



UNIVERSITI PUTRA MALAYSIA

***PREVALENCE OF ASTHENOPIA AND ITS RISK FACTORS AMONG
WHITE COLLARED POLICE OFFICERS IN BUKIT AMAN***

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FPSK4 2016 32**

**DETERMINATION OF NICOTINE CONCENTRATION IN E-LIQUID
AND ITS HEALTH RISK AMONG E-CIGARETTE USER IN
UNIVERSITI PUTRA MALAYSIA (UPM)**

BY

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**Thesis submitted in fulfilment of the requirement for degree of Bachelor Science
(Environmental and Occupational Health) from the Faculty of Medicine and
Health Sciences, Universiti Putra Malaysia**

ACKNOWLEDGEMENTS

Foremost, I would like to express my gratitude to my supervisor, Dr Emilia Binti Zainal Abidin for her patience, enthusiasm, aspiring guidance, and invaluable advice as well as ensuring me gaining adequate knowledge throughout my study. Endless help was given by her to finish this thesis.

Furthermore, I would like to Miss Aziemah Zulkifli and Miss Najihah Zainol Abidin for assisting me in conducting the survey and laboratory analysis. Suggestions given by them are useful to complete my thesis. Appreciation also goes to all the staff in Chromatography Laboratory, Faculty of Food Sciences and Technology for assisting and their support on GC-FID operation. In addition, special thanks also to all respondents who were participated in this study in providing information and data. This research financially supported by Fundamental Research Grant Scheme Ministry of Education Malaysia, under the Vote 5524532.

Special thanks to my parents and family members for unceasing encouragement and supporting me spiritually throughout my life. Lastly, I apologize all other unnamed who helped me in various ways during my research. A paper is not enough for me to express all the support and guidance I received from all of them.

ABSTRACT

DETERMINATION OF NICOTINE CONCENTRATION IN E-LIQUID AND ITS HEALTH RISK AMONG E-CIGARETTE USER IN UNIVERSITI PUTRA MALAYSIA (UPM)

Zuraidah Musbah

Introduction: The use of electronic cigarettes or EC has been gaining wide popularity in Malaysia. E-Liquid or solution contained in EC generally consists of base made from propylene glycol, glycerin, nicotine, and flavoring. This study was focused on nicotine where it is the primary addictive substances that can potentially contribute harmful effects to the users. **Objective:** The aim of this study is to determine the prevalence of EC use, nicotine concentration in local brands of most used e-liquids and assess the health risk of non-carcinogenic effects among EC user in a higher learning institution center. **Methodology:** This study recruited 179 students and staffs at Universiti Putra Malaysia that were selected using purposive sampling method. This study uses several tools for data collection, namely a modified and adapted questionnaire, which were disseminated in a survey in order to obtain the pattern of EC smoking and to identify the top local brands of e-liquids. 17 e-liquid brands were categorized into nine flavors and were analyzed using Gas Chromatography- Flame Ionisation Detector (GC-FID) to determine concentration of nicotine. The non-carcinogenic health effect due to exposure to nicotine in e-liquid was evaluated using Hazard Quotient. **Result:** The response rate of this study is 96%. The prevalence of current EC user among UPM male adults was 36.9%. The most reported reason for the use of EC was related to cessation of smoking which are 'to replace the conventional cigarette usage', 'EC act as nicotine reduction tools', 'to deal with craving for tobacco' and 'EC was less toxic than conventional cigarette'. Nicotine was detected in all selected brands of e-liquid with the mean concentration was 3.26 mg/mL. The detected nicotine concentration from the analysis was different from what was claimed on the labeling. Health risk was assessed for 44 EC users and 6.8% of them have Hazard Quotient of more than 1, indicating possibility of non-carcinogenic health risk arising from nicotine exposure. **Conclusion:** This study found prevalence of current EC user among smoking population were 36.9%. All of the e-liquid samples had nicotine but in concentrations which differs from the label. Nicotine exposure from the usage of e-liquid was likely to have potential adverse health effects. Hence, regulation of e-liquid containing nicotine should be enforced especially for accurate labeling and packaging of the products in order to prevent overdose consumption and acute health effect of nicotine to the EC user.

Keywords: Electronic-cigarette, e-liquid, nicotine, health risk.

ABSTRAK

PENENTUAN KANDUNGAN NIKOTIN DIDALAM CECAIR ROKOK ELEKTRONIK DAN RISIKO KESIHATAN DI DALAM KALANGA N PENGGUNA ROKOK ELEKTRONIK DI UNIVERSITI PUTRA MALAYSIA

Zuraidah Musbah

Pengenalan: Penggunaan rokok elektronik telah mendapat populariti yang meluas di Malaysia. Rokok elektronik merupakan satu alat yang membekalkan dos nikotin dalam bentuk wap). Secara amnya, Cecair rokok elektronik (*e-liquid*) mengandungi bahan asas seperti propilena glikol, gliserin, nikotin, dan perisa. Kajian ini tertumpu kepada kandungan nikotin dimana ia adalah bahan yang memberi kesan ketagihan dan mudah diserap ke dalam tubuh pengguna. **Objektif:** Tujuan kajian ini adalah untuk menentukan kadar kepekatan nikotin di dalam *e-liquid* buatan tempatan dan menilai risiko kesihatan terhadap pengguna rokok elektronik di institusi pusat pengajian tinggi. **Metodologi:** Kajian ini telah melibatkan seramai 179 orang lelaki dewasa terdiri daripada pelajar dan staf di UPM. Borang soal selidik yang di adaptasi dari pengkaji lain telah diedarkan bagi mengenal pasti corak penggunaan rokok elektronik dan juga mendapatkan jenama dan perasa *e-liquid* yang digunakan di dalam kalangan responden. 17 jenama *e-liquid* telah dipilih dan dikategorikan kepada sembilan kategori berdasarkan perasa. Sampel *e-liquid* dianalisa menggunakan Gas Kromatografi (GC-FID) untuk menentukan kepekatan nikotin. Risiko kesihatan tidak berkasinogenik terhadap pendedahan kepada nikotin telah dinilai menggunakan Hazad Quotient (HQ). **Hasil Kajian:** Kadar respon bagi kajian ini adalah 96%. Kelaziman untuk pengguna rokok elektronik bagi lelaki dewasa di UPM ialah 36.9%. Berdasarkan kajian yang telah dijalankan, antara faktor utama penggunaan rokok elektronik di kalangan pengguna semasa adalah antaranya; untuk menggantikan rokok konvensional, rokok elektronik dijadikan sebagai alat pengurangan nikotin, untuk mengatasi keinginan terhadap tembakau, dan rokok elektronik kurang bahaya daripada rokok konvensional. Nikotin dikesan di semua jenama *e-liquid* yang terpilih dengan purata 3.26 mg/mL. Kepekatan nikotin daripada analisis didapati berbeza dengan kepekatan yang dilabel pada botol *e-liquid*. Penilaian risiko kesihatan mendapati 3 (6.8%) daripada 44 pengguna rokok elektronik mempunyai Hazad Quotient lebih daripada 1 di mana ia menunjukkan bahawa mereka berpotensi menghadapi risiko kesihatan bukan karsinogen daripada pendedahan nikotin. **Kesimpulan:** Kajian ini mendapati kadar kelaziman pengguna rokok elektronik dikalangan lelaki dewasa yang merokok adalah 36.9%. Semua sampel e-cecair dikesan mengandungi kepekatan nikotin tetapi ia tidak konsisten dari pelabelan produk. Pendedahan nikotin daripada penggunaan *e-liquid* berkemungkinan mempunyai potensi kesan kesihatan yang buruk kepada pengguna rokok elektronik.

Kata kunci: Rokok elektronik, cecair rokok elektronik (*e-liquid*), nikotin, risiko kesihatan.

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LIST OF ABBREVIATIONS

µg/mL	Microgram per milliliter
ADD	Average Daily Dose
EC	Electronic Cigarette
EPA	Environmental Protection Agency
GC-FID	Gas Chromatography-Flame Ionisation Detector
HQ	Hazard Quotient
HRA	Health Risk Assessment
mg/mL	Milligram per milliliter
ml	Milliliter

CHAPTER 1

INTRODUCTION

1.0 Background

Electronic cigarette (EC) is one of the innovations in cigarette product that has grown exponentially in terms of its usage over the past few years. EC are Electronic Nicotine Delivery Device System (ENDS) that was first developed to closely approximate the sensory experience of smoking tobacco cigarette in 1963 by American engineer named Herbert A. Gilbert and it was invented modernly in 2003 by Chinese pharmacist named Hon Lik (Arnold, 2014; Cummings et al., 2014). According to World Health Organisation (2014), the EC was resembled the function of conventional cigarette which designed to deliver nicotine and other chemicals to the user via an aerosol vapour without involve any combustion of tobacco.

Generally, EC was available since 2005 and it was comes in various types which comprise of three sub-category products and design that describes as personal vaporiser (PV), advanced personal vaporizer (APV), and Electronic Nicotine Delivery System (ENDS) (Brown & Cheng, 2014). There is an improvement in the EC based on their functionality and characteristics that can be classified into three generation. The first generation of EC is not rechargeable or refillable and was built like a cigarette-shaped devices which consist of cartridge

containing an atomizer that might contain nicotine or without nicotine. Second generation of EC contain higher capacity of battery which can be rechargeable and provide larger reservoir known as tank system for the EC solution (e-liquid). The latest generation of EC products was known as ‘mods’ or ‘Personal Vaporiser (PV) consisting very large capacity lithium batteries with integrated circuit that allow users to change a voltage or power delivered to atomizer. Besides, this EC product can be easily modified and were often customized by the user (Maciej L. Goniewicz et al., 2015; Rachel Grana, Benowitz, & Glantz, 2014; Zhu et al., 2014).

