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A Study on Electronic Cigarette (E-Cigarette) Usage Among Adults in Taiping, Perak

Mohd Izani Othman*, Mohamad Ariff Azlan, Nuraina Harun

Faculty of Pharmacy, Universiti Teknologi MARA Cawangan Pulau Pinang, Kampus Bertam, 13200 Kepala Batas, Pulau Pinang, Malaysia

**Corresponding Author: mohdizani.othman@uitm.edu.my*

ABSTRACT

Electronic Nicotine Delivery Systems (ENDS), commonly known as e-cigarettes, are battery-powered devices that heat a liquid solution to produce aerosol, which users inhale. The prevalence of e-cigarette usage is steadily increasing, particularly among adolescents and adults seeking alternatives to traditional smoking. This study focuses on current and former e-cigarette users, categorized as individuals who have ever used e-cigarettes. Conducted through a cross-sectional survey in public places around Taiping, Perak, from February to April 2022, 118 randomly selected respondents participated. A modified version of the Global Adult Tobacco Surveys (GATS) tool was used as a structured questionnaire, and data analysis was performed using SPSS. The study findings revealed that 28% of respondents exclusively used e-cigarettes, 22% were dual users (using both cigarettes and e-cigarettes), 23.7% were former e-cigarette users, and 26.3% were former e-cigarette users who had transitioned to cigarette smoking. Notably, 99.2% of respondents were Malays, and 61.9% were unemployed. Significantly, a relationship was observed between the number of cigarettes smoked before and after the initiation of e-cigarette use ($p = 0.000$). The study underscores the emerging concern of increasing e-cigarette usage. The results suggest a need for further extensive research involving larger respondent samples in diverse settings to enhance the generalizability of findings. Additionally, these findings can inform policy-making and prevention strategies regarding e-cigarette use within the broader Malaysian population.

INTRODUCTION

The 21st century has witnessed the emergence of electronic cigarettes (e-cigarettes) as a significant global concern, garnering popularity among both Malaysian youth and adults. Recent research suggests that the initiation of smoking or e-cigarette use among young adults is influenced by abstract thinking patterns, where a perceived sense of continuous scrutiny from peers prompts engagement in risky health behaviours (Lim et al., 2018). This conceptualization creates an imaginary environment compelling them to adopt behaviours like smoking or e-cigarette use to seek attention. Simultaneously, e-cigarettes are gaining traction among adults, often chosen for reasons such as the perception of being less harmful than traditional cigarettes and as interventions for smoking cessation.

Despite the upward trend in e-cigarette usage, there remains insufficient evidence regarding its long-term consequences. The prevailing assumption that vaping is a safe alternative has permeated communities globally, contributing to the widespread adoption of e-cigarettes. Initially designed to mimic traditional tobacco cigarettes, e-cigarettes have evolved into various modifiable types, including disposable and rechargeable versions (Chen & Wang, 2017; Fadus et al., 2019). Rechargeable e-cigarettes are further categorized as pen-style medium-sized devices and tank-style large-sized devices, commonly known as vape pens and pods, respectively (Fadus et al., 2019). E-cigarettes typically comprise three main components: a battery, a liquid solution, and a cylindrical cartridge for solution storage (Rahman et al., 2014). When a user inhales, the device activates the battery, raising the temperature to vaporize the solution. The liquid solution usually contains propylene glycol, nicotine, and various flavors. Modern e-cigarettes often feature a larger solution tank in place of the cylindrical cartridge, allowing users to refill less frequently. As the landscape of e-cigarette usage evolves, understanding the intricacies of their design and the motivation behind their use becomes imperative for informed public health policies and interventions.

Therefore, this study aims to explore the characteristics of e-cigarette use in a representative population survey of adults in Taiping, Perak. The specific objectives include determining the prevalence of dual users among all ever-users of e-cigarettes, assessing the effectiveness of e-cigarette use as a smoking cessation method, and exploring participants' knowledge and awareness of health effects and harmfulness associated with e-cigarette usage.

