

Effects of Electronic Cigarette Use Amongst Cigarette Smokers In Klang Valley, Malaysia

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Abstract

Electronic cigarette (e-cigarette) is a battery powered device which imitates the feel and experiences of smoking a conventional cigarette. Recently, Malaysian government has banned the selling of e-cigarette and the nicotine-containing e-liquid. The decision may be influenced by studies from overseas. However, in-depth studies on the effectiveness of e-cigarette are needed especially in Malaysian setting. Thus, this study aimed to analyze the cost-effectiveness of using e-cigarette, the reduction in pack-year after using e-cigarette, % of users who completely changed from conventional cigarette to e-cigarette and to assess the general lung function of e-cigarette users using peak flow analysis in e-cigarette users in Klang Valley, Malaysia. This study was conducted at an e-cigarette stall in Kuala Lumpur Downtown Night Market, Cheras, Kuala Lumpur, Malaysia. Questionnaires were given to 73 e-cigarette users who met both inclusion and exclusion criteria. After answering the questionnaires, a peak flow meter test was carried out. The peak flow meter test was also carried out on conventional cigarette smokers for comparison. Findings from this study suggested that e-cigarette is a cost-effective device which showed a significant reduction of average monthly expenditure. In addition, results also showed that e-cigarette helped in the reduction of pack-year. The peak flow readings of the e-cigarette users are also significantly higher compared to the conventional cigarette smokers suggesting better general lung function in those who uses e-cigarette. In conclusion, e-cigarettes could serve as a viable alternative to nicotine

replacement therapy (NRT) for traditional cigarette smokers seeking to quit. Nonetheless, it is imperative to conduct long-term studies on the potential side effects of e-cigarettes to thoroughly evaluate their benefits against potential risks.

Keywords: Electronic Cigarette, E-Cigarette, Pack-Year Reduction, Cost-Effectiveness, Peak Flow Analysis, Conventional Cigarette, Nicotine Replacement Therapy

Introduction

Breaking the habit of cigarette smoking poses significant challenges, underscoring the need for enhanced smoking cessation methods. E-cigarette have emerged as a potential substitute for traditional cigarette smoking. By replicating certain smoking behaviors, e-cigarettes offer a means for smokers to abstain during cessation efforts or reduce their cigarette intake. However, research into the long-term efficacy and safety of e-cigarettes for smoking cessation or reduction remains unclear [1].

The idea of using nicotine to reduce cigarette cravings was evidenced from at least in the 1940s as researchers have worked on the effects of hypodermic nicotine delivery test [2]. Following that, nicotine replacement therapy (NRT) was developed commercially in 1960. In Switzerland during 1978, the original nicotine gum was later followed by transdermal patches, nicotine nasal sprays, nicotine inhalers and nicotine microtabs [3]. NRT acts as an effective and cost-effective treatment for tobacco dependence [19]. In addition, according to United States of America (US) Food and

Drug Administration [4], no tobacco products have been scientifically proven to reduce risk of tobacco-related disease, improve safety or cause less harm than other tobacco products.

According to the World Health Organization [5], the e-cigarette is one popular type of electronic nicotine delivery system (ENDS), a battery powered device that looks like a cigarette but does not involve smoke and enables users to inhale vaporized nicotine. Meanwhile, e-cigarette is also defined as an operated device that is typically made to look and perform like regular cigarette [4]. E-cigarette contains an inhalation activated mechanism that heats liquid from a cartridge composed of humectants and nicotine; although non-nicotine e-cigarette is also available [6]. E-cigarette users also known as “vapers” inhale the resulting vapor [4]. There are also many other terms, names, classifications, and definitions that have been used to describe e-cigarette. E-cigarette is also defined as a new type of device that delivers vaporized nicotine without the tobacco combustion or smoke of regular cigarette [7]. E-cigarettes are widely advertised as technologically advanced and healthier alternative to tobacco cigarette using youth-relevant appeals such as celebrity endorsement, trends, fashionable imaging and fruit, candy, and alcohol flavors [8].

