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Electronic Cigarette and Smoking Cessation – A cross Sectional Study among ARU Students

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Abstract

Introduction: Since electronic cigarettes have been introduced as a safe alternative for traditional cigarettes in the UK, the number of users has significantly increased raising concerns regarding their role as a cessation method and reasons behind using them. This research aimed to provide better understanding the effectiveness of electronic cigarette when it is used for smoking cessation.

Methods: A cross-sectional study of Anglia Ruskin University students was conducted between October 2019 and January 2020. The study included 67 E-cigarette users who completed an online questionnaire, and the primary outcome was self-reported smoking cessation for ≥ six months at the time of the survey.

Result: Among smokers, 66% of them reported smoking cessation for ≥ 6 months. Moreover, the odds of smoking cessation were 5.9 (95% CI 1.22 to 28.95) times higher among smokers who used an electronic cigarette for more than 12-month. Smokers who vaped in a daily pattern were more likely to quit smoking than non-daily users (Unadjusted OR=6.7, 95% CI 1.6 to 28.38).

Conclusion: Among students' smokers at ARU, smoking cessation was associated with long-term and daily use of electronic cigarette. Nevertheless, further studies, such as RCT, should be conducted to determine the efficacy of EC as a cessation tool.

Keywords: Smoking cessation; quit smoking; Stop smoking; Electronic Cigarettes; e-cigarettes; Electronic nicotine delivery systems; e-cig

Abbreviations: ARU: Anglia Ruskin University, CO: Carbone Monoxide, SREP: School Research Ethics Panel, EC: Electronic Cigarette, FREP: Faculty Research Ethics Panel, NRT: Nicotine Replacement Therapy, E-cigarette: Electronic Cigarette, NHS: National Health Service

Introduction

Electronic cigarettes, also called e-cigarettes or vape, are battery-operated devices developed to simulate tobacco smoking; they are composed of a mouthpiece, a heating element, a battery and a liquid storage container that is filled with a solution containing nicotine mixed with a flavor and propylene glycol or glycerin [1].

In the last few years, the popularity of EC has increased significantly in the UK [2]. In 2012, there was 49% of people who heard about e-cigarettes, but the proportion rose by 44% to reach 93% in 2018 [2]. EC has been promoted in the UK as a safe substitute for cigarettes; According to Public Health England [3], electronic cigarettes are 95% safer than traditional cigarettes, but long-term effects have not been approved yet. In the UK, 3.6 million people are using electronic cigarettes, which accounts for around 7.1% of the adult population, and this percentage remains growing [4]. EC is the most common method that used as a cessation aid in the UK, although it is not medicinally licensed product [3,4]. Also, approximately around two-millions of vape users are ex-smokers compared to 1.4 million of dual users [4]. Public Health England [3] stated that electronic cigarette has a low risk of smoking, and over 20,000 of cessation of tobacco use have been accomplished due to electronic cigarette. However, the National Institute for Health and Care Excellence [5] has recommended the use of medicinally licensed nicotine product rather than using an electronic cigarette and highlighted that the effectiveness of electronic cigarette as a cessation aid should be approved by conducting more research on that matter. Additionally, there are rising concerns that electronic cigarette could enhance tobacco smoking among adults as they have become addicted to nicotine [2].

A systematic review was conducted by Cochrane Library and included randomized control trials and cohort studies to examine the relationship between electronic cigarette and smoking cessation [6]. Although the authors concluded that electronic cigarette might help smokers to stop smoking in long-term, evidence was evaluated as low by GRADE standards. Also, Kalkhoran and Glantz [7] reviewed 38 previous studies, of which 20 of them were included in the meta-analysis. Authors' conclusion was that electronic cigarette is significantly associated with discouraging smoking abstinence, and the odds of cessation were 28% less among electronic cigarette users than non-users. On the other hand, a systematic review included meta-analysis found a positive effect. Rahman et al. [8] stated that electronic cigarette is an effective method for both smoking cessation and reduction.

Bullen et al. [9] compared between electronic cigarette and three quitting methods among 657 smokers, with a primary outcome of 6-month of regular cigarettes abstinence. Authors highlighted that electronic cigarette is modestly effective for smoking cessation and cigarette reduction, but nicotine patches could achieve a similar result. However, the verified abstinence rates in all groups were low, and as a result, weak statistical power was used to detect the differences. In contrast, another randomised controlled trial mentioned that electronic cigarettes were more effective than nicotine-replacement therapy in term of tobacco cessation, and smokers who used electronic cigarette had higher abstinence rates at one year than those who received nicotine replacement therapy [10].

