RESEARCH ARTICLE

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Vaping Topography and Reasons of Use among Adults in Klang Valley, Malaysia

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Abstract

Background: Consistency and accuracy of results in assessing health risks due to vaping or e-cigarette use are difficult to achieve without established consumption data. The present report covers baseline data on vaping topography and reasons for use among local users in Klang Valley, Malaysia. **Methods:** An 80-item survey regarding socio-demographic characteristics, smoking topography and reasons for e-cigarette use was employed to assess e-cigarette users recruited from several public universities and private organisations. The survey questionnaire was self-administered. Data were analysed using statistical software. **Results:** Eighty-six current e-cigarette users participated with more than half (51.2%) of them aged ≥ 25 years old. Significant proportions of the sample were single (51.2%), had a tertiary education level (63.5%) and a household income of less than USD1000 per month (65.2%). Median duration of e-cigarette use was less than a year; users drew approximately 50 puffs per day and refilled twice a day. The majority (74%) used e-liquids containing nicotine with a concentration of 6 μg/mL. Daily users spent USD18-23 per month. Reasons for using the e-cigarette included enjoyment of the products (85.9%), perception of lower toxicity than tobacco (87%), and the fact that it was a cheaper smoking alternative (61%). **Conclusion:** The data on e-cigarette smoking topography obtained in this study are novel. The reasons of usage were mainly users' enjoyment of e-cigarettes, preparation for quitting smoking, perception of low toxicity and a healthier smoking substitute and cheapness in the long run. The results establish basic knowledge for the local vaping topography and reference material for future e-cigarette-related research.

Keywords: Smoking pattern- electronic-cigarette- e-liquid- electronic-nicotine delivery system- e-juice

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Introduction

Electronic-cigarettes (e-cigarette) are battery-powered nicotine delivery systems that deliver nicotine aerosols to its users by heating a solution (e-liquid) that generally consists of propylene glycol or vegetable glycerin, artificial flavorings and nicotine (Goniewicz et al., 2013; Schripp et al., 2013). This product is rapidly becoming popular worldwide since its introduction in the United States (US) in 2007 (Hammett et al., Chen and Husten, 2014). Marketed as healthier, cleaner and cheaper smoking alternative compared to conventional cigarette (CC); e-cigarette has been associated with decrement in the use of CC and assists smoking cessation among smokers (Coleman et al., 2016; Grana and Ling, 2014). An increment of e-cigarette sales by 320.8% for disposable e-cigarettes, 72.4% for starter kits and 82% for cartridges were reported in a study done in US from 2012 to 2013 with total sales exceeded $3.5 billion in 2015 (Loomis et al., 2016).

The biggest concern for health practitioners and researchers is the potential adverse health effects due to e-cigarette use and the involuntary exposures from the vapours released. This concern has led to the development of many studies such as quantification of e-liquids contents, factors of e-cigarette usage, safety and probable health effects due to its usage or vapors exposure (Uchiyama et al., 2016; Farsalinos et al., 2016; Ioakeimidis et al., 2016; Pisinger and Døssing, 2014). However, the lack of consistency in the findings reported makes it difficult for researchers to rule out the potential health risks in favour of its benefits.

The inconsistencies of reported research findings may due to 1) the variety of e-cigarette devices that are currently available and 2) the variability of the usage pattern of e-cigarette users; normally termed as vaping

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topography (Behar et al., 2015). Vaping topography generally refers to the pattern of how a person uses e-cigarette including number of puffs, puff volume, duration, and velocity (Cunningham et al., 2016; Lee et al., 2015). This information is crucial in providing insight into puffing behavior, potential nicotine intake, and as baseline usage patterns between different brands, models, and users. Most importantly, established vaping topography data are needed to understand basic characteristics of the e-cigarettes use that will help to establish standardized protocols in conducting lab-based research working with these products. It is also critical information in conducting health risk assessment due to voluntary or involuntary exposures towards the e-cigarettes vapors. Thus, data on vaping topography to a specified studied population need to be obtained for a more accurate estimation to be made resulting in a better study outcome to assist in regulating e-cigarette-related policy. This study aims to collect the baseline data on vaping topography and promoting factors for its usage among users in Klang Valley, Malaysia. This study is important to assist researches related to e-cigarette for a more accurate, relevant and useful results to be used by local health practitioners, regulators and manufacturers.