The e-cigarette market has experienced rapid expansion, with vaping becoming increasingly popular among smokers in Malaysia and worldwide. The technology employed in e-cigarettes has garnered attention and has the potential to reshape public perceptions regarding smoking habits. Previous study noted that there is considerable interest in these devices and their potential impact on public health [9]. The benefits and risks of e-cigarettes are heavily influenced by public perceptions and usage patterns. It was suggested that the effectiveness of e-cigarettes in smoking cessation or reduction hinges on their ability to satisfy users and

alleviate withdrawal symptoms [9]. However, research on the overall effects of e-cigarettes and their efficacy as cessation aids is still in its early stages. It was also emphasized the need for further research to gather comprehensive data on the advantages and disadvantages of e-cigarettes for public health [9].

Currently in Malaysia, e-cigarettes have emerged as a popular alternative for smokers looking to quit traditional cigarette smoking [10]. The adoption of e-cigarettes has surged, reflecting a growing trend. Recently, the Malaysian government implemented a ban on the sale of e-cigarettes and nicotine-containing e-liquids, possibly influenced by findings from international studies. However, there remains a need for comprehensive research into the efficacy of e-cigarettes, particularly within the Malaysian context. Thus, this study aims to evaluate the cost-effectiveness of e-cigarette use, the reduction in pack-years post-e-cigarette adoption, the percentage of users who transition completely from conventional cigarettes to e-cigarettes, and the general lung function of e-cigarette users using peak flow analysis in the Klang Valley, Malaysia. The findings of this study are expected to provide valuable insights for policy makers in formulating regulations governing the sales and usage of e-cigarettes in Malaysia.

Materials and Methods

Sampling Size

The sample size of 73 e-cigarette users was obtained using an online calculator to generate the proportion sample size from www.openepi.com. Confidence level of 95% and prevalence of 5% were used in this study. A population of roughly 7.5 million was taken from a geographical dictionary or directory website in conjunction with atlas (www.world-gazetteer.com).

Study site

The study was conducted at an e-cigarette stall in Kuala Lumpur Downtown

Night Market, Bandar Tun Razak, Cheras, Kuala Lumpur for a period of one month. The location was chosen as the study site because it is one of the popular spots for e-cigarette users in Klang Valley. Respondents were targeted during the weekends which were on Friday, Saturday and Sunday from 10 pm to 2 am. Figure 2.1 shows the study site at Kuala Lumpur Downtown Night Market.

Inclusion and Exclusion criteria

E-cigarette users were included in the study if they live in Klang Valley during when this study was done, 18 years old and above and currently using e-cigarette. The e-

cigarette users were excluded from this study if they had been using e-cigarette for less than 3 months, they were never a conventional cigarette smoker before and if they have asthma or any other obstructive pulmonary diseases.

Questionnaire

The tool used for the data collection in this study was validated questionnaires. The questionnaires were adopted and adapted from previous studies [11,12]. The questionnaires were used to find out on the cost-effectiveness of using e-cigarette, the reduction in pack-year after using e-cigarette, % of users who completely changed from