The role that e-cigarettes play as smoking cessation tool is still uncertain. Some authors support the idea of using electronic cigarettes for smokers who seek to reduce or stop smoking while others consider electronic cigarettes as a gateway for adults to initiate smoking. Furthermore, electronic cigarette utilization is increasing,

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and different electronic cigarette designs and E-liquids are being introduced frequently, which requires a piece of new and up-to-date information to expand the existed knowledge.

This study aims to examine the relationship between electronic cigarette use and smoking cessation among students at Anglia Ruskin University (ARU).

The research question is "Is electronic cigarette an effective way to stop smoking among university student?"

The study has three objectives:

- Exploring the socio-demographic characteristic and smoking status of students.
- Knowing the smoking history amongst electronic cigarette users who have smoked traditional tobacco.
- To identify electronic cigarette practices and the most reasons that have made students use electronic cigarettes.

Materials and Methods

Study Design

This study is a quantitative and has a cross-sectional design. Data was collected from students at ARU in the UK for two months and three weeks between October 21, 2019, and January 2, 2020.

Participants

E-Cigarettes are mainly utilised by adults, and according to the Action on Smoking and Health [4], researches should concentrate more on this age group as they are more affected by this issue. Therefore, the target population was EC users at Anglia Ruskin University, UK. Inclusion and exclusion criteria included electronic cigarette users aged 18 years old or more without any other restrictions.

This study has a convenience sample of 67 participants due to several reasons. First, the sampling frame, which is EC users, is not feasible because of the lack of a structured way to contact them, such as email or a gatekeeper, and therefore convenience sampling would be more practical than random sampling [11]. Second, the study's questionnaire was online which makes it under the risk of coverage bias [12]. Finally, there was not data regarding prevalence of electronic cigarette users at ARU which is needed to calculate the sample size by using power calculation [13].

Data Collection

Data were collected by using an online questionnaire which was accessible by a link posted on My Anglia website (a university website can be accessed by students in different campuses). Also, posters to invite participants to take place in the study were posted on boards around campuses with QR scan to make participation more convenient. After one month, a new announcement was posted on My Anglia website, and other adverts were distributed as a reminder.

Previously validated questionnaire from articles [2,14–17] were reviewed and used to design the study questionnaire. Then, an informal pilot study was done which included six participants (colleagues who were using electronic cigarettes) to test the understanding of questions, and they reported a clear understanding.

The questionnaire was divided into three sections with 16 questions overall. The first section contained basic sensitive questions to explore socio-demographic characteristics of electronic cigarette users while the second part focused on smoking practice for those who have smoked traditional cigarette in their life. The last part was electronic cigarette practices and reasons behind using it.

Self-Reported smoking cessation was the measure that was used to estimate the primary outcome of the study. Although different chemical methods could be used to confirm abstinence from cigarettes, such as measuring cotinine level in urine and expired CO level, self-reported smoking abstinence in non-clinical studies is also a validated method [18-20]. Regarding reliability, the outcome (smoking cessation) was self-reported, and it has been reported as a reliable method to assess smoking abstinence [21].

Ethics Statement

An ethics approval has been obtained from the School Research Ethics Panel (SREP) and ratified by the Faculty Research Ethics Panel (FREP) following Anglia Ruskin University's Policy. Participant Information Sheet was included in the URL for the online questionnaire, and consent was assumed by completion of the survey.

Data Analysis

Measures

Outcome Variables

The dependent variable of this study was self-reported of smoking cessation for six months or more. According to the Centers for Disease Control and Prevention [22], a smoker is a person who has smoked 100 cigarettes in his or her entire life. Therefore, the question "Have you smoked at least 100 cigarettes in your entire life" has been included within the questionnaire to identify smokers. Smokers have been subsequently asked if they were able to quit smoking "Were you able to stop smoking for ≥ 6 months by using electronic cigarette", and those who responded "Yes" were categorised as former smokers. The primary outcome of this research is the previous explanation of former smokers.