Materials and Methods

E-cigarette users' who fulfilled the study's inclusive criteria of the following; 1) Malaysian, 2) aged 18 years old and above and 3) currently using e-cigarettes or dual user (using e-cigarette and conventional cigarette interchangeably) were recruited from several public universities and private companies throughout Klang Valley, Malaysia. The eligible respondents were asked to complete an 80-item survey questionnaire regarding their vaping topography and reasons of use of e-cigarettes. The questionnaire was back-to-back translated to Malay language from its original version (Etter and Bullen, 2011). It consists of three sections; namely Part A: Socio-demographic information, Part B: Usage pattern of e-cigarette and Part C: Reason of e-cigarette use. Copies of questionnaires were disseminated to the chosen respondents and token of appreciation were given after completion. Data reported here were collected between March, 2016 to May, 2017. The survey was approved by the ethics committee of Universiti Putra Malaysia (ref no: FPSK (EXP15) PO94).

Statistical analysis

All statistical analyses were performed with IBM SPSS Statistics for Windows, Version 22.0. Descriptive statistics were used to illustrate the demographic characteristics, e-cigarette usage pattern and reasons for e-cigarette use of the sample. Chi square test was used to determine differences between e-cigarette users only and dual-users for reasons of e-cigarettes usage. A p-value of <0.05 was used as the cut-off point for statistically significant differences.

Results

Table 1 shows more than half (51.2%) of the e-cigarette users aged ≥ 25 years old. A significant proportion of the study sample consisted of single (51.2%), having tertiary education level (63.5%) with a household income of less than USD 1,000 per month (65.2%). The vaping topography among e-cigarette users is showed in Table 2. In this study, majority of the e-cigarette users prefers to use the advanced version of the e-cigarette device known as Modular (MODs) with tank-style cartridge. Half of the e-cigarettes users reported to purchase their devices from retailer shops (vape shops) with the price around USD 58 to USD 180. Almost 75% are using nicotine-contained e-liquids with nicotine concentration of 6mg/ml. Majority of them are daily users and has been using e-cigarette for <1 year (nearly 9 months) with almost 50 puffs/day and claimed to refill e-liquid twice/day. The consumption of e-liquid is about 60 ml/month which is equivalent to two e-liquids bottles. Figure 1 shows the distribution of

Table 1. Socio- Demographic Information of the e-cigarette Users (N=86)

		E-cigarette users (N=50) N (%)	Dual users (N=36)	Total	$\chi 2$	p
Age						
	<25	17 (34.0)	25 (69.4)	42 (48.8)	10.524	0.002*
	≥25	33 (66.0)	11 (30.6)	44 (51.2)		
Marital status						
	Single	21 (42.0)	23 (63.9)	44 (51.2)	4.326	0.115
	Married	28 (56.0)	12 (33.3)	40 (46.5)		
	Single parent	1 (2.0)	1 (2.8)	2 (2.3)		
Education level						
	Secondary	20 (40.8)	11 (30.6)	31 (36.5)	0.943	0.369
	Tertiary	29 (59.2)	25 (69.4)	54 (63.5)		
Household income (N=66)						
	<USD1,000	21 (55.3)	22 (78.6)	43 (65.2)	3.858	0.043*
	≥USD1,000	17 (44.7)	6 (21.4)	23 (34.8)		

*significant at p<0.05

Table 2. Vaping Topography of e-cigarette Use among e-cigarette Users (N=86)