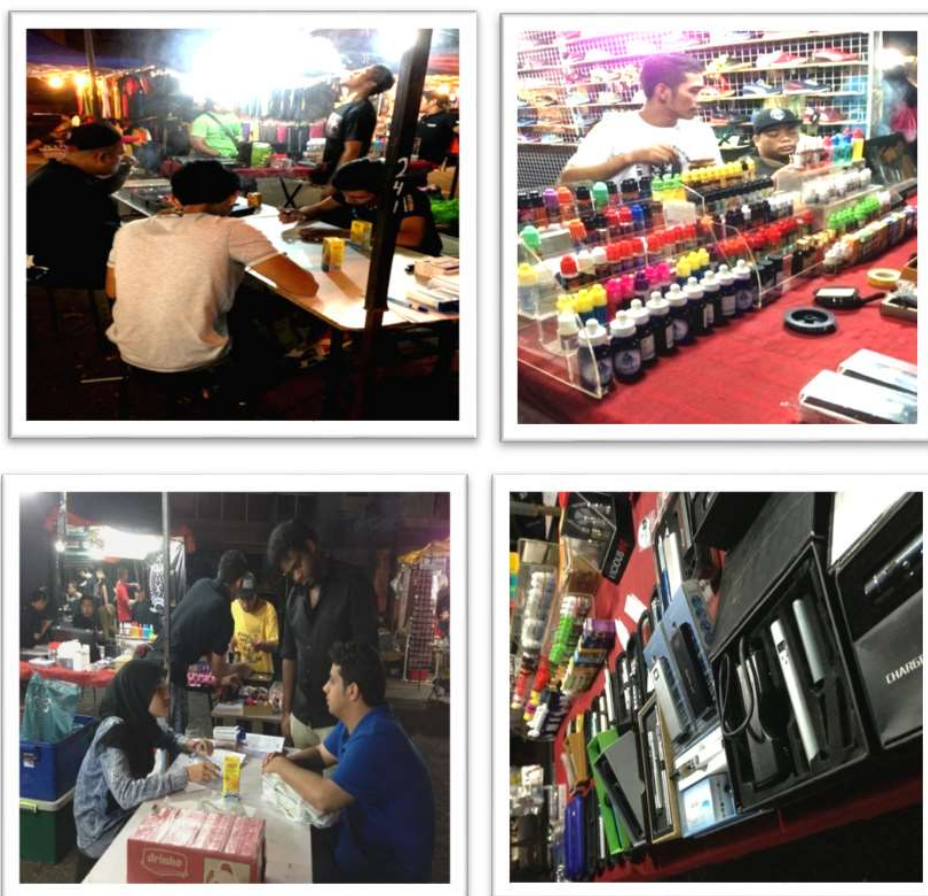


Figure 2.1: An e-cigarette stall at Kuala Lumpur Downtown Night Market, Cheras, Kuala Lumpur
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conventional cigarette to e-cigarette and to assess the general lung function of e-cigarette users using peak flow analysis in e-cigarette users. A peak flow test was conducted on both e-cigarette users and conventional cigarette smokers. Three readings were obtained for each of the respondents in order to get the average peak flow readings.

Data Analysis

Data was analyzed using Statistical Package for Social Sciences (SPSS) software version 20.0 for Windows. Paired sample T-test was used to measure whether means from subjects test group vary over two test conditions. Chi-square test was used to measure the strength of association between the variables. One way ANOVA was used to compare the sample means for a number of groups, multiple comparison methods for pairs of means and tests for the equality of the variances of the groups. Data were then tabulated and presented in tables and graphs using Microsoft Excel 2007.

Results and Discussion

Demographic Data

Figure 3.1 shows the percentage of e-cigarette users by age group. Majority of the e-cigarette users were from age group of 31 to 35 years old with 31.5% (n=23),

followed by the age group of 18 to 25 years old with 27.4% (n=20) and the age group of 26 to 30 years old with 24.7% (n=18). E-cigarette users in the age group of 36 to 40 years old and 41 to 45 years old shared the same percentage of 6.8% (n=5). The percentage of e-cigarette users by the age group of 46 to 50 years old and 56 to 60 years old showed the least percentage with only 1.4% (n=1) each.

Figure 3.2 shows the percentage of e-cigarette users by gender. All e-cigarette users were male 100% (n=73).

Figure 3.3 shows the percentage of e-cigarette users by class of income. Majority of the e-cigarette users were from the middle class of income which was between RM1000 to RM4000 with 75.3% (n=55), followed by the e-cigarette users from the class of income less than RM1000 with 16.4% (n=12). The percentage of e-cigarette users by the class of income more than RM 4000 showed the least percentage with 8.2% (n=6).

Cigarette Usage

Average monthly expenditure before using e-cigarette was obtained based on the cost of pack per day. Average monthly expenditure after using e-cigarette was obtained based on the cost of e-cigarette liquid and e-cigarette maintenance inclusive with conventional cigarette that the users still

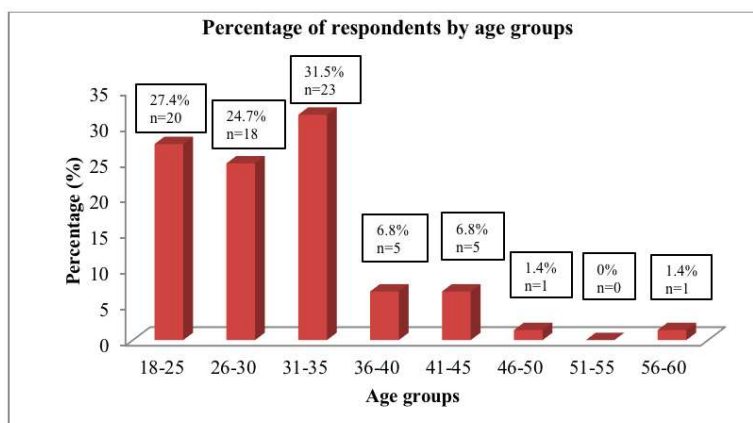


Figure 3.1: Bar chart of percentage of e-cigarette users by age groups
Electronic Cigarette Use Amongst Cigarette Smokers