Although design of EC differs slightly between manufacturers, most of EC consist the basic component which comprised of an aerosol generator, flow sensor, a battery and a e-liquid storage area / cartridge (Brown & Cheng, 2014). EC mechanism functions as a battery-powered device that are able to vaporize e-liquid, the liquid mixture inserted in the cartridge part of the device which is vaporized and inhaled when it is puffed at the mouthpiece and it may or may not contain nicotine (Maciej L Goniewicz, Lingas, & Hajek, 2013). Generally, the main ingredients of e-liquid consist of a mixture containing a humectant, which is glycerin, and propylene glycol that was used to produce aerosol in EC, flavoring (fruity, candy, tobacco, menthol, cola, and many others), and variable concentration of nicotine that was extracted from tobacco (American Lung Association, 2015).

According to Hahn et al., (2014), analysis of e-liquid using nuclear magnetic resonance spectroscopy was reported that e-liquid also contained compounds such 1,2- Propanediol, ethylene glycol, Thujone and ethyl vanillin. In addition, there is a study which reported that chemical analysis of e-liquid done by the United State Food and Drug Administration detected the presence on tobacco-specific nitrosamine (TSNA) which are classified as carcinogenic substances in the e-liquid sample (Farsalinos & Polosa, 2014). Notwithstanding this fact, there is study that found the level of toxic substances in e-liquid is 9-450 times lower than those in conventional cigarette (Britton J, 2014; Maciej Lukasz Goniewicz et al., 2014).

Currently, there is no government set of standard for e-liquids manufacturing and selling in Malaysia. Hence, the information of the e-liquid regarding to the design, labelling, content concentration and purities were not available or if available it is inconsistent. Even though the main ingredient use to produce e-liquid are obtainable with relative ease within Malaysia as they are already utilized in the food and pharmaceutical industries such as propylene glycol and flavouring, the harmness of the e-liquid use for EC especially for local brands cannot be proven due only limited study was done to evaluate the risk and effect of EC to the human health.

Another concern related to the EC is about the nicotine content in e-liquid. Nicotine is the primary addictive substances that can potentially contributes harmful effect because it is a substance that easily absorbed and gives the addictive effect to user (American Lung Association, 2015). Besides, nicotine is the main ingredient that contribute to the desired stimulatory effect same like nicotine in conventional cigarette. Thus, the nicotine-related effect of EC usage are expected to occur as the effects of nicotine in conventional cigarette such as acute effect on cardiovascular system, increased heart rate and increasing in blood pressure have been shown (Norwegian Institute of Pulic Health, 2015).

The concentration level of nicotine in e-liquid concentration has been found to vary based on the brands typically ranged between 0.1-324 $\mu\text{g/ml}$ (Hutzler et al., 2014) and usually some e-liquid was labelled as containing low, medium and high levels of nicotine where the user does not know how exact the nicotine intake and content in the e-liquid (Maciej L. Goniewicz, Kuma, Gawron, Knysak, & Kosmider, 2013; Schroeder & Hoffman, 2014).

1.1 Problem Statement

The usages of EC are rapidly rising in recent year and become prevalent in many countries including Malaysia (Farsalinos, Romagna, Tsiapras, Kyrzopoulos, & Voudris, 2014). The use of EC has been touted as a harm reduction tool for smokers to reduce smoking (Bullen et al., 2013; Farsalinos, Romagna, et al., 2014; Siegel, Tanwar, & Wood, 2011). Its effectiveness as a harm-reduction tool where study done by Farsalino et al., (2013) reported that in order to achieve complete substitution of smoking, EC user had to increase their nicotine concentration level in e-liquid and was experienced mild and temporary side effect. The problem for EC usage are, the normalization of smoking and the smoking habits being taken on by adults or young adolescents which have never taken up smoking in the first place (Abidin, Zulkifli, & Abidin, 2016). In a country like Malaysia, which has a prevalence of smoking among adult males of almost 50%, increasing the number of current smokers is against the goals set out in Article 5 of the Framework Convention of Tobacco Control treaty by World Health Organization (WHO) (WHO, 2015) which have been ratified by Malaysia. To make matters worse, EC trend has become a national concern where the outcome of the 10 country surveys shows that Malaysia had among the highest prevalence of current EC user at 14% compared to 9 other countries; UK, USA, Australia, China, Canada, Brazil, Mexico, Republic of Korea, and Netherland (Gravelly et al., 2014).

In addition, according to American Lung Association (2015), result from National Youth Tobacco Survey showed that there is an alarming increasing in the number of youth who have used EC but have never used conventional cigarettes was increase from 79,000 in 2011 to 263,000 in 2013. The usage of EC by non-smoker especially among youth could be gateway to the tobacco user and nicotine independence. Consequently, this can increase the number of EC user among smokers population.

Moreover, EC can be found sold exclusively in retail outlets such as small kiosk or via online because there is no specific clause of regulation have been made in Malaysia to ban the selling and purchasing of EC to any particular population group, unlike conventional cigarettes where it was placed under the Food Act 1983 as a regulation called The Control of Tobacco Product Regulation 2004 (Huap, 2015). Besides, the e-liquid use for EC was not manufactured by any tobacco or pharmaceutical companies (Maciej L. Goniewicz et al., 2013). Hence, the product of e-liquid were not tested by any authorised agencies such as Ministry of Health division or Food and Drug Agency (FDA) before being distributed to the consumer. Therefore, the ingredient of e-liquid especially that contain nicotine might not properly or have inaccurately labelled and the user of EC user is not well informed about the content of e-liquid whether it will cause health and safety risk or otherwise to them (Callahan-Lyon, 2014; Visser et al.,2015). Besides, due to no regulation related to EC manufacturer or suppliers have been enforced yet, there is no government set of standard for e-liquid in term of producing, packaging, selling

e-liquid in Malaysia. Consequently, e-liquid are not produced along typical standard imposed on nicotine delivery system unlike conventional cigarette, in which there is a maximum permitted level of nicotine which is 1.5 miligram (mg) for each stick of cigarette (British American Tobacco Malaysia, 2014). As such, the information on existing e-liquids in the market in terms of its labeling, content concentration, purities and packaging design are not available or if available it is inconsistent.

However, according to the American E-liquid Manufacturing Standard Association (2014), the maximum allowable nicotine content in final flavored product will be no greater than 36 mg / ml. The study done by Goniewicz et al. (2013) indicated that, 9 out of 20 cartridges analyzed in their study was differed from the labeled nicotine concentration and some was even exceeding a 20% difference from value declare by manufacturers.

According to Farsalino et al., (2014), the new generation of EC deliver nicotine to the bloodstream more effectively compared to the first generation of EC and give addictiveness effect to the user. Thus, the problem concern related to the usage of EC is an overdose of nicotine that might be associate with human health risk because nicotine is highly addictive substances that can be absorbed through skin, lung epithelium through respiration process and digestive organ (Farsalinos, Spyrou, Stefopoulos, & Tsimopoulou, 2015).

1.2 Study Justification

This study were performed to determine the prevalence of EC among adult smokers population in Universiti Putra Malaysia, Serdang, Selangor in order to determine whether the prevalence of EC usage is comparable to the prevalence at the national level. Recent reports have shown that approximately 21% of Malaysian adult are daily smokers and the current EC user consists of 8.7% of the adult's daily smoker population (Huap, 2015). The popularity of EC is especially among all age groups and conventional cigarette smokers have rapidly increased on a global scale (Centre for Disease Control & Prevention 2013; Pokhrel, 2014). From the Norwegian Institute Public Health (2015) assessment, it was indicated that mainly smokers and former smokers who have both tried and experienced the EC have become a regular EC user. However, there is also users who are using EC but was never smoker of any tobacco or cigarette product before they tried the EC. This study will be reveal the reason of using EC among current EC user that currently gaining wide popularity worldwide.

In Malaysia, there are still no published research involving the concentration of nicotine in local brands of e-liquid that are sold in the market. Thus, the analysis of the nicotine concentration in the local brands of e-liquids that commonly used by the EC user in this study are necessary in order to identify the consistency and accuracy of the nicotine content as stated in the packaging information. The nicotine concentration that was detected from the analysis was

used as information to perform assessment due to EC usage via Health Risk Assessment approach to characterize the non-cancer risk.

In addition due to no health data related to EC usage and contents especially in Malaysia, there are many who assumes the usage of EC are less harmful than conventional cigarette because EC mechanism involves heating a liquid amount rather than burning tobacco leaves. Based on the report from Public and Health England (2015), EC are 95% less harmful compared to conventional cigarette plus it was help in smoking cessation. It is necessity for this issue to be further studied so that there will be baseline information on this problem.

1.3 Definition of term

1.3.1 Adult

Conceptual : Adults were defined as people between 18 to 64 years of age (World Health Organisation, 2011). The adults can be categorised by age into young adult (18-35), middle age (36-55), older adult (aged older than 55 years).

Operational: Adult who are 18-64 range of age in Univesiti Putra Malaysia including staffs and students who fulfill the inclusive criteria which is male who are smokers, EC user and Malaysian citizen.

1.3.2 Current EC user (vapers)

Conceptual: According to Shiplo et. al., (2015), current EC user was defined as having tried an EC and having used one in the last 30 days.