Vaping topography	(min,max)	(med±IQR)	N (%)
Type of e-cigarette use			
Commercial			36 (41.9)
Modular (MODs)			50 (58.1)
Place of e-cigarette purchase			
Online			19 (22.1)
Retailer			40 (46.5)
Gift from friend			9 (10.5)
Mall/kiosk			18 (20.9)
No. of puff (N/day) (N=80)	(2,500)	(48.5±80)	
Nicotine concentration in e-liquid (mg/ml)	(1,24)	(6±3)	
Type of cartridge			
Tank			63 (73.3)
Drops of liquid			23 (26.7)
Nicotine content in e-liquid			
Do not know			13 (15.1)
Yes			64 (74.4)
No			9 (10.5)
Price of e-cigarette (N=83)	(301,000)	(250±200)	
Period of using e-cigarette (wk)	(1,312)	(34±70)	
E-cigarette usage (days/wk) (N=81)	(1,7)	(7±4)	
Quantity of e-liquid (ml/mth)	(3,300)	(60±60)	
No. of refill (N/day) (N=79)	(1,20)	(2±2)	
No. of puff (N/bottle of e-liquid) (N=81)	(10,500)	(50±70)	
Period of puff before refill e-liquid (min) (N=82)	(14,320)	(40±100)	
Period of puff before battery recharge (hrs) (N=82)	(1,150)	(8±20)	
No. of puff before battery recharge (N=79)	(2,500)	(100±100)	
Ever use e-cigarette and CC on the same day			
Yes			46 (53.5)
No			40 (46.5)
Ever modify e-cigarette			
Yes			23 (26.7)
No			63 (73.3)
Ever replace original battery			
Yes			27 (31.4)
No			59 (68.6)

respondents in terms of their promoting factors for using e-cigarettes. The majority of respondents stated that the enjoy using e-cigarettes (85.9%). More than 80% of the respondents use e-cigarette claiming it as preparation to quit smoking. A significant proportion of the respondents perceived that e-cigarette is less toxic and a healthier smoking substitute to its users (87.1%). A total of 61.2% respondents reported that they use e-cigarette for its cheaper price in the long run compared to CC. In addition, half of the respondents use e-cigarette for its ability to be used in smoke-free public areas (49.9%).

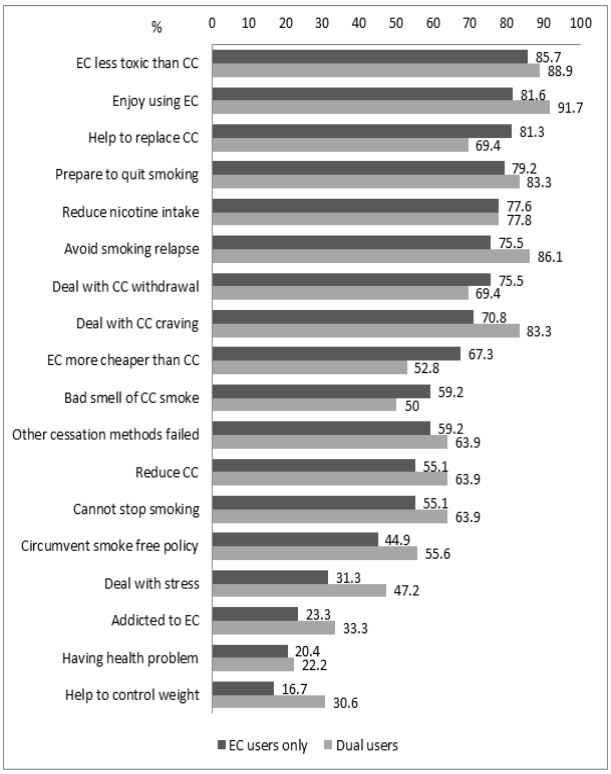

Figure 1. Reasons of e-cigarette Usage among e-cigarette Only Users and Dual Users (N=86) (EC: Electronic Cigarette; CC, Conventional cigarette)

