; Wareham, N.; Day, N.; Bingham, S.; Welch, A.; Oakes, S.; Khaw, K. T., Residential area deprivation predicts smoking habit independently of individual educational level and occupational social class. A cross sectional study in the Norfolk cohort of the European Investigation into Cancer (EPIC-Norfolk). *Journal of epidemiology and community health* 2003, 57 (4), 270-6.
42. Anand, V.; McGinty, K. L.; O'Brien, K.; Guenther, G.; Hahn, E.; Martin, C. A., E-cigarette Use and Beliefs Among Urban Public High School Students in North Carolina. *The Journal of adolescent health : official publication of the Society for Adolescent Medicine* 2015, 57 (1), 46-51.
43. Bertrand, D.; Bricard, D., Real-Time Characterization of E-Cigarettes Use: The 1 Million Puffs Study. *Journal of Addiction Research & Therapy* 2015, 6.
44. Goniewicz, M. L.; Zielinska-Danch, W., Electronic cigarette use among teenagers and young adults in Poland. *Pediatrics* 2012, 130 (4), e879-85.
45. Callahan-Lyon, P., Electronic cigarettes: human health effects. *Tobacco control* 2014, 23 Suppl 2 (Suppl 2), ii36-40.
46. Avenevoli, S.; Merikangas, K. R., Familial influences on adolescent smoking. *Addiction (Abingdon, England)* 2003, 98 Suppl 1, 1-20.
47. Piñeiro, B.; Correa, J. B.; Simmons, V. N.; Harrell, P. T.; Menzie, N. S.; Unrod, M.; Meltzer, L. R.; Brandon, T. H., Gender differences in use and expectancies of e-cigarettes: Online survey results. *Addictive behaviors* 2016, 52, 91-7.