Operational: Respondents was identified as current EC user when they used EC for the past 30 days based on the last date answered in questionnaire. The current EC user also were asked whether they used EC monthly, weekly or daily.

1.3.3 Nicotine in e-liquid

Conceptual: Nicotine is the highly addictive component found in conventional cigarette and EC (Williams, 2013). Nicotine in e-liquid consist of varying

concentration ranging from extra high (36 milligram per milliliters (mg/mL)), medium (12-16 mg/L) and none or free nicotine (0 mg/mL) (Wink, 2015).

Operational: Concentration of nicotine in e-liquid was determined by analysed top 17 brands of e-liquid used by the respondents using Gas Chromatography system. The concentrations of nicotine was measured in milligram per milliliters (mg/mL).

1.3.3 Health risk assessment (HRA)

Conceptual: HRA was defined as characterization of probability of potentially adverse health effect from human exposure to chemical and its relationship between exposure and dose. There are two form of HRA namely quantitative and qualitative health risk assessment (Department of Environment (DOE) Malaysia, 2012).

Operational: The quantitative health risk assessment was done by calculating the hazard quotient (HQ) to express the non-carcinogenic risk of nicotine. The HQ formula used is:

$$\text{Hazard Quotient (HQ)} = \frac{\text{ADD}}{\text{RfD}}$$

(Equation 1.1)

HQ = Hazard quotient

ADD = Average daily dose (mg/kg-day)

RfD = Reference Dose (mg/kg-day)

1.4 Conceptual Framework

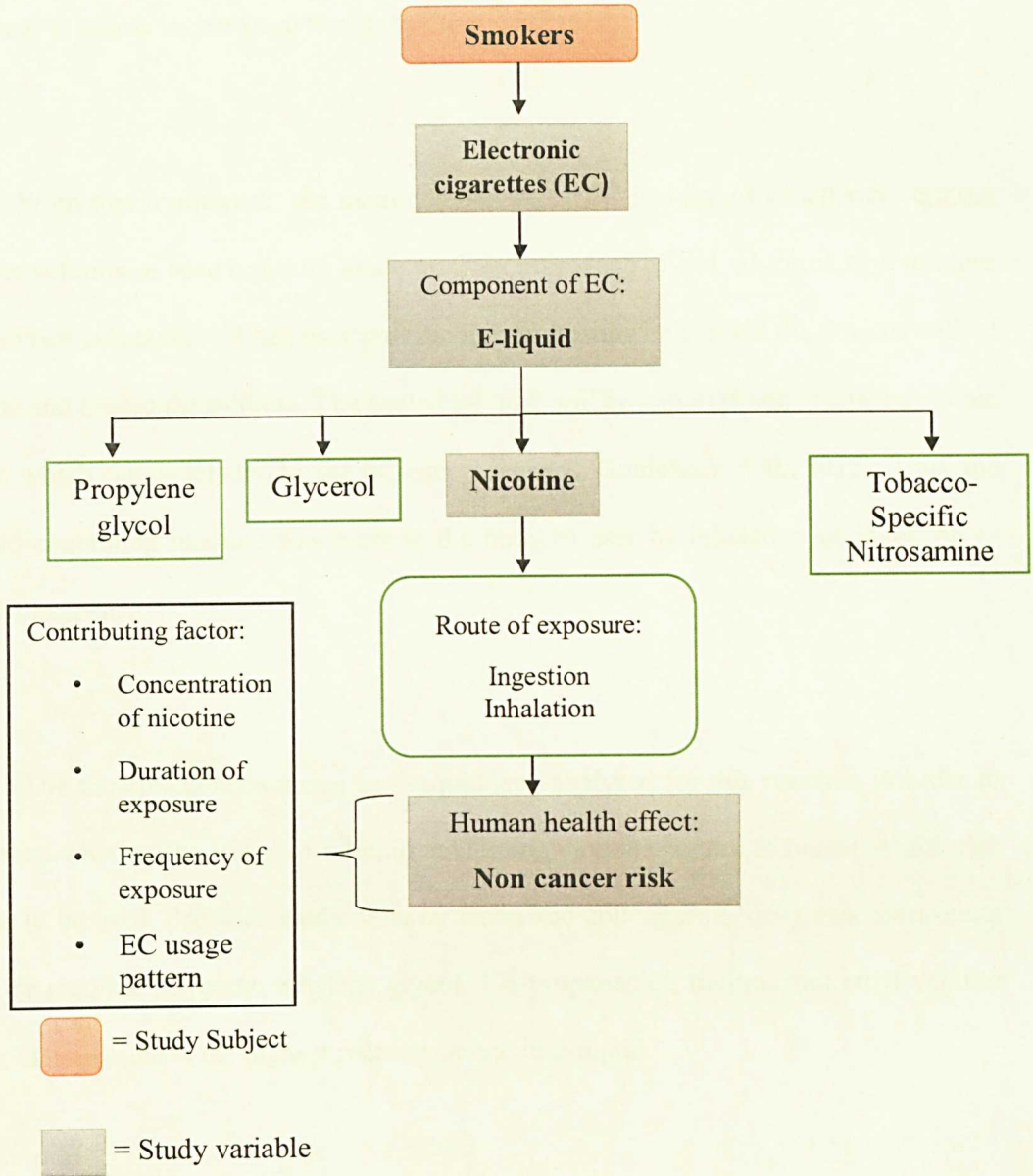


Figure 1.1 : The conceptual framework for the research

Figure 1.1 shows the conceptual framework of this research. The aim of this study is to determine the concentration of nicotine in different brands mostly used by adults in UPM and to assess its potential health risk to the EC user.

From this framework, the main component of EC is e-liquid which consists of a nicotine solution, a base typically made up from propylene glycol, glycerol, or a mixture of these two substances. When user puffs the EC the heating coil inside the device will be activated and heated the e-liquid. The heated e-liquid will be vaporized and create the visible vapour which can be inhaled by the EC user (Maciej L. Goniewicz et al., 2015). Thus, the e-liquid containing nicotine enters the body of user by inhalation or ingestion as route of exposure.

The nicotine concentration in e-liquid was analysed for this research in order to determine whether the usage of e-liquid containing nicotine is a pose to human health risk or safe to be used. Previous study done by Hahn and colleagues (2014), risk assessment done for nicotine, glycerol, ethylene glycol, 1-3-propanediol, thujone and ethyl vanillin shows that nicotine is the highest risk compound in e-liquid.

1.5 Objectives

In general, the objective of this study is to determine the concentration of nicotine in local brand of e-liquid and to assess its potential health risk among EC user in a higher learning institution center in Malaysia.

1.5.1 Specific Objectives

1. To determine the prevalence of EC user among male adult in UPM.
2. To determine the reason for the usage of e-cigarette and its association with vapers in UPM.
3. To determine the concentration of nicotine in the top local brands of e-liquid used among staffs and students in UPM.
4. To determine health risk associated with the use of EC among vapers in UPM.

1.6 Research question

1. Does the prevalence of vapers among staffs and students in Malaysia exceeds the national prevalence of EC user in Malaysia?
2. Does the level of nicotine in each of the e-liquid sample consistent with the labelling?
3. Does the usage of EC causes any potential non-carcinogenic health risk by the Vapers?

1.7 Hypothesis

1. There is association between most reported reasons for the usage of EC with vapers in UPM.

CHAPTER 2

LITERATURE REVIEW

2.1 Mechanism of EC

EC is a battery powered device that delivers a vaporized liquid nicotine solution in propylene glycol or glycerin without involve any combustion of tobacco leaves that can provide flavors and physical sensation similar as inhaled tobacco smoke (Maciej L. Goniewicz, Hajek, & McRobbie, 2014). The basic component comprise in EC aerosol generator, flow sensor, a battery, and e-liquid storage area or cartridge.

The EC operation start when the user puff on the EC to activate the airflow sensor. Then, the airflow sensor will detect the pressure changes and prompt the flow of power to light-emitting diode (LED) and the heating coil inside the devices was manually or automatically activated. The e-liquid was heated and aerosolised to create the visible vapor which can be inhaled by the user of devices (Brown & Cheng, 2014; Maciej L. Goniewicz et al., 2015). Even the EC comes with many design and brands the basic operation of the EC was the same.

2.2 Prevalence of EC user

The determination of prevalence will help to track use of EC over the time and may identify the use of EC in among people who non-smokers, current –smokers or stopped for more than a year. The user of EC have increased in number in many countries. Finding from two studies shows that Malaysia have highest percentage on current EC user. Data provided from the population-based Global Adult Tobacco Survey (GATS) conducted from 2011 to 2013 reported the prevalence of current EC users in four countries including Greece (2.2%), Qatar (1.8%), Malaysia (3.9%) and Indonesia (2.5%) with Malaysia being the country with the highest percentage of users. Similar to study done by Gravely and colleagues (2014), the Malaysia have highest number of EC current use which is 14% compared to Republic of Korea (7%), Australia (7%), United States (6%), United Kingdom (4%), Netherland (3%), Canada (1%), and China (0.5%).

Besides, there are many studies were done on prevalence of EC usage internationally. The users of EC have increased in numbers in many countries (Dawkins, Turner, Roberts, & Soar, n.d.). For example, data provided by ASH surveys demonstrated that 5.5% of adult population of England was used EC in 2015 and it was increased 0.5% of EC user from 2011. Others prevalence study done by Samantha and colleagues (2015) shows that, despite a ban of EC containing nicotine in Canada 0.3% of younger-nonsmokers, 18% from younger smokers, and 10% of older smokers was reported currently use EC containing nicotine.