Discussion

This study is the first study in Malaysia to report vaping topography unique to the local e-cigarette users and the factors that promotes their usage. Adults aged 25 years old and above reported to prefer using only e-cigarette compared to younger users that use both e-cigarette and conventional cigarette (dual users). The latter group possibly at the phase of experimenting both products due to curiosity, peer pressure, easy access and variety choice of flavours that influence them to try prior choosing one (Martínez-Sánchez et al., 2014; Lee et al., 2015; Kong et al., 2015). Having less economy commitment may be the reason of more single respondents using e-cigarette as the starter kit (e-cigarette device) is expensive compared to a pack of conventional cigarette (Zielinska-Danch et al., 2010; Etter and Bullen, 2011; Dockrell et al., 2013). The minimum price for one third-generation e-cigarette device and a bottle of e-liquid sold in Malaysia is approximately about USD73 compared to USD5.2 for a pack of 20 cigarettes.

The most obvious difference of the findings in this study compared to others is the majority e-cigarette users in this study prefer to purchase their e-cigarette and e-liquids in vape shops/retailers compared to purchasing online (Etter and Bullen, 2011; Giovenco et al., 2014). This may due to the convenience of finding a vape shop locally and the fact that they are allowed to test different brands of products prior purchasing any that suit their preferences (Tackett et al., 2015). Recent estimates reported that there are approximately 600 vape shops located in Kuala Lumpur in 2015 and the number is expected to be increasing by year (Hutt, 2016). One of

the top local vape companies in Malaysia has almost 50 outlets nationwide (The Star, 2015).

Daily usage of e-cigarette users in this study (measured in puffs per day) (average of 50 puffs and twice refills per day, that is, 25 puffs per refill) is more than two times lower than reported in a study by Etter and Bullen (2011) which was 120 puffs per day. The average of 25 puffs per refill is considerably less than reported from in vitro tests of 170-300 smokeable puffs per refill (Trtchounian et al., 2010). This perhaps because the local users may refill small amount of e-liquid compared to the maximum 5 ml allowable capacity of the e-cigarette tank. Since it is not mandatory to refill up to the maximum, the users may refill just enough for their daily consumption. They may as well refill when the flavour or the nicotine taste started to fade out.

The reported preferences of nicotine concentration in this study is 6 mg/mL which is lower than reported elsewhere; 12 mg/mL (Etter and Bullen, 2011) and >15 mg/mL (Farsalinos et al., 2013). However, the cumulative concentration exposed to the users in this study is 180 mg (30 ml per bottle x 6 mg/mL) using e-liquids with the lowest nicotine concentration available. It is a health and safety concern because fatal dose of nicotine is estimated to be 30-60 mg for adults and 10 mg for children (Etter and Bullen. 2011; Mayer, 2014). Apart from that, the amount of nicotine supplied to its users is also influenced by the efficiency of the device in vaporizing the nicotine in the e-liquid and the electrical power input used by the users in setting the device (Shihadeh et al., 2015). It was reported that only one-third to one-fourth of nicotine is delivered after 5 minutes use of e-liquids with nicotine concentration of 18 mg/mL (Farsalinos et al., 2013). Thus, there is a possibility for a higher nicotine concentration of e-liquids chosen to fulfill the users' nicotine addiction.

The biggest promoting factor for e-cigarette use in this study is the fact that the users reported to enjoy using e-cigarette as a tobacco product. The enjoyment may due to the variety of taste and flavours of e-liquids currently available in the market (Farsalinos et al., 2013; Barbeau et al., 2013). A published study which examined e-cigarette brands and e-liquids advertised and sold on the internet reported a net increase of 242 new flavours per month (Zhu et al., 2014). In this study, it was found that the users reported to use many locally customized e-liquids flavours common to the Malaysian palate such as Mango Lassi and Sirap Bandung. This study also found that users report the use of flavours such as sweet and candy-like of e-liquids. In literature, it was reported that sweet and candy-like flavours is the preference of select population of smokers such as youngsters while creamy e-liquid flavour is more suited to the preference of female smokers (Jackler and Ramamurthi, 2016). There is no study as of yet which have been done to elucidate e-cigarette usage among specific sub-populations of those who are less than 18 years of age or of the female population in Malaysia. As with other Asian countries, smoking is a norm among males and the prevalence of smoking among females remain low between 1.2% to 4.8% (MOH, 2015; Tsai et al., 2008). From this study, it is clear that the manufacturing of e-liquids according to the demands of the local consumers is given precedence and there is a need for a regulated system to be developed to monitor its manufacturing at the regulatory level.