Prevalence of E-cigarettes Worldwide

The surge in the usage of electronic cigarettes (e-cigarettes) has drawn the attention of researchers and scientists globally, leading to a plethora of literature exploring the increasing prevalence, distinctive characteristics, and the overall impact of e-cigarettes. A study by Ab Rahman et al. (2019) highlighted that in New Zealand, 0.8% of total adults were identified as current e-cigarette users. Meanwhile, the United Kingdom experienced a notable rise in current adult e-cigarette users, increasing from 2.7% to 6.7%.

In the United States, Benowitz (2014) reported a substantial 11.4% prevalence of e-cigarette users in 2012, with 4.1% actively using these devices within the past 30 days. These findings underscore the significant and escalating presence of e-cigarette use in diverse global contexts. Turning to Malaysia, the 2011 Global Adult Tobacco Survey (GATS) (IPH, 2012) revealed that approximately 21% of adolescents and adults aged 15 and above were aware of e-cigarettes. Notably, the prevalence of actual e-cigarette usage among this population was reported at 0.8%. This suggests that, despite a relatively low prevalence at the time, the awareness and influence of e-cigarette use had already permeated Malaysian society. The evolving landscape of e-cigarette prevalence underscores the need for continuous monitoring and research to inform public health initiatives and policies worldwide.

E-cigarette Usage Among Adolescents

A study by Wang et al. (2018) highlighted that young adults exhibited the highest prevalence of e-cigarette use in 2017. This observation aligns with findings from the 2012 National Youth Tobacco Survey, revealing a surge in e-cigarette use among middle school students from 0.6% to 1.1% and among high school students from 1.5% to 2.8% between 2011 and 2012 (Benowitz,

2014). The allure of e-cigarettes to adolescents may be attributed, in part, to the desire to enhance their physical appearance.

Research conducted in the United States suggests that young adults perceive smokers as cool and more socially connected, having more friends than non-smokers (Osman et al., 2019). Furthermore, the pervasive influence of e-cigarettes among adolescents can be attributed to the robust marketing strategies employed by tobacco companies. These companies capitalize on youth appeal by utilizing models and celebrities as ambassadors, intending to convey an image of glamour and modernity (Benowitz, 2014). The convergence of social perceptions, marketing strategies, and celebrity endorsements underscores the need for targeted interventions and awareness campaigns aimed at mitigating the appeal of e-cigarettes among adolescents. It is imperative to address these influences to curb the rising trend of e-cigarette use among the youth population.

E-cigarette Use Among Adults

E-cigarette usage is observed across a wide age range, with individuals employing these devices for various reasons and purposes. The potential health impacts of e-cigarettes remain unclear and subject to ongoing investigation. A contentious debate surrounds the concept of e-cigarettes acting as a 'gateway' for those attempting to quit smoking, perpetuated by marketing strategies of e-cigarette manufacturers that emphasize harm reduction beliefs (Benowitz, 2014; Wipfli et al., 2019). Filippidis et al. (2016) found that current smokers were more inclined to use e-cigarettes with the belief that it could aid in smoking cessation. In England, an estimated 32.0% (1,080,000 people) of adult smokers attempted to quit smoking by using e-cigarettes in 2014 (West et al., 2015). In essence, this suggests that individuals, particularly current smokers seeking cessation aids, may be influenced and "brainwashed" into perceiving e-cigarettes as effective and safe without due consideration of potential health implications.

Negative Health Effects Caused by E-cigarette Use

As concerns about the potential toxicity of electronic cigarettes grow, emerging research provides valuable information. Laboratory experiments using animal models indicate that long-term e-cigarette use may negatively impact the neurovascular system, leading to cognitive dysfunction (Heldt et al., 2020). E-cigarette users are also susceptible to various side effects, including pulmonary disease, myocardial infarction, seizures, altered cardiovascular hemodynamic, impaired endothelial function, and the promotion of insulin resistance, potentially leading to diabetes mellitus (King et al., 2020; Benowitz, 2014).