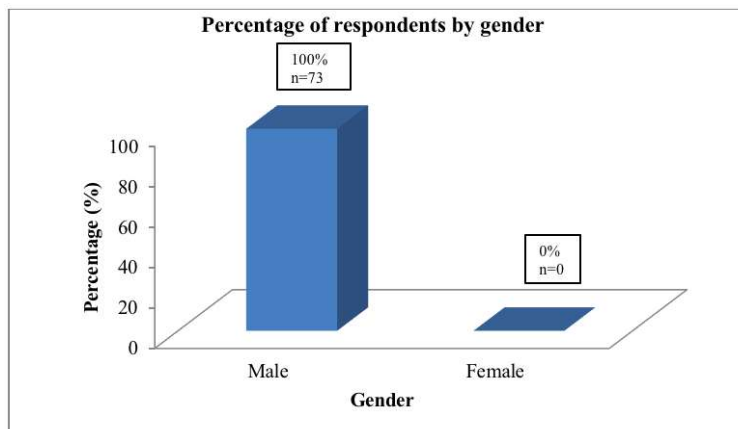


Figure 3.2: Bar chart of percentage of e-cigarette users by gender

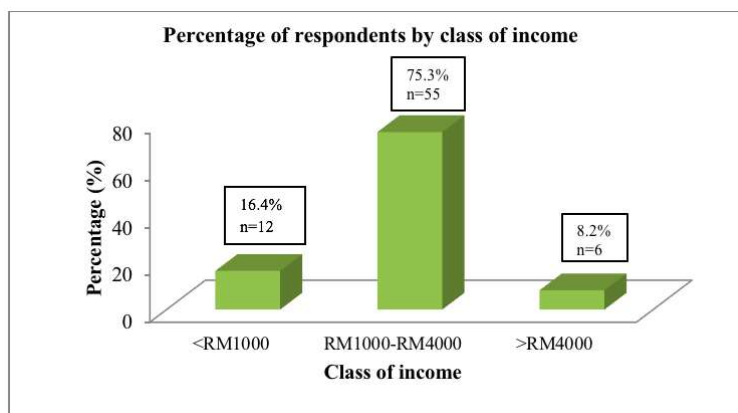


Figure 3.3: Bar chart of percentage of e-cigarette users by class of income

buy. Comparison between the average monthly expenditure before and after e-cigarette usage was done to evaluate the difference in term of cost on conventional cigarette and e-cigarette. Table 3.1 shows the mean of average monthly expenditure before and after e-cigarette usage. The mean for average monthly expenditure before e-cigarette usage was RM339.59 (± 14.490) while the mean for average monthly expenditure after e-cigarette usage was RM117.67 (± 4.531). The difference in the average monthly expenditure before and after e-cigarette usage was RM221.92 (± 9.959). A paired-sample t-test was

performed to compare the average monthly expenditure before e-cigarette usage with that of after e-cigarette usage. It was found that there is a significant difference in the mean of average monthly expenditure before e-cigarette usage when compared to that of the mean of average monthly expenditure after e-cigarette usage with ($p < 0.05$). These results suggest that smokers spent a significant amount of money for conventional cigarette and that if the conventional cigarette smokers changed from conventional cigarette to e-cigarette, the conventional cigarette smokers could save a significant amount of money.

Reduction in pack-year: Reduction of pack-year before and after e-cigarette usage

Table 3.2 shows the mean of pack-year before and after e-cigarette usage. The mean of pack-year before e-cigarette usage was 13.49 (± 1.037) while the mean of pack-year after e-cigarette usage was 1.67 (± 0.560). A paired sample t-test was performed to compare the mean of pack-year before e-cigarette usage with that of the mean of pack-year after e-cigarette usage. It was found that there is a significant difference in the mean of pack-year before e-cigarette usage when compared to that of the mean of pack-year after e-cigarette usage with ($p < 0.05$). These results indicate that e-cigarette helps in the withdrawal of conventional cigarette consumption.