Potential Confounders

The socio-demographic variables included age, gender, marital status, facilities and academic level. Furthermore, responses to "Prefer not to answer" were treated as a missing data. For smoking practices, responders who smoked 100 cigarettes in their lifetime were required to answer further questions about their smoking behaviour. They were asked: "For how long you have smoked or did you smoke?" and answer were three categories (less than 2 years, 2 to 4 years and more than 4 years). Also, a question to address the number of consumed cigarettes before start using electronic cigarette had five groups' answer (Occasionally, less than one cigarette, 1-10 cigarettes/day, 10-20 cigarettes/day and >20 cigarettes/day); the question was used to estimate nicotine dependence [23]. Smokers who did not quit smoking and E-cigarette users who have started smoking were both considered as dual users. They were asked about the number of cigarettes they were smoking while using electronic cigarettes, and the answer was categorized into four groups (None, Occasionally, 1-10 cigarettes a day and More than 10 cigarettes a day). A reduction of 50% of smoked cigarettes per day was considered a substantial reduction [24,25]. In term of EC practices, participants were asked about the reason behind electronic cigarette use; and the duration of using electronic cigarettes. Three groups of answers (daily, weekly and occasionally) were provided for the question "How often do you smoke Electronic cigarette?" To know the frequency of electronic cigarette use, which could be associated with the study outcome [26]. Then, they were

asked about the nicotine level of EC.

Descriptive analysis was applied to describe socio-demographic characteristics, traditional cigarette and electronic cigarettes practices of the responders. Restricted to the subset of smokers excluding those who were not smokers before using E-cigarette, Chi-square test or cross-tabulation was conducted to find a significant relationship between smoking cessation (categorical variable) and independent categorical variables while Fisher's exact test was used for categorical variables with few responses. Then, significant variables were entered into the binary logistic regression to determine which categories were associated with smoking cessation and to calculate unadjusted Odds Ratio. In Univariate logistic regression, due to small responses in some cells, we combined some categories and created a new categorical group. For frequency of vaping, we combined occasional and weekly users into non-daily users whereas, for the duration of using electronic cigarettes, 12-12 months and more than 24 months categories were joined a new category (more than 12 months). All statistical analyses were conducted by IBM SPSS version 25, with a 95% confidence interval and P values <0.05 indicating statistical significance.

Results

Socio-Demographic Characteristics

Table 1 shows the socio-demographic characteristics of a total of 67 participants who responded to this survey. The majority of participants were above 23 years old (n=37, 55.2%), male (n=35, 52.2%) and single (n=45, 67.2%). Around half of the respondents were at faculty of Business and Law/Health, Education, Medicine and Social Care, and were undergraduate students (n=34, 50.7% and n=47, 70.1% respectively). 79.1% (n=53) of respondents were smokers compared to 20.9% (n=14) of non-smokers.

E-cigarette practices

In term of reasons behind electronic cigarette use, the majority of respondents reported using electronic cigarette as a method to quit or abstain from smoking (40.3%). The percentage of respondents who chose to use electronic cigarette to cut down their cigarette consumption was 11.9%, and this proportion was similar for those who were using electronic cigarette because they enjoyed it. 14.9% of participants were using electronic cigarettes for other reason, whereas 6% were using electronic cigarette as a friend suggested it. For saving money and curiosity, the percentage was 4.5% for each whereas 6% of users were advised to use electronic cigarette by a friend. For both of those who used electronic cigarettes to smoke in places where smoking is prohibited and those who were advised by a healthcare practitioner, the percentage was 1.5% for each.

More than half of the respondents (56.7%) were still using electronic cigarette at the time of the survey, while 43.3% of them have stopped using it. Concerning the duration of using electronic cigarettes, respondents who mentioned 1 to 6 months of usage represented the majority of electronic cigarette users with 38.8% following by 22.4% of those who used electronic cigarettes for 6 to 12 months and 12 to 24 months. Also, this percentage more than two years of usage was 16.4%.

The majority of respondents used electronic cigarettes daily (55.2%) whereas occasionally and weekly users were 35.8% and 9% of total respondents correspondingly. A low concentration of nicotine (1-8 mg) with electronic cigarette solution was reported by 37.3% of respondents whereas medium concentration (9-16 mg of nicotine) was chosen by 22.4%. For high concentrated solution (16-24 mg of nicotine) and extra high (>24 mg), they were inhaled by 17.9% and a mere 1.5% of respondents respectively. Furthermore, 20.9% of participants used free-nicotine liquid with electronic cigarettes.