Nicotine Characteristics and Addiction

Historically, e-cigarettes served as a device to satisfy nicotine cravings and addiction, with nicotine being a primary ingredient in the liquid solutions (Benowitz, 2014). Nicotine content in e-cigarettes typically ranges from 6 mg/mL to 24 mg/mL and can increase over time with use (Heldt et al., 2020). Recent studies demonstrate that nicotine aerosol from e-cigarettes can have a bitter and harsh taste, but this can be mitigated by incorporating non-tobacco flavours into the solution to mask the bitterness and harshness (Leventhal et al., 2020). Upon release into the bloodstream, nicotine induces pharmacological effects, altering neurochemicals in the brain and producing positive psychological effects such as pleasure and mood modulation (Benowitz, 2014). This alteration fosters addiction as increased exposure to nicotine heightens

dependence. As the brain becomes more tolerant, quitting becomes challenging, leading to withdrawal symptoms such as irritability, anxiety, difficulty concentrating, and communication issues with family and friends (Benowitz, 2014).

Multiple Tobacco Products (MTP) and Dual Users

High rates of concurrent use of Multiple Tobacco Products (MTP) are noted, surpassing the number of single product users (Osman et al., 2019). MTP users are found to be more nicotine dependent and less likely to have intentions of quitting compared to single product users. Additionally, dual users, engaging in both e-cigarette and conventional cigarette use simultaneously, tend to experience stronger e-cigarette dependence while engaging in less frequent smoking (Morean et al., 2018). This aligns with the observation that dual users exhibit stronger e-cigarette dependence than exclusive e-cigarette users. Notably, all e-cigarette users acknowledge that liquid solutions containing nicotine result in stronger addiction compared to nicotine-free alternatives (Morean et al., 2020). These complexities highlight the challenges associated with understanding and addressing nicotine addiction in the context of diverse tobacco product use.

MATERIAL AND METHODS

Study Design and Respondents

Between February and April 2022, we conducted a cross-sectional survey (Othman et al., 2022), collecting data from respondents at public places, specifically shopping malls, in Taiping, Perak. The study focused on current and former users who had ever used e-cigarettes. Eligibility was determined by a positive response to the question, "Have you ever used an e-cigarette or other electronic 'vaping' product, even just one time, in your entire life?" The sample size was calculated based on an estimated prevalence of current e-cigarette users in Malaysia (14%, Gravely et al., 2014), a margin of error of 5%, and a 95% confidence interval (Othman et al., 2024; Othman et al., 2023a), yielding a targeted sample size of 185. However, the final sample consisted of 118 individuals who agreed to participate. Inclusion criteria required respondents to live in or have stayed or worked in Taiping for at least 6 months in the past year, understand Bahasa Melayu, and be male aged 18 to 64 years old.

Questionnaires and Data Collection

We utilized a self-administered questionnaire adapted from the 2011 version of the Global Adult Tobacco Survey (GATS), tailored to our study's objectives and population. The questionnaire, developed in Bahasa Melayu, comprised five sections: background details, current and historical e-cigarette use and tobacco smoking status, and knowledge and awareness about e-cigarettes.

Sections A (demographic and smoking/e-cigarette use status) and E (knowledge, awareness, and perception) were mandatory for all participants. Section B was exclusively for current e-cigarette users and dual users, exploring factors like the age of initiation and the introduction to e-cigarettes. Section C was designated for former e-cigarette users, focusing on cessation methods employed in the past 12 months. Section D, relevant only for current

conventional smokers, aimed to assess e-cigarette effectiveness as a cessation aid, including perceptions after e-cigarette use.

Data Analysis

IBM SPSS Statistics version 26 was used for data analysis (Othman et al., 2023b). The Kolmogorov-Smirnov test confirmed non-normal distribution of the data (Pallant, 2020). Chi-square tests were employed for analysing demographic characteristics and user types. Frequencies and percentages were utilized for analysing smoking and e-cigarette use profiles among respondents. The statistical analysis aimed to provide comprehensive insights into the patterns and characteristics of e-cigarette usage among the surveyed population.

RESULTS

Sociodemographic Characteristics

A total of 118 male participants completed the survey, with an average age of 23 years. The majority (70%) fell within the 18 – 22 years age range. Almost all participants were Malays (99.2%), except for one Chinese participant (0.8%), and none were Indian. Employment status indicated that 61.9% were unemployed, while 38.1% were employed.