Association between classification of e-cigarette users based on their previous conventional cigarette pack-year and the tendency to completely change from conventional cigarette to e-cigarette

Conventional cigarette withdrawal is a problem associated with nicotine replacement therapy; thus, this association was made to further see the effect of e-cigarette on the classification of e-cigarette users based on their previous conventional cigarette pack-year towards the tendency to completely change from conventional

cigarette to e-cigarette. In order to know whether there was an association between the classification of e-cigarette users as shown in Figure 3.4 and the tendency to completely change from conventional cigarette to e-cigarette, a Chi-square test was performed. Table 3.3 shows the percentage of respondents who completely changed to e-cigarette based on the classification of e-cigarette users. The e-cigarette users based on their previous conventional cigarette pack-year were classified into three; light, moderate and heavy smoker which was classified based on their previous pack-year of less than 15, 16 to 24 and more than 24 respectively. It was found that the light smoker had the highest percentage to completely change from conventional cigarette to e-cigarette with 58.9% ($n=43$), followed by the heavy smoker which completely change from conventional cigarette to e-cigarette with 8.2% ($n=6$). The lowest percentage to completely change from conventional cigarette to e-cigarette was the moderate smoker with 5.5% ($n=4$). However, there is no significant association between the classification of e-cigarette users and the tendency to completely change from conventional cigarette to e-cigarette. These results suggest that the tendency to completely change from conventional cigarette to e-cigarette was not associated with the classification of e-cigarette users.

Table 3.1: Mean of average monthly expenditure before and after e-cigarette usage

Parameters	Before using electronic cigarette (RM)	After using electronic cigarette (RM)	(p value)
	Mean (\pm SEM)		
Average monthly expenditure	339.59 (± 14.490)	117.67 (± 4.531)	0.012 ^a

Table 3.2: Mean of pack-year before and after e-cigarette usage

Parameters	Before using electronic cigarette	After using electronic cigarette	(p value)
	Mean (\pm SEM)		
Mean of pack-year	13.49 (± 1.037)	1.67 (± 0.560)	0.048 ^a

Peak flow reading (PEFR) between e-cigarette users and conventional cigarette smokers

In this study, the same number of conventional cigarette smokers were also recruited so that the peak flow reading of the conventional cigarette smokers could be compared with that of the peak flow reading of the e-cigarette users. In this present study too, e-cigarette users were further divided into two groups based on whether the users used the e-cigarette alone or whether the users used the e-cigarette in addition to conventional cigarette as described in Figure 3.5.

Figure 3.6 shows the general peak flow readings and frequency between

conventional cigarette smokers and the e-cigarette users (e-cigarette users alone and e-cigarette users who also smoke conventional cigarette alternately or occasionally). Generally, the peak flow readings of the conventional cigarette smokers were less than 400 L/min and the peak flow readings of the e-cigarette users (e-cigarette users alone and e-cigarette users who also smoke conventional cigarette alternately or occasionally) were more than 500 L/min Figure 3.7.

Table 3.4 shows multiple comparisons for peak flow meter readings between the three groups which were e-cigarette users who used e-cigarette alone, e-cigarette users who used e-cigarette in

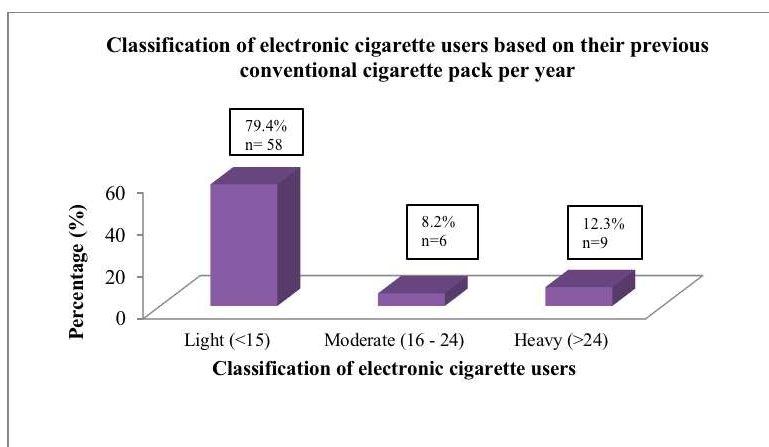


Figure 3.4: Bar chart of percentage and classification of e-cigarette users based on their previous conventional cigarette pack-year. Light smoker was a smoker with previous pack-year less than 15. Moderate smoker was a smoker with previous pack-year of 16 to 24. Heavy smoker was a smoker with previous pack-year of more than 24. The classification of the type of smoker based on pack-year was adapted from previous study [18]