2.3 Pattern use of EC usage

EC is the innovation of cigarette that gain popularity worldwide since it was introduced to the market especially among the youngest age group and there is increment on the usage of EC with regular cigarette (Norwegian Institute of Pulic Health, 2015).

There is study was reported that the user of EC among non-smokers in Canada is very low compared to the current smokers. The data provided shows current use of EC among current smokers is 15% while 1% were from non-smokers group. (Czoli, 2014). Similarly, the data provided by Action on Smoking and Health (2015) surveys reported the number of current smokers who use EC were rise from 2.7% in 2010 to 17.6% in 2014.

Study done on the use of EC among adults in Great Britain found that, currently most of the EC user were used second and third generation EC product which is rechargeable or refilled cartridge rather than first generation (disposable EC product) while for the flavour of EC solution or e-liquid, tobacco flavour is the most often use by the current vapers from the smokers group and was followed by fruity and menthol flavour (ASH, 2015).

Survey done by Etter (2010) on EC pattern usage found that, most of the EC user participated in his study using EC for slightly longer than three month and tooks about 157 puff per days. The number of puff per day reported by his respondents was 10 to 600 puff

per day in range. Even the number of puff produced by the EC user was substantial, the previous study show that EC deliver less nicotine per puff compared to conventional cigarette and produce less exposure towards nicotine where each puff of EC contain one third to one half nicotine in tobacco cigarette's puff (Laugesen, 2008).

2.4 Regulation toward EC

Regulation regarding to EC are not regulate yet in some countries. According to the Tobacco Atlas (2015), some of the countries was regulated the EC in different regulatory stance. For example, in European Union (EU) EC was regulate as part of EU Tobacco Product Directive where all ingredient used in manufacturing of EC required to be established and disclose and EC advertising are prohibited in this country. Besides, the ministry of health in France was proposed to ban EC use. Additionally, Unite Arab Emirates and Singapore was banned EC use and sales due to health concern.

In Malaysia, regulation regarding e-cigarette was in discussion status. The Ministry of health is in the process of determining the safety usage of e-cigarette. Scientific research need to be done thoroughly including the comparison between e-cigarette with conventional cigarette before any regulation was implemented. Currently, liquid nicotine is regulated under the 1952 Poisons Act and is scheduled under Group C of the poisons category (Huap, 2015).

2.5 Reason of EC usage

Interest of EC usage was rapidly increase recently among the smokers especially among youth and adult (Carroll Chapman & Wu, 2014; Li, Newcombe, & Walton, 2015). The manufacturers including tobacco companies was show their interest towards EC through rising number of vape shops and varieties of EC brands. A few studies was done reported that, most reason for use EC among adults who were ever-tried EC is curiosity (Li et al., 2015; Saddleson et al., 2015; Shiplo et al., 2015).

Besides, EC used was gained popularity among patient to aid in tobacco cessation even it was not clarified or tested scientifically by related agencies such as Food and Drug Administration (FDA)(Odum, O'Dell, & Schepers, 2012).

Others study done by Shiplo and his colleagues (2015), one of the reason usage of EC was help in smoking cessation and considered to be less harmful that conventional cigarette. The current user who are smoked conventional cigarette choose to use EC rather than prescribed medication like nicotine patches or lozenge to quit smoking.

In addition, study done by Farsalino et al., (2015), their finding on examined the reason for initiating EC use shows that reducing or quitting smoking for having healthy lifestyle gave the highest score for non-smoking vapers and dual user. While in term of economic reason where the user said EC is cheaper than conventional cigarette and

avoiding smoking ban in public area gave the lower score. Hence, vapers believes that EC helped them to quit smoking and vaping less harmful than smoking (J. F. Etter & Bullen, 2011).

2.6 E-liquid

Unlike conventional cigarette, e-cigarette does not involve the combustion of tobacco because it only heat liquid. Liquid or solution contain in e-cigarette are called e-liquid which generally consist of base made from propylene glycol, glycerin, nicotine and flavoring (Goniewicz et. al, 2015). Besides, e- liquid also have been detected contain tobacco-specific nitrosamine which classify as carcinogenic substances to human (Konstantinos & Polosa, 2014)

E-liquid comes in hundred varieties of brands and flavor that appear to target the user especially among youth. Previous study show until January 2014, there are about 7764 flavors was identified (Zhu et al., 2014) Survey Action on Smoking Health (ASH), (2015) shows that the most popular e-liquid flavor by smoker and ex-smoker was tobacco followed by fruit flavor and menthol flavor. In addition, e-liquid cost varies depending on quality and origin of manufactured. Generally, for imported brand of e-liquid which commonly manufactured from United state cost about RM 90 per 30 ml, whereas flavor manufactured locally in Malaysia usually cost about RM 30-RM60 per 30ml (Huap, 2015).

2.7 Nicotine

Nicotine is tertiary amine composed of a pyridine and a pyrrolidine ring (Benowitz, 1992). It was primarily psychoactive compound found in tobacco products and most addictive properties in tobacco use Nicotine was absorbed to the body through inhalation, ingestion or dermal route of exposure depending on the product used. Nicotine contain in the cigarette usually enter to the body through inhalation. When the smokers inhaled the cigarette, nicotine was absorbed into the pulmonary veins and distributed through the atrial circulation then finally diffused readily in brain tissue. (Benowitz, 2010).

Although nicotine is not categorized as a component which causes cancer, its exposure has been linked to addiction and other some acute health effects by the International Agency for Research Cancer (IARC) (2010). While in term of safety dose of nicotine, the lethal dose for adult is 60 mg while the ingestion of five cigarette or 10 ml of dilute- containing solution can kill an adult (Mayer, 2014).

2.8 Effect of nicotine on health

Most of the analysis of e-liquid that have been done by researcher was found that e-cigarette consist of nicotine (Stefanie et. al, 2015; Jason et. al, 2015; Hahn et. al, 2014). According to American Lung Association (2015), nicotine is an additive substance that can pose risk on human health effect such as exposure of nicotine during pregnancy can harms the fetus that lead to bad consequence on brain developing and lung function.

Nicotine gave acute health effect especially for smoking behavior such as increase heart rate, and cardiac contractility, constrict cutaneous and coronary blood vessels, and transiently increases blood pressure(Benowitz, 2010). However, nicotine also helps in improving psychomotor activity and cognition by stimulates rewarding effect such as pleasure, reduces stress and anxiety (Ng, 2015).

Previous study done by Sherwin and Carl (2015), the finding about comparison EC products and conventional cigarette product containing nicotine shows that both product has acute effect related to presence of nicotine. The cardiovascular response such as diastolic and systolic blood pressure and heart rate was increased after using the both product. However, the regular cigarette produce more effect compared to EC products.

2.9 E-liquid analysis

Most of the e-cigarette liquid or e-liquid composed of propylene glycol or glycerol, nicotine and flavoring agent. There are multiple method to identify and quantify nicotine using variety types of instruments. Previous study done to analyse the concentration of nicotine in EC liquid was used Gas Chromatography that was completely equipped with an Agilent Flame ionization detector (Herrington, Myers, & Rigdon, n.d.).

Besides, nicotine in e-liquid also can be analyse with gradient method by using Dionex Ultimet 3000 RS Ultra High Performance Liquid Chromatography. However, these methods are not suitable and valid to analyse e-liquid refill solution (J. F. Etter, Zather, & Svensson, 2013).

2.10 Health Risk Assessment (HRA)

HRA can be define as characterization of the probability adverse health effect in human who may be exposed to chemical either it can be beneficial or harmful when exposed. In general, HRA was used to determine if a particular chemical exposed to the human poses a significant risk to human health in certain condition such as carcinogenic or non-carcinogenic risk (California Environmental Protection Agency, 2000).

2.10.1 Health Risk Assessment studies on EC.

Rapid market of EC has called upon many researcher to study on the health implication from the EC usage such as detection of chemical hazards and risk assessment of the EC (Farsalinos & Polosa, 2014; Hutzler et al., 2014; Kienhuis et al., 2015; Varlet, Farsalinos, Augsburger, Thomas, & Etter, 2015).

A review studies done by Aziemah et al.,(2016) on health risk assessment related to EC revealed that, there is limited study was done regarding to HRA of EC. This study was reported that only four studies on HRA of EC had been performed. Study done by Farsalino et al.,(2015) was health risk of metal emitted from aerosol in 13 product of EC. This study reveal that metal emitted from to the aerosol are not likely to have significant adverse health effect to EC user.

Others study done by Hahn et al., (2014) on chemical composition and exposure estimation of EC shows that, nicotine was found as t high risk category compound e-liquid. This study was use Margin of Exposure (MOE) instead of using Hazard Quotient. The risk assessment shows nicotine MOE nicotine was range below 10 to 0.1. The MOE was interpreted as acceptable risk if above 10 and high risk when below 1.

2.11 EC as cessation tool of smoking

EC use was widely gaining popularity in term of usage especially among current conventional cigarette smoker and it has been touted as effective smoking cessation tools despite it was not being scientifically approved (Bullen et al., 2013; Odum et al., 2012).

Previous study on effectiveness EC as smoking cessation tools done by Siegel et al,(2011) shows that about more than two third participants in this study reported having reduce the number of tobacco cigarette smoked per day after trying an EC and there is respondent who are reported that they are successfully quit smoking after they trying using EC . In addition, other study was reported most of the smoker who participated in this study told that EC was help them to quit smoking and easy to abstain from smoking when they tried EC (J. F. Etter & Bullen, 2011). The policies and regulation should be implemented in order to prohibit the claims of EC as smoking cessation tools and effective method for quit smoking until scientific evidence was reveal (R Grana, Benowitz, & Glantz, 2013).