Regarding e-cigarette usage, 28% were exclusive e-cigarette users, 22% were dual users (using both cigarettes and e-cigarettes), making a total of 50% being current e-cigarette users. Additionally, 23.7% were former e-cigarette users, while 26.3% were former e-cigarette users who had transitioned to cigarette smoking. The demographic characteristics of the respondents are summarized in Table 1, and the distribution of cigarette or e-cigarette status is visually presented in Figure 1.

Table 1: Sociodemographic characteristics of respondents

Socio Demographic Characteristics	Frequency (n)	Percentage (%)
Age		
18 - 22 years old	83	70.3
23 - 27 years old	23	19.5
28 - 32 years old	6	5.1
33 – 64 years old	6	5.1
Ethnicity		
Malay	117	99.2
Chinese	1	0.8
Indian	0	0.0
Working status		
Employed	45	38.1

Unemployed	73	61.9

E-cigarette Use Profile of Respondents

For this analysis, 38 respondents were excluded due to their former e-cigarette user status, considered as missing data. Among current e-cigarette users, 50.8% reported daily usage, while 16.9% did not use e-cigarettes every day. Approximately 44.9% of respondents initiated e-cigarette use between the ages of 16 and 20, with smaller percentages starting at 10 – 15 years old (5.1%), 21-25 years old (13.6%), and 31 years old and above (4.2%).

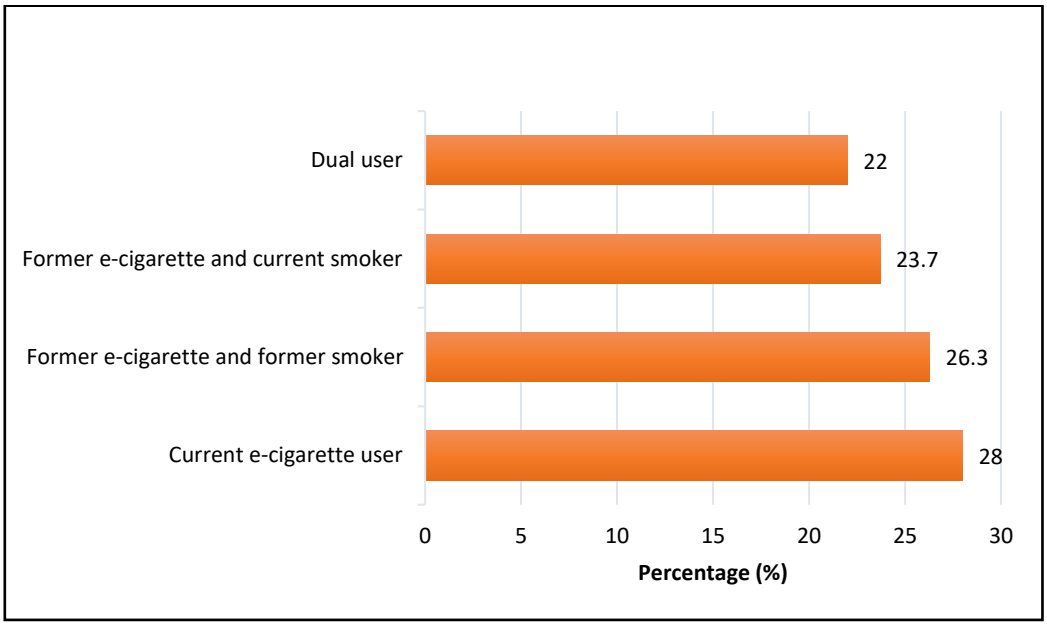

Figure 1: Cigarette / E-cigarette status among participants (n = 118)

In terms of introduction to e-cigarettes, 45.8% (n = 53) credited friends, 5.9% (n = 7) mentioned family members, 11.9% discovered e-cigarettes through the internet, and 4.5% learned about them from media advertising (television, radio, mail, print, billboards, and outdoor advertisements). Regarding motivations for continuing e-cigarette use, 19.4% cited following current trends, while 48.5% claimed to use e-cigarettes as a means for smoking cessation. Table 2 provides a summary of the e-cigarette use profile, encompassing the frequency of use, age of initiation, sources of introduction, and motivations to continue using e-cigarettes.