Table 3.3: Percentage of respondents who completely changed from conventional cigarette to e-cigarette based on the classification of e-cigarette users (which was based on their previous conventional cigarette pack-year)

Type of electronic cigarette users based on their previous conventional cigarette pack per year	Completely change to electronic cigarette %		(p value)
	Yes	No	
Light (≤15)	58.9	20.5	
Moderate (16-24)	5.5	2.7	0.846 ^a
Heavy (≥24)	8.2	4.2	

addition to the conventional cigarette occasionally or alternately and conventional cigarette smokers. The means for e-cigarette alone, e-cigarette users who used e-cigarette in addition to the conventional cigarette occasionally or alternately and conventional cigarette smokers were 506.23 (± 9.98), 495.00 (± 14.40) and 393.29 (± 2.63) respectively. A Tukey's post hoc test was done to further see the level of significance

between the three groups. From the findings, it was found that there are significant differences in the mean peak flow readings of the e-cigarette users who used e-cigarette alone and e-cigarette users who used e-cigarette in addition to the conventional cigarette occasionally or alternately to that of the mean of peak flow readings of the conventional cigarette smokers ($p < 0.001$; One way ANOVA with Tukey's post hoc test).

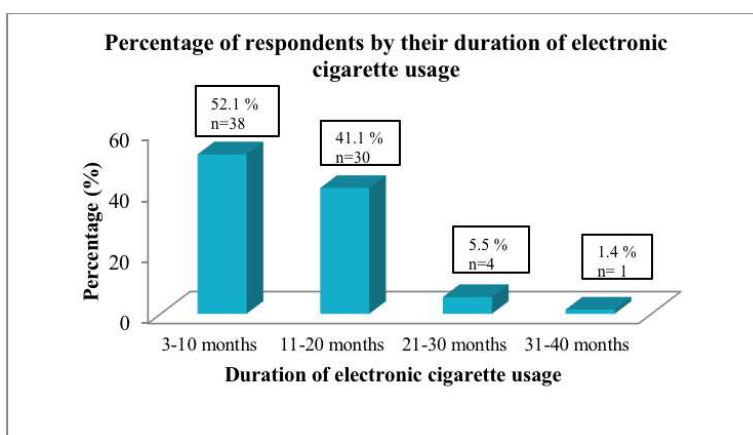


Figure 3.5: Bar chart of percentage of respondents by duration of e-cigarette usage

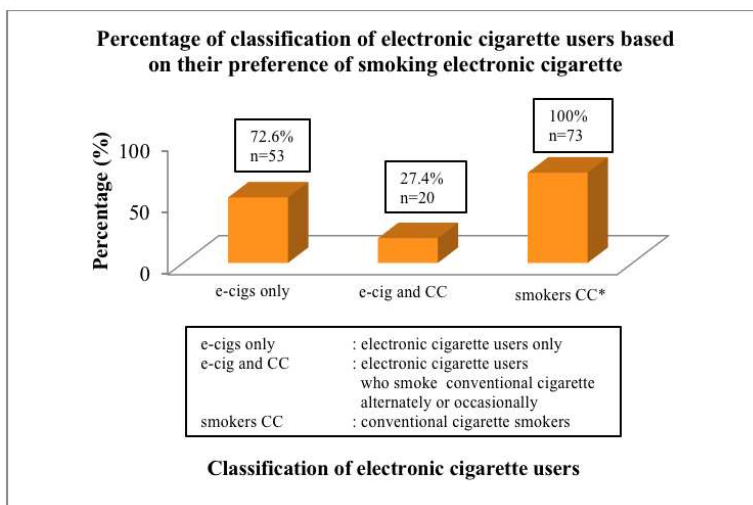


Figure 3.6: Bar chart of percentage of classification of e-cigarette users based on their preference of smoking e-cigarette. *Note that the smoker CC were sampled separately (n=73) to obtain their peak flow readings for 3.2.3