CHAPTER 3

METHODOLOGY

3.1 Study design

This research had been implemented with a cross-sectional study design to analyse the concentration of nicotine in local brands of e-liquid and assess the potential health risk on EC user among adults in Universiti Putra Malaysia. Data collection and laboratory analysis were performed between the months of January to May 2016. Prior to the commencement of this study, institutional ethics review board was obtained from the Universiti Putra Malaysia and respective permissions were gained before respondents were invited into this study.

3.2 Study Location

This research was conducted in University Putra Malaysia (UPM), Serdang Selangor. The respondents of this study was participated among the male staffs and students of UPM by answering the distributed questionnaire. Fourteen faculties that participated in this study were

- Faculty of Agriculture
- Faculty of Forestry
- Faculty of Engineering
- Faculty of Educational Studies

- Faculty of Food Science and Technology
- Faculty of Economics and Management
- Faculty of Design and Architecture
- Faculty of Medicine and Health Sciences
- Faculty of Computer Science and Information Technology
- Faculty of Environmental Studies
- Faculty of Human Ecology

3.3 Sampling

3.3.1 Sampling Population

The population of the respondents consist of the non-academic staff and students who are in the age range of 18-64 years old.

3.3.3 Study Sample

The study sample consist of male adult in UPM who are in the age range of 18 to 64 years old. The male adults was included the non-academic staff and students. The respondent of this study was involved who are conventional cigarette smokers and current EC user.

Inclusion criteria in this study were Malaysian adults who are aged above 18 years old, male, used to be conventional cigarette and EC smokers or currently still practicing

conventional and electronic cigarette. Exclusion criteria of this study was female staff and students and non-Malaysian.

3.3.4 Sample Size

Based on previous research, the reported prevalence of current EC user in Malaysia is 14% (Gravely et al., 2014). The study sample had been calculated based on the formula of Lemeshow, 1990 as the following:

$$N = \frac{Z_{1-\alpha/2}^2 P (1 - P)}{d^2}$$

(E.q 3.1)

Where,

N = Sample size

$Z_{1-\alpha/2} = 1.96$ (Standard error associated with confidence interval (95%))

P = Prevalence of current EC user in Malaysia (Gravely et al., 2014)

$d^2 =$ Desired precision (0.05)

$$N = \frac{1.96^2 0.14 (1 - 0.14)}{0.05^2}$$

$$N = 185$$

The total sample sized required according to sample size calculation for this study were 185 respondents. The questionnaires were distributed to the male non-academic staffs and students of UPM who are use conventional and electronic cigarette. However, due to the time constraints and lack of resources to reach these respondents, the response rate of the respondents in answering the questionnaires was only around 96% which were 179 respondents over 185 respondents supposedly.

3.3.5 Sampling method

Respondents were selected using purposive sampling method based on the inclusive criteria which is male adults who are in the age range above 18 years old and are smokers (conventional and electronic cigarette user). Female adults, and non-Malaysian was excluded from this study.

3.4 Study Instruments

3.4.1 Questionnaires

This study uses several tools for data collection, namely a modified questionnaire adapted from Etter, (2012) which were disseminated in a survey in order to obtain information on sociodemographic characteristics and reported history on smoking for both conventional cigarettes and EC, brands and flavors of EC used by respondents, duration of EC usage, frequency of EC usage and other relevant information such as the reason of

using EC. The questionnaires were prepared in Malay language and were self-administered to the respondents. To prepare the questionnaire, the items in the original questionnaire were back-to-back translated to the Malay language. Also, the questionnaire were pre-tested among 20 male adults, 10% of actual sample size before conducted the data collections. It was conducted at MARDI, Serdang and Makhostia Sdn. Bhd., Putrajaya. The pre-test was validated using Cronbach's Alpha which is the common type of intestinal consistency reliability. The Cronbach alpha value for pre-tested questionnaires was 0.96.

The standardized questionnaires disseminated to the respondents comprised of five parts:

- Part A : Socio-demographic Information
- Part B: Smoking Status
- Part C: Pattern of EC usage
- Part D: Reason of EC usage
- Part E: Effect of EC towards health and smoking habit

The sample of questionnaire can be referred in **APPENDIX 4**.

3.4.2 Gas Chromatography- Flame Ionisation Detector (GC-FID)

The following system was used to analyse sample of EC e-liquid nicotine concentration: an Agilent 6850N GC equipped with an Agilent Flame Ionisation Detector (FID) (Figure 3.1).



Figure 3.1: Gas-chromatography equipped with FID

The nicotine concentration was detected using GC-FID system based on retention time which is 12.38 minutes.

3.5 Study Ethics

This study was approved by the Ethic Committee for Research involving Human Subject (JKEUPM) [UPM/TNCPI/RMC/1.4.18.1 (JKEUPM)/F2]. The approval letter was attached in **APPENDIX 1**. A clear information indicating the research background and the purpose of the project was given to all respondents. Written consent were obtained from the respondent prior the study. The privacy of information gathered was protected at all phase of study. Subject Information Sheet and Consent Form was attached in **APPENDIX 2**.





3.6 Data Collection

3.6.1 Selection of samples

As this study involves the determination of the concentration of nicotine in local brands of e-liquid, the major e-liquids used among the respondents were identified from the questionnaire survey. The identified e-liquid samples were then purchased from the local vape shops around Seri Kembangan area. The e-liquid samples were categorized according to the flavor and were matched with the brands provided by the respondents. The e-liquid were categorized as the following: (I) Chocolate, (II) Mint/menthol, (III) Vanilla, (IV) Coffee, (V) Tobacco, (VI) Fruity, (VII) Creamy, (VIII) Cola, and (IX) '*sirap bandung*'.

All 17 samples (Table 3.1) of e-liquids purchased were stored in their closed original container at room temperature and were not exposed to sunlight prior to analysis, in order to minimize the risk of nicotine degradation (Varlet et al., 2015) The e-liquids samples were analyzed using an Agilent 6850N GC equipped with an Agilent Flame Ionisation Detector (FID) methods a week after being purchased in duplicates. The analyses of nicotine concentration in e-liquids were performed at the Chromatography Laboratory, Faculty of Food Science and Technology, Universiti Putra Malaysia.

Table 3.1 (a): List of brand's e-liquid samples and its category

Chocolate	
	
1. VaporBoy Cadburry	
Mint/Menthol	
	
2. Madhouz (Shiver)	3. Dr. Brew
Vanilla	
	
4. Caribbean	

Coffee



5. Starfcuks Coffee



6. Mixed Cream

Tobacco



7. Tobacco Lover

Fruity



8. AJ Vape
(Peach
Lemon)



9. Fcuking
Flava
(blue)



10. Horny
Mango



11. Mango Lassi

Creamy



12. Creamy Suckerz



13. Royal Juice Premium



14. Caribbean



15. Suck 'N' Puff

Cola



16. Fanta (Grape)

Sirap Bandung



17. Cloud Chaser (Sirap Bandung)

3.7 Sample Preparation

The method by Geiss *et. al* (2015) was applied for the determination of nicotine in e-liquid samples. E-liquid samples were diluted with five times dilution factors in *i*-propanol. 5 millilitres (5 mL) of e-liquid samples were collected from the container using pipetting technique to the 25 mL volumetric flask. The sample were then diluted for five times dilution factors with 60.10 M isopropyl alcohol. The samples were then shaken vigorously and transferred to the 1.5 mL Agilent vials. 1.0 microlitres (1.0 μ L) of each samples were injected using the GC-FID program. The parameter for 6890 GC methods were presented in Table (3.2).

Table 3.2: Agilent 6890 GC-FID Method

Agilent 6890 GC-FID	
Column	Capillary column, Agilent HP-624, 30m, length, 250 μ m diameter, 1.40 μ m thickness
Carrier Gas flow (Hydrogen) Makeup Gas type: Nitrogen	30.0 mL/minutes
Injector and detector temperature	250 $^{\circ}$ C
Oven	
Initial Temperature	100 $^{\circ}$ C
Maximum Temperature	260 $^{\circ}$ C
Total run time	22.00 minutes

3.8 Quality Control for GC-FID method analysis

For each batch of samples analysis, a method blank was carried throughout the entire sample preparation and analytical process. These blanks were useful for determining if the samples were contaminated and if there is carry over from previous injection. The blanks used for this analysis that is isopropanol alcohol was analysed with same method but without adding the sample. The GC-FID was calibrated with nicotine standard that had been serially diluted with isopropyl alcohol at a five-point calibration curve. Linearity of calibration curve for each sample was evaluated by the coefficient determination (R^2). Each brand of e-liquid samples was analyzed in duplicate in order to gain more precise estimation of the results. Figure 3.2 showed the calibration curve used to obtain nicotine concentration by using standard samples of nicotine within the range of 0.2 to 1.0 milligram per litre (mg/mL). The equation from the calibration curve was $y=0.7497x$, where 'y' represents the peak area of GC-FID and 'x' is the nicotine concentration. The five-point calibration curve showed good linearity over the concentration range from 0.2 to 1.0 mg/mL, where correlation coefficient was 0.9998.