Table 2: Respondents e-cigarette use profile

Profiles	Frequency (n)	Percentage (%)
Frequency of e-cigarette use		
Every day	60	50.8
Not every day	20	16.9

Age of use initiation (years)		
10 – 15	6	5.1
16 – 20	53	44.9
21 – 25	16	13.6
31 and above	5	4.2
Source of e-cigarette introduction		
Peers	54	45.8
Family members	7	5.9
Internet	14	11.9
Media advertising	15	4.5
Motivation to continue use e-cigarettes		
To follow the trend	23	19.4
As an alternative to quit smoking	57	48.5

Association between E-cigarette Use and Number of Cigarettes Smoked

Out of all participants, 59 (37.3%) were identified as e-cigarette users, with 44 agreeing to participate and 15 choosing not to answer this specific question. The number of cigarettes smoked by dual users before and after incorporating e-cigarettes into their routine was analysed (Table 3). The Wilcoxon Signed Ranks Test was employed to examine the association between e-cigarette use and the number of cigarettes smoked (Table 4). Given the non-normal distribution of the data, a significance level of P = 0.05 was used. The null hypothesis posited no difference in the median score difference of the number of cigarettes smoked before and after using e-cigarettes. Results from the Wilcoxon Signed Ranks test demonstrated a statistically significant difference in the number of cigarettes smoked before and after the introduction of e-cigarettes ($Z = -3.636$, $p = .000$). Therefore, the null hypothesis was rejected, indicating a significant relationship between the number of cigarettes smoked before and after incorporating e-cigarettes into the smoking routine.

Table 3: The amount of cigarette smoked before and after using e-cigarette

Number of cigarettes smoked before using e-cigarette (%)			**Number of cigarettes smoked after using e-cigarette (%)**		
<10	10	>10	<10	10	>10
13 (11)	5 (4.2)	26 (22.0)	34 (28.8)	3 (2.5)	7 (5.9)

Table 4: Analysis of Wilcoxon Signed Rank test

		N	Mean Rank	Sum of Ranks
Number cigarette smoked after using e-cigarette - Number cigarette smoked before using e-cigarette	Negative Ranks	26[a]	15.19	395
	Positive Ranks	4[b]	17.5	70
	Ties	14[c]		
	Total	44		

a. Number cigarette smoked after using e-cigarette < Number cigarette smoked before using e-cigarette
b. Number cigarette smoked after using e-cigarette > Number cigarette smoked before using e-cigarette
c. Number cigarette smoked after using e-cigarette = Number cigarette smoked before using e-cigarette

Number cigarette smoked after using e-cigarette - Number cigarette smoked before using e-cigarette	
Z	-3.636[b]
Asymp. Sig. (2-tailed)	0.000

a. Wilcoxon Signed Ranks Test; b. Based on positive ranks

Perceptions of Current E-cigarette Users Regarding Smoking Cessation

Our findings indicate that a significant portion of current e-cigarette users remains uncertain about the effectiveness of e-cigarettes as a tool for quitting smoking. Out of the 44 respondents, 10.2% (n = 12) and 5.9% (n = 7) expressed indecision with responses such as "I still can't decide whether to quit smoking or not" and "I don't know," reflecting confusion about the role of e-cigarettes in smoking cessation. Conversely, 8.5% (n = 10) voted to quit smoking immediately after using e-cigarettes, while 9.3% (n = 11) expressed the intention to quit smoking but not in the immediate future. Additionally, 3.4% (n = 4) voted against smoking cessation altogether, with the remaining participants expressing varying degrees of confusion. Figure 2 visually presents a pie chart depicting respondents' perceptions regarding the use of e-cigarettes as an alternative for quitting smoking.