Electronic Cigarette Use Amongst Cigarette Smokers

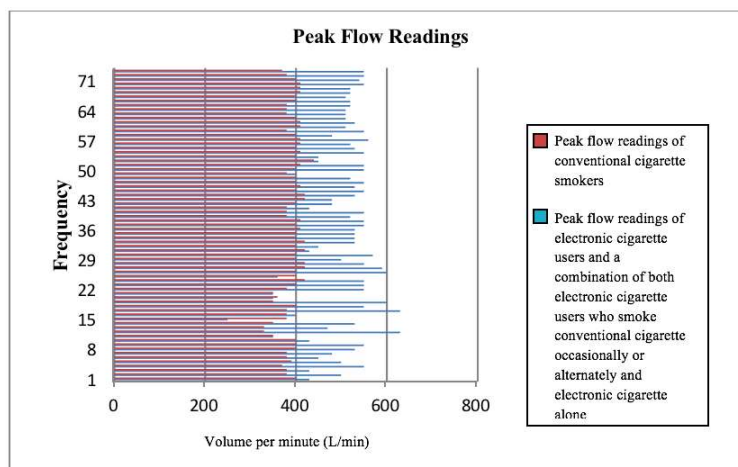


Figure 3.7: Peak flow readings between the conventional cigarette smokers and the e-cigarette users (e-cigarette users alone and e-cigarette users who also smoke conventional cigarette alternately or occasionally).

Table 3.4: Multiple comparisons for peak flow readings between three groups (which was based on their preferences of smoking e-cigarette as shown in Figure 3.6)

Dependent variables	(I) Groups	(J) Groups	(p value)
	Electronic cigarette users who used electronic cigarette alone (Mean = 506.23±9.98)	E-cigarette users who used e-cigarette in addition to the conventional cigarette	0.692
		Conventional cigarette smokers	0.000 ^d
	Electronic cigarette users who used electronic cigarette in addition to the conventional cigarette (Mean = 495.00±14.40)	E-cigarette users who used electronic cigarette alone	0.692
		Conventional cigarette smokers	0.000 ^d
	Conventional cigarette smokers (Mean = 393.29±2.63)	Electronic cigarette users who used electronic cigarette in addition to the conventional cigarette	0.000 ^d
		Electronic cigarette users who used electronic cigarette alone	0.000 ^d

^dOne-way ANOVA with Tukey's Post Hoc Test

Discussion

Cost effective: Difference in average monthly expenditure before and after e-cigarette usage

It has been a major issue for smokers at least in Malaysia that the average

monthly expenditure for conventional cigarette is ever increasing. In 2007, excise tax duty was increased by 25%. As of 2010, tax constitutes about 54% of the retail price of popular brand cigarettes and these retail prices must get prior approval from the government. Cigarettes were set at a

minimum price of RM15.70 per pack [13]. In addition, government is battling to reduce death due to smoking with increment in cigarette price. This has been a challenge for Malaysian smokers to continue smoking. However, cigarette addiction is tough to break thus some Malaysian smokers had opted for e-cigarette as an alternative. Concerns had been raised whether they use e-cigarette to cease smoking or to reduce average monthly expenditure. In the present study, the average monthly expenditure for smoking e-cigarette was evaluated and compared with that of the average expenditure before the respondents switched to e-cigarette. Based on the present study, it was found that there is a significant reduction in the average of monthly expenditure after the respondents opted to use e-cigarette.

The price of conventional cigarette in Malaysia is considered high compared to other countries. The price of e-cigarette is considerably cheaper as some e-liquid is made locally. When e-cigarette users slowly shifting from conventional cigarette, the e-cigarette users slowly saving some amount of money. One of the criteria looked upon in quit smoking is the cost. This is supported by a study done in US, daily users spent US\$33 per month for e-cigarettes which is much cheaper than smoking one pack per day incurring the cost of US\$150 to US\$200 per month in respondents countries [12]. In comparison to the respondents of this study, average monthly expenditure before using e-cigarette was RM300 (US\$94) to RM350 (US\$110) and this amount decreased to RM100 (US\$31) to RM150 (US\$47) after the usage of e-cigarette taking the latest currency exchange rate at US\$1 = RM3.18. The study shared that with a significant reduction in the average monthly expenditure, the e-cigarette may be a competitive alternative to conventional cigarette in an attempt to reduce the cost. However, no economic analyses were identified specifically addressing the cost effectiveness of nicotine replacement therapy in comparison with e-cigarette [14].