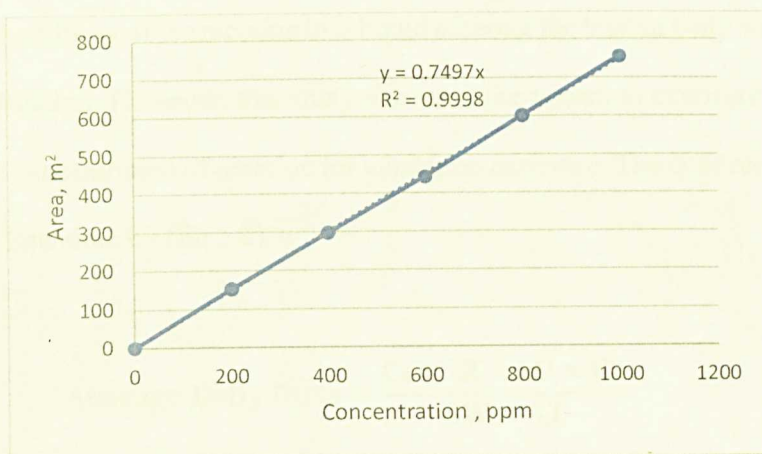


Figure 3.2 : Calibration Curve for Determination of Nicotine Concentration

All of the sample containers were washed using acid wash mixture with 37% of hydrochloric acid mixed with distilled ionization water. The sample container were soaked and left overnight in the acid wash solution to prevent any contamination from the previous samples preparation.

3.9 Quantitative Health Risk Assessment

Based on the results of the survey and analysis of nicotine in e-liquid, a Health Risk Assessment (HRA) using the method given by Environmental Protection Agency (EPA) was done. To predict risk assessment associated with the use of EC, HRA was performed by integrating data of nicotine concentration in e-liquid coupled with data on usage pattern of EC. For this study, Hazard Quotient (HQ) for each respondent was calculated to measure the possibility of non-carcinogenic health effects among the exposed respondents.

The major pathway of the nicotine in e-liquid entering the human body was through ingestion and inhalation. However, this study was used the ingestion exposure due to no data on reference concentration of nicotine for inhalation exposure. The dose received was calculated using Equation 3.2 (Eq.3.2)

$$\text{Average Daily Dose} = \frac{C_p \times IR \times ED \times EF}{BW \times AT}$$

(Eq.3.2)

Table 3.3: Interpretation of Average Daily Dose

Element	Symbol	References
Concentration of nicotine in e-liquid (mg/mL)	C _p	This Study
Ingestion Rate (mg/day): $\frac{\text{e - liquid intake per month (mL)}}{30 \text{ days}} \times \text{Concentration of nicotine } \left(\frac{\text{mg}}{\text{mL}}\right)$ <p style="text-align: right;">(Eq. 3.3)</p>	IR	This study
Exposure Duration (years)	ED	This study
Exposure Frequency (days): $\frac{\text{Frequency of using EC } \left(\frac{\text{day}}{\text{week}}\right) \times 52 \frac{\text{weeks}}{\text{year}} \times ED}{\text{Averaging Time } \left(\frac{\text{days}}{\text{year}}\right)}$ <p style="text-align: right;">(Eq. 3.4)</p>	EF	This study
Body Weight (kg)	BW	This study
Averaging time: $\frac{\text{Exposure Duration}}{365 \text{ days/year}}$ <p style="text-align: right;">(Eq. 3.5)</p>	AT	This study

After the ADD was calculated, a hazard quotient (HQ) based on non-cancer toxic risk calculated by dividing daily dose to a specific reference dose (RfD).

$$\text{Hazard Quotient (HQ)} = \frac{\text{ADD}}{\text{RfD}} \quad (\text{Eq.3.6})$$

Where,

HQ = Hazard quotient

ADD = Average daily dose (mg/kg-day)

RfD = Reference Dose (mg/kg-day)

The reference dose (RfD) for nicotine was 0.0008 mg/kg/day (European food Safety Authority, 2009). For the interpretation, if the calculated HQ was equal or less than 1, it indicates that there is no appreciable risk that non-cancer health effects will occur (USEPA, 2015). On the other hand, when HQ value was more than 1, it is believed that the exposed person/population would encounter non-carcinogenic health risk.

3.10 Statistical Analysis

Descriptive statistical analyses were used in this study to describe the socio-demographic information, prevalence of EC user, EC usage pattern and concentration of nicotine in 17 samples of e-liquid.

Categorical variable were tested for association between reasons of EC usage and Current EC user by using Chi-square analysis and were presented as frequencies and percentage. In this study p-value less than 0.05 was considered as statistically significant.

CHAPTER 4

RESULTS

4.1 Socio-demographic information of respondents

A total number of 179 respondents were participated in this study. The response rate for this study was 96%. The mean (standard deviation) age of respondents were 28.21 \pm 8.497 years. Majority of the participants who were involved in this study is within the age range of 18-24 years old (50.8%). This age group consisted mostly of undergraduate students. The respondents were mainly from the Malay ethnicity (97.2%), and had attained tertiary education level (68.7%). Majority of respondents are single (57.0%), and has a household income less than RM 2000 (38.5%). The socio-demographic information of respondents was summarized in Table 4.1.

Table 4.1: Socio-demographic characteristic of respondents

Variables	N	Percentage (%)	Mean±SD
Age (years) (N=179)			
18-24	91	50.8	
25-34	60	33.5	
35-44	15	8.4	28.21±8.497
45-54	9	5.0	
55-64	4	2.2	
Ethnicity (N=179)			
Malay	174	97.2	
Indian	2	1.1	
Chinese	2	1.1	
Others	1	0.6	
Educational level (N=179)			
UPSR & PMR	4	2.2	
SPM	51	28.5	
STPMDiploma	27	15.1	
Bachelor	96	53.6	
Master/PHD	1	0.6	
Marital Status (N=179)			
Single	102	57.0	
Married	74	41.3	
Single father/mother	3	1.7	
Householde income (RM) (N=143)			
<2000	69	38.5	
2000-3999	58	32.4	
>4000	16	8.9	

SD: Standard Deviation

4.2 Smoking status among male adults in UPM

The information on smoking status among respondents was obtained from the questionnaire and was recorded in Table 4.2. As shown in Table 4.2, 66.5% of the respondents reported conventional tobacco cigarette usage only. Dual-use of tobacco cigarette and EC was reported by 20.7% of smokers. Among all of the respondents, 16 (8.9%) respondents reported to no longer use conventional smokers but are currently using EC only. About 3.9% of the respondents reported the use of EC but have never smoke or tried any tobacco product or conventional cigarette before.

Table 4.2: Distribution of smoking status among respondents

Smoking Status (N= 179)	Frequency (%)
Tobacco cigarette smokers	119 (66.5)
Current conventional cigarette smokers and e-cigarette user (Dual user)	37 (20.7)
Former smoker who use e-cigarette	16 (8.9)
Non tobacco cigarette smoker who use e-cigarette (Vape only)	7 (3.9)

4.3 Prevalence of EC user among male adult in UPM

Prevalence for current EC users among adults in UPM is 36.9% that include occasional and daily usage of EC. The mean±standard deviation age group for the current EC users was 28±7 years old.

The finding of this study shows that 29.6% of EC user was reported as ever tried EC. The respondents said that currently they are not using e-cigarette but it was used in the past. The current EC users were higher than those who had ever-tried EC. Table 4.3 presents the prevalence of ever-tried EC and current EC user among respondents.

Table 4.3: Prevalence of ever-tried e-cigarette and current e-cigarette user among respondents

Characteristics (N=119)	Frequency (%)	Age Mean±SD
Ever-tried e-cigarette	53 (29.6)	25.91±7.00
Current e-cigarette user	66(36.9)	
• <i>Occasionally</i> (non-daily smokers)	39 (21.8)	28.41±9.59
• <i>Daily</i> (use e-cigarette for 7 days/week)	27 (15.1)	27.56±5.77

SD: Standard Deviation

Ever-tried e-cigarette: Respondents who are currently not using e-cigarette but had used it in the past.

4.4 Reason of usage EC among current EC user in UPM

For this study, the reason for usage of EC is shown in Table 4.4. The current EC user was categorized into non-dual user and dual user. Non-dual users are comprised of former smokers while for dual user, they are currently using EC and conventional cigarette at the same time.

The reasons 'to replace the conventional cigarette usage', 'EC act as nicotine reduction tools', 'to deal with craving for tobacco' and 'less toxic than conventional

cigarette' and 'to reduce tobacco consumption as preparation to quit smoking' has significant association with current EC user.

Table 4.4: Association of current EC user and reason of EC usage among user in UPM

Reasons		Current e-cigarette user		χ^2	p-value
		Non-dual user ¹ (=16) (%)	Dual user ² (N=37) (%)		
To replace the conventional cigarette usage	Yes	56.5	43.5	13.369	0.001*
	No	10.0	90.0		
E-cigarette act as nicotine reduction tools	Yes	55.6	44.4	8.322	0.010*
	No	17.1	82.9		
As enjoyment	Yes	40.0	60.0	0.965	0.342
	No	26.3	73.7		
To deal with craving for tobacco	Yes	56.5	43.5	13.369	0.001*
	No	10.0	90.0		
To quit smoking and avoid from relapsing to smoking	Yes	48.1	51.9	8.423	0.006*
	No	11.5	88.5		
E-cigarette less toxic than conventional cigarette	Yes	56.5	43.5	13.369	0.001*
	No	10.0	90.0		
To reduce tobacco consumption as preparation to quit smoking	Yes	42.9	57.1	4.520	0.041*
	No	16.0	84.0		

*Significant at p value less than 0.05

¹ Non- Dual user: Have only use e-cigarette (ex-conventional cigarette smokers)

² Dual user: Currently use both conventional cigarette and e-cigarette.