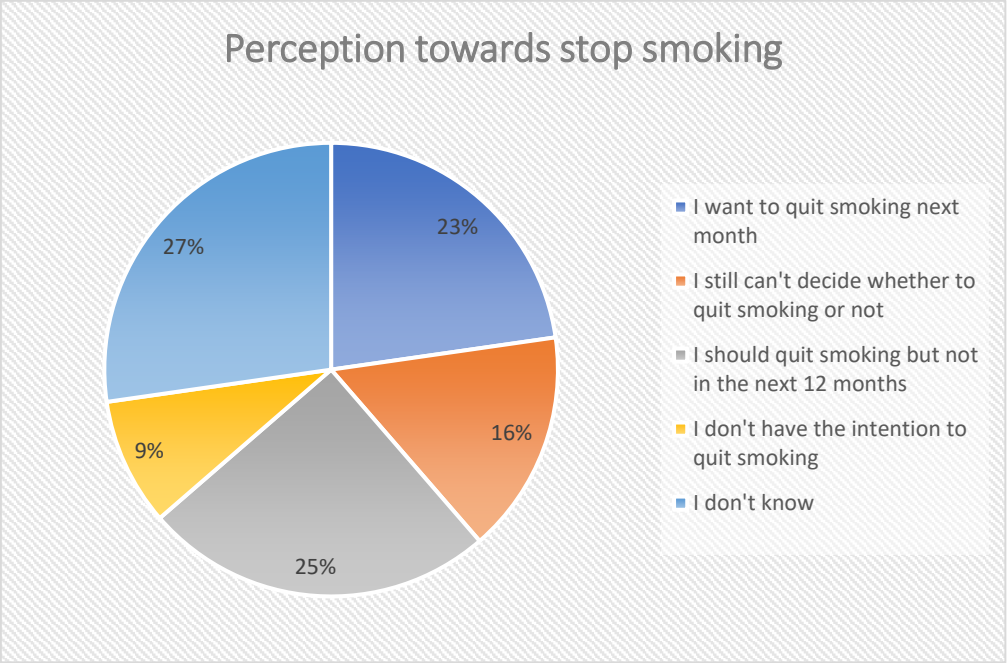

Figure 2: Perception towards smoking cessation

Knowledge and Awareness of E-cigarette

Table 5 presents a comprehensive overview of respondents' knowledge and awareness regarding the use of e-cigarettes, highlighting frequencies and percentages. To assess potential variations in awareness levels across different user categories, Kruskal-Wallis tests were conducted for various aspects of e-cigarette awareness. The results are detailed as follows:

Firstly, in terms of the awareness of e-cigarettes causing serious diseases, including current e-cigarette users (Mean Rank = 58.68), former e-cigarette and cigarette "clean" users (Mean Rank = 56.95), former e-cigarette users but current smokers (Mean Rank = 58.11), and dual users (Mean Rank = 65.08), the Kruskal-Wallis test yielded non-significant results ($H = 1.255$, $df = 3$, $N = 118$, $p = 0.740$, Cohen's $f = 0.105$).

Similarly, the awareness of e-cigarettes leading to stroke, heart attack, and cancer demonstrated consistent findings across user categories. The mean ranks for current e-cigarette users, former e-cigarette and cigarette "clean" users, former e-cigarette users but current smokers, and dual users were 61.55, 54.45, 59.82, and 62.58, respectively. The Kruskal-Wallis test indicated no statistically significant differences ($H = 1.399$, $df = 3$, $N = 118$, $p = 0.706$, Cohen's $f = 0.11$). In terms of awareness regarding e-cigarette causing addiction, the mean ranks for the mentioned user categories were 65.24, 55.32, 58.86, and 57.88, respectively. The Kruskal-Wallis test revealed non-significant differences ($H = 2.333$, $df = 3$, $N = 118$, $p = 0.506$, Cohen's $f = 0.143$).

Finally, the awareness regarding the danger of e-cigarette and cigarette showed mean ranks of 67.06, 50.98, 55.63, and 64.23 across user categories. The Kruskal-Wallis test did not

indicate statistically significant differences (H = 5.581, df = 3, N = 118, p = 0.134, Cohen's f = 0.225). Overall, the Kruskal-Wallis tests consistently demonstrated that there were no statistically significant differences in awareness levels among different user categories concerning the health implications and risks associated with e-cigarette use.