Reduction in pack-year: Reduction of pack-year before and after e-cigarette usage

Findings from this study show significant reduction of pack-year before and after using e-cigarette. Pack-year is calculated based on the sticks of the cigarettes times the years of smoking and divided by 20 sticks per pack. In the calculation, reduction in stick per day helped in reducing the pack-year. A study done on the effectiveness and tolerability of e-cigarette in real life in a 24-month prospective observational study showed that there was more than 50% reduction in cigarette smoking observed in 27.5% of participants, with a substantial reduction from 24 to 4 cigarettes per day [1]. In comparison with other nicotine replacement therapy, it was supported that nicotine replacement therapy does help in reduction of cigarette consumption. A study was done using nicotine replacement therapy in reducing cigarette consumption. The results from the study stated that, after one year, nicotine replacement therapy was effective in maintaining reduced consumption of e-cigarette by more than 50% of baseline level than placebo with 16 to 19% effectively [15]. The use of nicotine replacement therapy for smoking reduction and temporary abstinence was found to be positively associated with attempts to quit smoking and with abstinence at 6-month follow-up. Use of nicotine replacement therapy for smoking reduction and temporary abstinence was associated with a small reduction in daily cigarette consumption [16].

E-cigarette users experience a reduction in pack-year once they switched from conventional cigarette to e-cigarette. Not only e-cigarette reduced the cost, shifting to e-cigarette may be beneficial as conventional cigarette is the main cause of lung cancer once being exposed to the carcinogenic substances such as tar and carbon monoxide. Even though there is reduction in cigarette consumption, a proper study is still crucial to thoroughly evaluate if there is any reduction in nicotine intake.

Association between classification of ecigarette users based on their previous conventional cigarette pack-year and the tendency to change from conventional cigarette to e-cigarette

Findings from this study show that there is no significant association between classification of e-cigarette users based on their previous conventional cigarette pack-year and the tendency to change from conventional cigarette to e-cigarette. The e-cigarette users based on their previous conventional cigarette pack-year were classified into three. In this study, smokers with the lowest pack per year tend to change into e-cigarette completely. E-cigarette helps the smokers in competing with withdrawal symptoms of cigarette. This is supported by a survey with responses of 216 first time buyers of e-cigarette, about two thirds of participants 66.8% reduced cigarette consumption, almost half of them 48.8% were temporarily smoke free and 31% of users reported being completely smoke free within six months after starting to use e-cigarette. Most of these former conventional cigarette smokers 56.7% continue to use e-cigarette but only about one third of them have stopped using nicotine containing products [12]. In addition, e-cigarette reduces the desire to smoke and nicotine withdrawal symptoms after 20 mins of its usage [17].

Limitation of Study

Several limitations were identified during the execution of this study. Firstly, the sample size was generally small, which may not fully represent all e-cigarette users in Klang Valley. Additionally, the survey was conducted at a single location, potentially introducing site bias and influencing the outcomes. However, it's noteworthy that the chosen study site, Kuala Lumpur Downtown Night Market, Cheras, Kuala Lumpur, serves as a primary hub for e-cigarette users to access device maintenance and liquid. Future studies should consider conducting surveys at multiple locations to enhance the reliability and accuracy of the findings.

Regarding peak flow readings, many were obtained only once from each e-cigarette user for convenience, and some users declined multiple readings, potentially introducing bias and impacting the results. To address this in future research, a prospective study could be implemented to closely monitor each respondent's cigarette consumption and provide more robust data on reduction outcomes.

Conclusion

Findings from this study suggested that e-cigarette is a cost-effective alternative to conventional cigarette. Besides, e-cigarette reduces cigarette consumption which leads to decrease in pack-year amongst users and better peak flow readings which may indicate better lung function. Therefore, the results of this study imply that e-cigarettes could be a promising approach for smoking cessation and merit further investigation and research design.

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