4.5 Flavors of e-liquid

The information about flavors of e-liquid was obtained based on the questionnaire distributed to the respondents. The flavors was categorized into nine category which are Vanilla, Fruits, Coffee, Creamy, Tobacco, Menthol, Cola, Chocolate, and *Sirap Bandung*. As shown in Table 4.5, most common flavor prefer by respondents were fruits (32.10%) followed by menthol (15.43%), Vanilla (14.20%) and Creamy (13.58%).

Table 4.5: Flavors and brands of e-liquid use by EC user in UPM

Flavors (N=162)	Frequency, (Percentage) (%)	Brands
Fruits	52 (32.10)	Mango Lassi AJ Vape Horny Mango Fcukin Flava
Vanilla	23 (14.2)	Caribbean Killer
Coffee	9 (5.56)	Starfcuk Coffee Mixed Cream
Creamy	22 (13.58)	PV juice Suck 'n' Puff Royal Juice premium Creamy Suckerz
Tobacco	7 (4.32)	Tobacco Lover
Menthol	25 (15.43)	Dr. Brew Shiver
Cola	9 (5.56)	Fanta
Chocolate	11 (6.79)	Cadbury VaporBoy
<i>Sirap Bandung</i>	4 (2.47)	Cloud Chaser

4.6 Pattern of EC usage among respondents

The information on pattern of EC usage among EC users in UPM was obtained from the questionnaire and was recorded in Table 4.6. In terms of number of puff produced per day by the EC user, the mean reported was 70.33 puffs per day. However there is one respondent who reported to produce 500 puffs per day. Most of the respondents reported take 30-60 ml of e-liquid per month where it was equivalent to one to two bottles of e-liquids per month. An e-liquid comes in a bottle of 30 ml size. The mean for quantity of e-liquid intake per month was 54.76 ml. About 56.7% of respondents used EC for less than one year for their entire life and most of them used EC for 6-7 days per week, which is almost every day. Mean for duration of EC usage and frequency of EC usage was 0.98 years 5.20 days respectively. This information obtained was to be used in the calculation of ingestion rate, exposure duration and exposure frequency for Health Risk Assessment.

Table 4.6: Pattern of EC usage among respondents

Pattern of e-cigarette usage	Frequency	Percentage (%)	Mean \pm SD
Number of puff (per day)			
Less than 50	37	61.7	70.33 \pm 88.75
50-100	7	11.7	
100-200	8	13.3	
300-400	3	5.0	
500-600	1	1.7	
Quantity of e-liquid per month (ml)			
5-25	12	20.0	54.76 \pm 41.76
30-60	33	55.0	
80-120	12	20.0	
150-120	1	1.7	
More than 200	1	1.7	
Duration of e-cigarette usage (years)			
Less than 1	34	56.7	0.98 \pm 1.03
1-2	21	35.0	
3-4	4	6.7	
More than 4	1	1.7	
Frequency of e-cigarette usage per week (days)			
Less than 2	12	20.0	5.20 \pm 2.2
3-5	15	25.0	
6-7	33	55.0	

SD: Standard Deviation

4.7 Determination of nicotine concentration in local brands of e-liquids

17 e-liquids were selected from the outcome of the survey. Analysis of nicotine in e-liquid was done in 17 brands of e-liquid that was purchased from local vape shops. The concentration on nicotine in local brands of e-liquid was summarized in Table 4.7.

Based on the calculation done for concentration of nicotine, the brands with the highest nicotine concentration of 5.15 mg/mL was found in Fanta brands which were categorized under Cola flavor. The lowest concentration detected among the 17 local brands of e-liquid was Starfcuk Coffee with concentration of 1.60 mg/mL. The mean of nicotine concentration was 3.26 mg/mL.

Table 4.7: Nicotine concentration in the top popular brands e-liquid used by male adult in UPM

Brands (N=17)	Category	Calculated Nicotine Concentration (mg/mL)	Labeled Nicotine Concentration (mg/mL)	Mean ± SD
Mixcream Cream	Coffee	1.80	0	
Tobacco Lover	Tobacco	3.48	0	
Starfeuk Coffee	Coffee	1.60	6	
Horny Mango	Fruity	2.38	6	
	<i>Sirap</i>			
Cloud Chaser	<i>Bandung</i>	3.26	6	
Cadbury vapor boy	Chocolate	3.62	6	3.26 ± 1.03
PV Juice Milk series	Creamy	3.55	6	
Suck and Puff	Creamy	3.65	6	
Creamy Suckerz	Creamy	3.99	6	
The Madhouz				
Shiver	Menthol	4.41	6	
AJ Vape	Fruity	2.07	NI	
Fcukin Flava	Fruity	2.48	NI	
Mango Lassi	Fruity	2.67	NI	
Dr. Brew	Menthol	2.45	NI	
Royal juice	Creamy	4.38	NI	
Caribbean killer	Vanilla	4.47	NI	
Fanta	Cola	5.15	NI	

NI: Not Indicated SD: Standard Deviation

4.8 Health Risk encountered by respondents from nicotine exposure through the usage of local brands of e-liquid

Based on the results of the survey and analysis of nicotine in e-liquid, the Health Risk Assessment (HRA) was done. For this study, Average Daily Dose (ADD) and Hazard Quotient (HQ) were calculated using (E.q 3.2) and (E.q 3.6) respectively to measure the possibility of non-carcinogenic health effects among the exposed respondents. The total nicotine intake was calculated and termed as ADD for non-carcinogenic risk. The elements needed for calculation of ADD was summarized in Table 4.10(a), (b), and (c). The mean for both ADD and HQ were 3.66×10^{-4} and 0.458 respectively. Results are shown in Table 4.8.

Table 4.8: Mean of Average Daily Dose and Hazard Quotient

	Minimum	Maximum	Mean \pm SD
Average Daily Dose (ADD) (mg/kg/day)	1.0×10^{-7}	4.92×10^{-3}	$3.66 \times 10^{-4} \pm 7.89 \times 10^{-4}$
Hazard quotient (HQ)	1.0×10^{-4}	6.1496	0.458 \pm 0.986

SD: Standard Deviation

This HRA was calculated individually among respondents who used local brands of e-liquid. As shown in Table 4.9, in general there were three respondents who reported having HQ more than 1 where it indicates that they would be exposed to non-carcinogenic health risk.

Table 4.9: Descriptive data for Hazard Quotient (HQ)

Hazard Quotient (HQ) Category (N=44)	Frequency (n)	Percentage (%)
HQ>1	3	6.8
HQ<1	41	93.2

Table 4.10 (a): Non Carcinogenic Health Risk Assessment for exposure among EC user towards nicotine in local brands of e-liquid

E-cigarette user (N=44)	Body weight (kg)	Concentration of nicotine (mg/mL)	Exposure duration (years)	Ingestion Rate (mg/day)	Exposure frequency (days)	Averaging Time (days)	Average Daily dose (mg/kg.day)	HQ
User 1	84	5.1468	1.1538	20.5792	1.4247	421.1538	4.92×10^{-3}	6.1519
User 2	84	4.3835	0.3077	1.4703	0.1425	112.3077	2.99×10^{-5}	0.0374
User 3	70	3.6468	2.0769	2.4302	0.9973	758.0769	3.46×10^{-4}	0.4324
User 4	70	3.6172	0.3846	7.2316	0.4274	140.3846	4.37×10^{-4}	0.5469
User 5	60	3.2610	1.000	10.8657	0.9973	365.000	1.61×10^{-3}	2.0169
User 6	72	3.2610	0.7692	6.5194	0.7123	280.7692	5.76×10^{-4}	0.7203
User 7	78	3.2610	0.3846	3.2597	0.9973	140.3846	3.72×10^{-4}	0.4654
User 8	90	2.6754	1.0000	10.6976	0.0192	365.0000	1.67×10^{-5}	0.0209
User 9	80	2.6754	2.0000	8.9147	0.2849	730.0000	2.33×10^{-4}	0.2909
User 10	91	2.6754	1.0000	2.6744	0.9973	365.0000	2.14×10^{-4}	0.2679
User 11	70	2.6754	0.6154	2.6744	0.7123	224.6154	1.99×10^{-4}	0.2493
User 12	46	2.6754	3.0000	2.6744	0.4274	1095.000	1.82×10^{-4}	0.2277
User 13	65	2.6754	1.0000	2.6744	0.2849	365.000	8.59×10^{-5}	0.1074
User 14	70	2.5278	0.9615	21.0567	0.8548	350.9615	1.78×10^{-3}	2.2259

Table 4.10(b): Non Carcinogenic Health Risk Assessment for exposure among EC user towards nicotine in local brands of e-liquid