Socio-demographic characteristics		**No(%)**
Age	18 to 20	15 (22.4%)
	21 to 23	14 (20.9%)
	Above 23	37 (55.2%)
	Prefer not to answer	1 (1.5%)
Gender	Male	35 (52.2%)
	Female	31 (46.3%)
	Transgender	1 (1.5%)
	Prefer not to answer	0
Marital status	Married or Unmarried (Living with a partner)	14 (20.9%)
	Divorced or separate	4 (6%)
	Widowed	0
	Single	45 (67.2%)
	Prefer not to answer	4 (6%)
Faculty	Arts, Humanities and Social Science	12 (17.9%)
	Business and Law/Health, Education, Medicine and Social Care	34 (50.7%)
	Science and Engineering	21 (31.3%)

Academic Level	Foundation level	2 (3%)
	Undergraduate level	47 (70.1)
	Postgraduate level	18 (26.9%)
Have you smoked at least 100 cigarettes in your entire life?	Yes	53 (79.1%)
	No	14 (20.9%)
Reasons of using E-cigarette	To quit or abstain from smoking	27 (40.3)
	To save money	3 (4.5%)
	To cut down amount smoked	8 (11.9%)
	Enjoyment	8 (11.9%)
	Just to give it a try/ Curiosity	3 (4.5%)
	Suggested by a friend	4 (6%)
	Protect against second-hand smoking	2 (3%)
	For places where cannot smoke	1 (1.5%)
	Advised by a health professional	1 (1.5%)
	Other	10 (14.9%)
Are you still using E-cigarette (Vape)?	Yes	38 (56.7%)
	No	29 (43.3%)
Duration of using E-cigarette	1-6 months	26 (38.8%)
	6-12 months	15 (22.4%)
	12-24 months	15 (22.4%)
	More than 24 months	11 (16.4%)
Frequency of E-cigarette use	Daily	37 (55.2%)
	Weekly	6 (9%)
	Occasionally	24 (35.8%)
Nicotine level (Electronic Cigarette)	Zero (0 mg)	14 (20.9%)
	Low (1-8 mg)	25 (37.3%)
	Medium (9-16 mg)	15 (22.4%)
	High (16-24 mg)	12 (17.9%)
	Extra high (>24 mg)	1 (1.5%)

Table 1: Descriptive Statistics for student by socio-demographic factors and E-cigarette practices (N=67)

Smoking Practices

Further questions regarding smoking behaviour were asked to smokers (N=53), and results are showed in Table 2. 62.3% (n=33) of smokers stated that they smoked traditional cigarettes for more than four years. The majority of smokers smoked traditional cigarettes before they started using electronic cigarette (n=47, 88.7%), and only 11.3% (n=6) of smokers had used electronic cigarette before consuming traditional cigarette. Among 47 respondents who were smokers before starting electronic cigarette, most of them consumed 10-20 cigarettes per day (n=21, 44.7%) followed by 34% (n=16) of those who smoked 1-10 cigarettes per day. Then, they were asked if they were able to stop smoking for six months or more by using electronic cigarette; the majority of them (31 smokers) quitted smoking for ≥ 6 months, with 66%. For those who were not able to stop smoking for six months and more (16 smokers) and those who started smoking after using electronic cigarette (6 smokers), they were considered dual users; 45.5% of them consumed in a day 1 to 10 cigarettes and 22.7% smoked more than 10 cigarettes per a day while they were using electronic cigarette compared to 18.2% who smoked occasionally. Among dual users, 13.6% reported no cigarette smoking although they answered "No" to cigarette cessation, and the reason for this could be that they have stopped smoking but for a duration less than 6 months.

Smoking practice		**No (%)**
Duration of cigarette smoking	Less than 2 years	13 (24.5%)
	2 to 4 years	7 (13.2%)
	More than 4 years	33 (62.3%)

Were you a smoker when you started to vape?	Yes	47 (88.7%)
	No	6 (11.3%)
Number of smoked cigarette before E-cigarette use	Occasionally	3 (6.4%)
	Less than one cigarette	2 (4.3%)
	1-10 cigarettes/day	16 (34%)
	10-20 cigarettes/day	21 (44.7%)
	>20 cigarettes/day	5 (10.6%)
Smoking cessation for ≥ 6 months	Yes	31 (66%)
	No	16 (34%)
Number of smoked cigarette while using E-cigarette	None	3 (13.6%)
	Occasionally	4 (18.2%)
	1-10 cigarettes a day	10 (45.5%)
	More than 10 cigarettes a day	5 (22.7%)