Table 5: Summary of e-cigarette knowledge among the participants

Profiles	Frequency (n)	Percentage (%)
E-cigarette cause serious disease		
Yes	52	44.1
No	66	55.9
E-cigarette leads to stroke, heart attack, cancer		
Yes	47	39.8
No	71	60.2
Cigarette and e-cigarette cause addiction		
Yes	83	70.3
No	35	29.7
E-cigarette more dangerous than cigarette		
More dangerous	15	12.7
Equal dangerous	36	30.5
Less dangerous	67	56.8

DISCUSSION

The findings of this study align with existing population-based research on e-cigarette use, indicating a continual rise in prevalence, particularly among young adults, and a strong association with conventional cigarette use. Our examination of factors related to e-cigarette use allowed us to profile users, revealing a predominant demographic of young, Malay, and unemployed individuals. Notably, a significant majority of respondents (70.3%) fell within the 18 to 22 years age range, consistent with Cheah et al.'s (2019) research, suggesting that younger individuals exhibit greater awareness and interest in e-cigarette use, possibly due to their familiarity with technology and exposure to cigarette-related information.

The exclusive representation of Malays in our study, except for one Chinese respondent, echoes previous findings highlighting Malays' higher awareness of e-cigarettes compared to other ethnicities (Cheah et al., 2019). The assumption that a majority of respondents were students or unemployed (61.9% unemployed) reinforces the perception that younger, non-working individuals are more captivated by emerging technologies and devices. Consistent with prior research, our study unveils a high prevalence of e-cigarette use among young adults,

with nearly half initiating e-cigarette use between the ages of 16 and 20 (Chen & Wang, 2017; Lim et al., 2018; Fadus et al., 2019). Peers emerged as the primary influencing factor, followed by the internet, family members, and media advertising. The influence of peers may stem from social interactions or being offered e-cigarettes during socializing, fuelled by the curiosity and experimentation common among young adults.

While 50% of respondents were current e-cigarette users, 22% identified as dual users, concurrently using e-cigarettes and traditional cigarettes. This suggests that some individuals may adopt e-cigarettes as a smoking cessation aid, aligning with findings from other studies (Puteh et al., 2018). The relationship between e-cigarette uses and conventional cigarette smoking was further explored among dual users, revealing a significant association ($p = 0.000$), with most respondents reducing their cigarette consumption after incorporating e-cigarettes. Interestingly, some current e-cigarette users expressed confusion and indecision regarding quitting smoking after using e-cigarettes, while others had decided to quit but were uncertain about the timeline. This underscores the need for future research to comprehensively evaluate the effectiveness of e-cigarettes as smoking cessation tools.

Our study diverges from Park et al.'s (2019) findings, which reported high awareness of e-cigarette health effects. In contrast, our respondents exhibited a lack of knowledge and awareness regarding various diseases associated with e-cigarette use. Efforts to educate both never-users and ever-users about the health consequences of e-cigarettes are imperative. Notably, more than half of our respondents believed that e-cigarettes were less harmful than traditional cigarettes and a safer means of consuming nicotine or aiding in smoking cessation.

Despite providing valuable insights, this study has limitations. The data were collected in a specific district within a limited timeframe, and the sample size did not meet the intended target. Self-reported data are subject to recall and social desirability biases. The cross-sectional nature of the survey restricts causal inferences. Additionally, missing data on variables such as student status and income levels limit a comprehensive analysis of e-cigarette prevalence. Future research should address these limitations and continue exploring the evolving landscape of e-cigarette use.

CONCLUSION

In the dynamic landscape of emerging tobacco product trends, this study serves as a foundational resource, delivering evidence-based insights to both current and potential users of e-cigarettes. The imperative to shield the youth from tobacco product dependence takes precedence, urging concerted efforts to dissuade and prevent initiation among both cigarette users and non-users. While the use of e-cigarettes as a tool for tobacco cessation is prevalent, the effectiveness of such practices warrants further exploration and substantiation. The findings underscore the need for comprehensive studies that not only validate the efficacy but also delve into the nuanced effects of e-cigarettes in aiding smoking cessation.

This study sheds light on a noteworthy observation—high intentions to quit smoking among dual users using e-cigarettes, yet a persistent struggle in finding a definitive path toward cessation. Additionally, it unveils a prevailing lack of knowledge, awareness, and understanding regarding e-cigarette use within the studied community. To achieve substantial mitigation of tobacco product use, a collaborative approach involving academia, civil society,

government, industry, and communities is imperative. This united front must strive to uncover and implement the most effective strategies, aiming to curtail the e-cigarette and cigarette smoking epidemic and mitigate the associated health risks.

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