Other studies elsewhere have reported that the enjoyment of e-cigarette usage is due to the perception of vaping as a cool and trendy activity which is commonly associated with a new kind of lifestyle or a subculture (Grana, 2013). Thus, this implicates that the use of e-cigarette or transition from CC to e-cigarette is not solely due to health concern of the harmful tobacco or the intention of quit smoking, but more likely due to the feeling of enjoyment which may due to pleasure of having varieties of flavours to choose from and being in trend. Furthermore, it creates a higher and bolder consumer demands since its usage is generated due to users' enjoyment rather than being for health concerns.

This study found that users perceived e-cigarette as less toxic and a healthier smoking substitute. Although e-cigarette is portrayed as a harm reduction tool and produces less amount of contaminants, the chemicals contained in e-cigarette liquids or vapours are yet to be fully characterised by on-going studies leaving its safety claims unproven (Margham et al., 2016; Polosa et al., 2011). It has been reported that e-cigarette potentially releases and exposes the users to carcinogenic compounds such as formaldehyde, tobacco specific N-nitrosamines and heavy metals namely lead, chromium and nickel in varying levels (Uchiyama et al., 2013; Williams et al., 2013). In addition, many local e-liquids such as in Malaysia are being produced and sold by small local companies that seldom provide detail composition of each ingredients used in the manufacturing of e-liquids. Thus, there is a need to establish that local e-liquids is not entirely risk-free or is proven harmless; indicating that the introduction of a strict regulation for accurate labelling of e-liquids as urgently needed.

Price is also a promoting factor that is interesting which it influences users in developed and developing countries in terms the purchasing power. In Malaysia, e-cigarette is considered cheaper in the long run compared to CC. For a pack of 20 cigarettes, the minimum retailing price is about USD 3.5 (USD 105 per month) compared to USD 70 for one e-cigarette device (for starters) and maintenance cost of only USD 12 to USD 23 per month referring to the usage two bottles of e-liquids per month as reported in this study. Only half of the respondents in this study used e-cigarette as to circumvent the smoke-free policy which may reflect the loose enforcement by the authorities in regulating the existing smoking prohibition regulation in all 21 selected local premises (Abidin, 2016; Abidin et al., 2013). The compliance to the existing local smoke-free law seems to be a challenge since its introduction, thus the rising number of e-cigarette users is afraid to result in renormalization of smoking especially in these prohibited areas and further weaken the existing regulation.

Study Limitation

Due to unavailable and difficulty to obtain sampling frame for e-cigarette users in Malaysia as no studies has been published in terms of its population in details,

this study recruited a convenience sample of e-cigarette users in several public universities (staffs and students) and selected cooperative private companies. Thus, the results should be interpreted with caution and may not be generalised to the whole local e-cigarette user population. Apart from that, since the respondents are those who use e-cigarette, this study might over-sampled satisfied users, long-term users or heavy users of the product which may generate results that favoured to defend e-cigarette.

In conclusion, this study reported vaping topography among current e-cigarette users specifically in Klang Valley, Malaysia. The vaping topography is different from the studies reported elsewhere and the result of this study is unique to the local Malaysian population. However, the reasons for its consumption are mainly parallel with other studies which are the enjoyment of using the products, perception of less toxic and cheaper than CC making it the chosen smoking alternatives. This study adds to the currently limited published study on vaping topography especially among e-cigarette users in Asian countries and strongly believed provides valuable additional information for its users, clinicians, health practitioners, regulators and policy makers.

Competing interest

None.

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