Table 2: Descriptive Statistics for student by smoking behaviour (N= 53)

Smoking Cessation

Table 3 and 4 show Chi-square and Fisher's exact test analysis. Among smokers, there were no statistically significant associations between smoking cessation for ≥ 6 months and age, gender, marital status, faculty, academic level, duration of cigarette smoking, Number of smoked cigarettes before E-cigarette use or nicotine level. However, it also revealed that the reasons which made smokers start using electronic cigarette were statistically significant associated with their ability to succeed in quitting for 6-month or more (P=0.016). Moreover, the period that smokers had been vaping and the frequency of usage was significantly associated with smoking abstinence.

Characteristics	Smoking cessation for ≥ 6 months		Chi-square / Fisher's exact test
	No	Yes	
Age, no (%)			
18 to 20	2 (4.3%)	5 (10.9%)	0.91
21 to 23	3 (6.5%)	8 (17.4%)	
Above 23	10 (21.7%)	18 (39.1%)	
Gender, no (%)			
Male	7 (15.2%)	5 (41.3%)	$x^2 = 0.2$
Female	9 (19.6%)	11 (23.9%)	
Marital status, no (%)			
Married or unmarried (Living with a partner)	2 (4.4%)	10 (22.2%)	0.17
Divorced or separate	2 (4.4%)	1 (2.2%)	
Single	11 (24.4%)	19 (42.2%)	
Faculty, no (%)			
Art, Humanities and Social Science	2 (4.3%)	7 (14.9%)	0.56
Business and Law/Health, Education, Medicine and Social Care	9 (19.1%)	12 (25.5%)	
Science and Engineering	5 (10.6%)	12 (25.5%)	
Academic level, no (%)			
Foundation level	0	2 (4.3%)	0.12
Undergraduate level	9 (19.1%)	24 (51.1%)	
Postgraduate level	7 (14.9%)	5 (10.6%)	

Table 3: Comparison of smokers' characteristics by smoking cessation (N= 47)

x^2 = Chi-square test

Characteristics	Smoking cessation for ≥ 6 months		Chi-square / Fisher's exact test
			P value
	No	Yes	
Duration of cigarette smoking, no (%)			
Less than 2 years	2 (4.3%)	7 (14.9%)	
2 to 4 years	3 (6.4%)	3 (6.4%)	0.52
More than 4 years	11 (23.4%)	21 (44.7%)	
Number of smoked cigarette before E-cigarette use, no (%)			
Occasionally	1 (2.1%)	2 (4.3%)	
Less than one cigarette	0	2 (4.3%)	0.26
1-10 cigarettes/day	8 (17%)	8 (17%)	
10-20 cigarettes/day	7 (14.9%)	14 (29.8%)	
>20 cigarettes/day	0	5 (10.6%)	
Reasons of using Electronic cigarette, no (%)			
To quit or abstain from smoking	6 (12.8%)	19 (40.4%)	
To save money	3 (6.4%)	0	
To cut down amount smoked	4 (8.5%)	1 (2.1%)	
Enjoyment	1 (2.1%)	5 (10.6%)	0.016*
Just to give it a try/Curiosity	1 (2.1%)	2 (4.3%)	
Suggested by a friend	0	1 (2.1%)	
Protect against second-hand smoking	0	2 (4.3%)	
For places where cannot smoke	1 (2.1%)	0	
Other	0	1 (2.1%)	
Duration of Using E-cigarette, no (%)			
1-6 months	7 (15.2%)	4 (8.7%)	
6-12 months	4 (8.7%)	9 (19.6%)	0.01*
12-24 months	5 (10.9%)	6 (13%)	
More than 24 months	0	11 (23.9%)	
Frequency of E-cigarette use, no (%)			
Daily	8 (17%)	27 (57.4%)	
Weekly	2 (4.3%)	1 (2.1%)	0.014*
Occasionally	6 (12.8%)	3 (6.4%)	
Nicotine level, no (%)			
Zero (0 mg)	1 (2.1%)	3 (6.4%)	
Low (1-8 mg)	7 (14.9%)	15 (31.9%)	
Medium (9-16 mg)	4 (8.5%)	7 (14.9%)	0.97
High (16-24 mg)	4 (8.5%)	5 (10.6%)	

Table 4: Comparison of E-cigarette use and smoking characteristics of smokers by smoking cessation (N= 47)

* P<0.05

Table 5 shows the univariate logistic regression of ≥ 6 months cigarette cessation; smokers who vaped for more than 1 year had 5.9 (95% CI 1.22 to 28.95) times the odds of stopping cigarette smoking compared with those who used electronic cigarettes for 1-6 months. Furthermore, smokers who used electronic cigarette in a daily pattern were 6.7 (95% CI 1.6 to 28.38) more likely to abstinence from cigarette for 6 months or more than non-daily users.

Smoking cessation for ≥ 6 months			
	Unadjusted OR	**(95% CI)**	**P value**
Duration of Using E-cigarette, no (%)			
1-6 months	Ref	-	-
6-12 months	4	(0.72 to 21.6)	0.11
More than 24 months	5.9	(1.22 to 28.95)	0.03*
Frequency of E-cigarette use, no (%)			
Non-daily	Ref	-	-
Daily	6.7	(1.6 to 28.38)	0.009*

ARU	Anglia Ruskin University
CO	Carbone Monoxide
EC	Electronic Cigarette
SREP	School Research Ethics Panel
FREP	Faculty Research Ethics Panel
NRT	Nicotine Replacement Therapy
E-cigarette	Electronic Cigarette
NHS	National Health Service

Table 5: Association between dependent variable and smoking cessation of ≥ 6 months cigarette cessation

CI= Confidence Interval; OR= Odds Ratio; *P<0.05

Discussion

The primary outcome of this study was a self-reported smoking cessation for ≥ 6 months among students who were smokers and used electronic cigarettes. This study found that 66% of smokers reported abstinence from smoking for ≥ 6 months following electronic cigarette usage, and this suggests that electronic cigarette might be a useful method for smoking cessation. This finding is consistent with previous studies including randomised controlled trials, cohort and cross-sectional studies [9,27,28]. In a randomised trial, Hajek et al. [10] compared the rate of smoking abstinence, validated biochemically by CO level, after 1 year of follow-up between the two groups; the first group used electronic cigarette while a nicotine-replacement therapy group and both received behavioural support. Authors reported a higher cessation rate among electronic cigarette group (18%) than the nicotine-replacement therapy group (9.9%). Likewise, Nelson et al. [29] collected data of 144 adults who were long-term users (more than 6-month) of either electronic cigarettes or nicotine-replacement therapy to assess their smoking status by measure the expired Carbone Monoxide (CO). In the study, participants, who stopped smoking, mentioned that electronic cigarette is more helpful as a smoking cessation aid than nicotine-replacement therapy.

Moreover, the pattern of using electronic cigarette was significantly associated with smoking cessation. Smokers who were using electronic cigarette daily were more likely to quit smoking than non-daily users (OR=6.7; P<0.009). This relationship was recognised in a longitudinal study in the UK by Hitchman et al. [26] who pointed out the importance of frequent electronic cigarette use and smoking abstinence. The study reported that daily tank users had higher odds of quitting than the non-daily tank and cig-a-like users. Moreover, a cohort study was conducted by Berry et al. [30] to compare electronic cigarette users (daily and non-daily) and non-users. The study stated that daily users had 7.88 the odds of quitting smoking for 30 days than non-users, while infrequent use was not associated with cessation. Another cohort study reported that quit success was positively associated with increased frequency of e-cigarette use, and comparing to ever users, those who used electronic cigarette frequently had a higher possibility of 3-month or more of traditional cigarette cessation [31]. Likewise, Biener and Hargraves [32] stated that using electronic cigarettes in the daily pattern was associated with six time's greater chance of smoking abstinence, while occasional use was either negatively or not associated.

Our study found that smokers who used electronic cigarette more than 12 months had 5.9 time the odds of having smoking cessation for ≥ 6 months compared to those who vaped less than one year. Hence, this result is consistent with previous studies [27,33]. Specifically, Zhuang et al. [27] conducted a cohort study over two years to assess the odds of smoking cessation among long-term electronic cigarette users (used E-cigarette at baseline and two years follow-up). The study reported that long-term users had a significantly higher chance of quitting compared to short-term and non-users. Also, Polosa et al. [34] followed a cohort of adults who smoked at least for ten years with no intention to quit. After 24 months of following-up, authors reported that long-term use of electronic cigarette is useful to aid smoking cessation among smokers who are not interesting to quit. This means that long-term use of electronic cigarette has a positive impact

on smoking cessation; however, health effects of such a practice for long-duration still unknown, and more studies are required to prove the safety of using electronic cigarettes for a long-term.

Furthermore, we could not find a relationship between smoking cessation and nicotine concentration within E-cigarette's liquid, which means using free-nicotine or nicotine-containing liquids does not affect quitting success. This finding is shared with two randomised trials which reported that electronic cigarette, with or without nicotine, is an effective method for smoking cessation. Caponnetto et al. [35] explored the efficacy and safety of electronic cigarettes with different nicotine concentration for smoking cessation by conducting a 12-month randomised, quasi-controlled trial. The trial included three groups of electronic cigarette users (non-nicotine users (placebo), low nicotine users and high nicotine users), and found no significant relationship between cessation rate (in 6-month or 1-year) and the three study groups. It stated that using electronic cigarette, with or without nicotine, leads to smoking abstinence among smokers who have no intend to quit. Similarly, Bullen et al. [9] examined the effectiveness of electronic cigarette (with and without nicotine) compared to nicotine patches among smokers intended to quit. They reported that both electronic cigarettes not containing nicotine and nicotine patch have a similar achievement of smoking cessation, suggesting that factors such as habits associated with cigarette handling and manipulation may also play an important role. This result could be helpful to regulate nicotine concentration within electronic cigarette's liquids as nicotine exposure is a part of concern associated with electronic cigarettes. Nevertheless, more studies (randomised control trial) are needed to compare using E-liquid (with or without nicotine) and longer-term abstinence.

Vickerman et al. [36] explored the reason for using electronic cigarette and cessation rate among smokers at the 6-month survey. Authors found that smokers who used electronic cigarettes to stop smoking were more likely to succeed than those who used it for other reasons. Vickerman and colleagues suggested that the reason behind electronic cigarette use might be an essential factor of successful cessation. Our study shares a similar finding; the relationship between smoking cessation for ≥ 6 months and reasons for using electronic cigarette was statistically significant among students. Nevertheless, due to the small sample size, we could not identify which reason is associated with smoking cessation. Additionally, our study demonstrates that using electronic cigarettes to abstain from smoking is the most chosen reason that made student starting vaping. This finding is in accordance with results reported by three cross-sectional studies [15,37,38] and one longitudinal study [39]. They found that the vast majority of those who use electronic cigarettes treat them as smoking-cessation aids.

This study is subject to four limitations. First, this study cannot determine a causal relationship between smoking abstinence and electronic cigarette use as it has a cross-sectional design. Therefore, longitudinal study design or a randomized trial is necessary to establish, if it present, the causal association. Second, the sample is not representative the whole smokers who have used electronic cigarette due to non-probability sampling, which also affect generalizability of the study's results. Also, because of the small sample size, we could not adjust our finding to potential confounders. However, to avoid result bias, we conducted statistical methods that suitable for small sample size such as Fisher's Exact Test. Third, smoking abstinence was self-reported instead of verified biochemically, but it is still reliable to assess smoking abstinence among smokers [21]. Finally, we did not ask a question about the type of electronic cigarette's device which has been found to affect the ability of smokers to quit [26,40].

Conclusions

In this study, most of smokers who tried electronic cigarette reported smoking abstinence for ≥ 6 months, and abstinence is more likely to be achieved when smokers vape daily and for a long duration (more than 1 year). The results suggest that electronic cigarette might be useful when it is used as a smoking cessation aid. However, further studies, such as randomised controlled trials, are needed to explore the efficacy of electronic cigarette as a quitting tool in addition to their safety when they are used for long-term. In addition, despite their safety compared to traditional cigarette smoking, the long-term health impacts of electronic cigarette are unknown. As a result, observational studies (case-control and cohort studies) should be conducted for that matter.

Author Contributions

Conceptualization, W.A.; methodology, W.A.; software, W.A.; validation, W.A.; formal analysis, W.A.; investigation, W.A.; resources, W.A.; data curation, W.A.; writing—original draft preparation, W.A.; writing—review and editing, W.A. and A.P. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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