E-cigarette user (N=44)	Body weight (kg)	Concentration of nicotine (mg/mL)	Exposure duration (years)	Ingestion Rate (mg/day)	Exposure frequency (days)	Averaging Time (days)	Average Daily dose (mg/kg.day)	HQ
User 15	85	2.5278	0.6731	2.1057	0.0326	245.6731	5.60×10^{-6}	0.0070
User 16	75	2.4767	1.5000	2.4757	0.7123	547.5000	1.60×10^{-4}	0.1994
User 17	56	2.4767	3.0000	2.4757	0.0192	1095.0000	5.80×10^{-6}	0.0072
User 18	60	2.4767	2.0000	0.4126	0.0164	730.0000	8.0×10^{-7}	0.0010
User 19	80	2.4767	0.6923	0.8252	0.2849	252.6923	1.99×10^{-5}	0.0249
User 20	72	2.4767	1.0769	4.9514	0.9973	393.0769	4.65×10^{-4}	0.5817
User 21	72	2.4767	1.0000	4.9514	0.0192	365.0000	8.90×10^{-6}	0.0112
User 22	98	2.4767	0.3077	2.4757	0.8548	112.3077	1.47×10^{-4}	0.1832
User 23	68	2.4767	1.0000	1.2379	0.4274	365.0000	5.28×10^{-5}	0.0660
User 24	58	2.4541	0.3077	2.4531	0.7123	112.3077	2.026×10^{-4}	0.2532
User 25	95	2.4541	6.0000	2.0443	0.0082	2190.0000	1.2×10^{-6}	0.0015
User 26	92	2.4541	0.4615	4.9062	0.9973	168.4615	3.576×10^{-4}	0.4467
User 27	59	2.4013	3.0000	4.0007	0.6137	1095.0000	2.737×10^{-4}	0.3422
User 28	71	2.4013	1.8462	4.0007	0.9973	673.8462	3.697×10^{-4}	0.4621
User 29	65	2.4013	0.5385	6.4011	0.9973	196.5385	6.461×10^{-4}	0.8076

Table 4.10(c): Non Carcinogenic Health Risk Assessment for exposure among EC user towards nicotine in local brands of e-liquid

E-cigarette user (N=44)	Body weight (kg)	Concentration of nicotine (mg/mL)	Exposure duration (years)	Ingestion Rate (mg/day)	Exposure frequency (days)	Averaging Time (days)	Average Daily dose (mg/kg.day)	HQ
User 30	100	2.4013	0.8462	3.2005	0.7123	308.8462	1.500×10^{-4}	0.1875
User 31	78	2.4013	1.0000	0.2400	0.0027	365.0000	1.00×10^{-7}	0.0001
User 32	70	2.4013	0.4615	2.8005	0.2849	168.4615	7.50×10^{-5}	0.0934
User 33	50	2.4013	1.0000	2.4004	0.2849	365.0000	9.00×10^{-5}	0.1125
User 34	120	2.3802	0.1346	7.1376	0.9973	49.1346	3.868×10^{-4}	0.4835
User 35	95	2.3802	0.2500	0.2379	0.1534	91.2500	2.50×10^{-6}	0.0031
User 36	70	2.0731	0.4615	5.5261	0.8548	168.4615	3.833×10^{-4}	0.4791
User 37	60	2.0731	0.3077	5.5261	0.4274	112.3077	2.236×10^{-4}	0.2795
User 38	83	2.0731	0.4615	4.1446	0.7123	168.4615	2.020×10^{-4}	0.2525
User 39	86	2.0731	0.6923	4.1446	0.7123	252.6923	1.950×10^{-4}	0.2437
User 40	82	2.0731	0.3846	4.1446	0.1425	140.3846	4.09×10^{-5}	0.0511
User 41	66	2.0731	0.2500	5.5261	0.1973	91.2500	9.38×10^{-5}	0.1173
User 42	70	2.0731	0.5000	2.0723	0.0115	182.5000	1.90×10^{-6}	0.0024
User 43	67	1.8011	1.0000	5.4012	0.9973	365.0000	3.96×10^{-4}	0.4958
User 44	90	1.6009	0.3462	3.2004	0.9973	126.3462	1.55×10^{-4}	0.1944

CHAPTER 5

DISCUSSION

In this study, male adults were chosen to participate in this study as a respondent while females were excluded. This is because female smoking prevalence is currently much lower than the prevalence of smoking among men, as is common in many South East Asian countries (G.Emmanuel Boisclair, Guindon, 2003). Based on Global Adults Tobacco Survey (2011), 4.7 million adult was currently smoked tobacco and comprised 43.9% of men, 1.0% of women. Additionally, it is difficult to reach female smokers because the norm of the Malaysian society is smoking was an unacceptable practice for a female. Even so, the prevalence of smoking among women is increasing, and the use of EC among women may likely have started to take up root.

In this study, the prevalence of current EC users among male adults in UPM were 36.9% which was performed among smoker population. The national studies done by Gravely and his colleagues (2014) showed current EC user in Malaysia was 14% which is three-fold lower compared to this study. However, the study by Gravely et al., (2014) was performed among smoking and non-smoking populations, unlike in this study. Compared with another previous study, the current finding indicates a higher prevalence in ever-tried EC user (Shiplo et al., 2015). In the present study most participants was young adults who are within the age range of 18-24 years old. Furthermore, most of the current EC users and those who ever-tried EC were within the age range of 18-24 years

old and could be contributing to the increasing prevalent of current EC users due to their interest in trying and using EC. Similarly, a previous study on EC use among adults in United States of America (USA) showed young adults were more likely to currently use EC compared to older adults (Schoenborn & Gindi, 2015).

Based on smoking status, a higher rate of current EC user was reported by current conventional cigarette smoker compared to those who were ex-tobacco smokers and never smoked any tobacco product before. Based on the survey done, this finding reveal that dual user reported that they like to use both conventional cigarette at the same time (45%) and use EC to help in reducing the tobacco consumption (40%). The most reported reason for the use of EC was related to cessation of smoking ('to replace the conventional cigarette usage', 'EC act as nicotine reduction tools', 'to deal with craving for tobacco', 'to reduce tobacco consumption as preparation to quit smoking' and 'less toxic') and has significant association with current EC user . Some of the reasons reported was similar to previous study done by Saddleson et. al (2015) such as 'enjoy to use EC', 'EC was less toxic than conventional cigarette', 'to deal craving with tobacco', 'to quit smoking and avoid from relapsing to smoking and ' to reduce tobacco consumption'.

A previous study have reported that EC helps in cutting down smoking habit or to help quit smoking altogether in which 46% of smokers who were vaping daily was successful after one year (J. F. Etter & Bullen, 2014). However, there is still lack of evidence and scientific tests done yet to claim EC as a smoking cessation device (Schroeder & Hoffman, 2014).

The flavours and brand of e-liquid was selected to be a sample based on the top choices by respondents from the questionnaire. This recent study show fruits flavor had highest demanding flavour choose by the EC user followed by menthol. This finding was consistent with previous study done by Shiplo and his colleagues (2015), where data provided show most e-liquid flavours used were fruits, menthol, tobacco and candy. The information obtain from the e-liquid seller and retailer, local brands of e-liquid mostly comprised of fruits and creamy flavours while least production of vanilla flavours was made in Malaysia.

The present study was found that there is variable nicotine concentration from different brands of e-liquid. The detected nicotine concentration from the analysis was different from what was claimed from the manufacturer. Most of the nicotine concentration was labeled as 6 mg, while the calculated nicotine concentration from less than 50% of the brands were lower than the labeled concentration. However, for Mixcream and Tobacco Lover brands that have been labeled as to contain 0 mg nicotine had nicotine detected in its contents with concentration of 1.80 and 3.48 mg/mL respectively. Furthermore, seven local brands of e-liquid does not have a label to indicate

the amount of nicotine concentration and only state in the ingredient as ‘contain nicotine’ and ‘may contain’ yet there were nicotine concentration detected for these products. Thus, this study revealed that nicotine was not accurately labeled on the e-liquid bottles.

Similarly, other study done to determine the nicotine level in refill EC solution found that there is significant difference between labeled and measured nicotine in refill EC solution (Maciej L. Goniewicz et al., 2013). In Malaysia, there still no regulation made related to the manufactured or production and distribution of e-liquid. Inconsistency of the e-liquid products especially in context of labeling arise because of no guideline was enforced for production of e-liquid unlike in other developed countries. In USA, there is standards for e-liquid production which were made in order to create a safe practice in the manufacturing of e-liquid used in EC (American E-liquid Manufacturing Standard Association, 2014). Additionally, in Malaysia nicotine are classified as a category C poison under the Malaysian Poison Act 1952 which means that nicotine and any product containing nicotine can only be dispensed by licensed personnel. As such, the selling of e-liquids containing nicotine in Malaysia needs to be regulated under the Malaysian Poison Act.

However, this study only selected the e-liquid brands based on the popularity among respondents who use local brands of e-liquid. Hence, this study is not comprehensive enough and were not able to verify whether the selected brands of e-liquid are also popular or mostly used by other EC user. Besides, not all brands of e-liquids used by the respondents were included in the analysis. Additionally, the nicotine concentration of a selected flavor was measured in a single bottle for each brand. Thus, future studies

should look at the consistency of nicotine concentration across batch of same brands and measure the health risk for all brands of e-liquid used by the EC user.

The mean ADD value for EC users did not exceed the acceptable daily intake (ADI) established by international risk assessment body (European Safety Authority, 2009). The ADI for nicotine is 8.0×10^{-4} mg/kg/day in order to avoid acute effects of nicotine. However, three respondents who had HQ more than 1, their ADD calculated exceeded the ADI value. The calculation for ADD takes into account six elements that are concentration of nicotine, ingestion rate, exposure duration, exposure frequency, respondent's body weight and averaging time.

According to the data for ADD parameter in Table 4.10 (a), (b), and (c), ingestion rate may contribute to the high value of ADD and hence causing the value of HQ to be more than 1. The ingestion rate refers to the rate of nicotine intake into the body in terms of mg/day. About 25% of the respondents in this study used 30 ml of e-liquid per month, which equals to one bottle of e-liquid. However, there is one respondent who used 250 ml of e-liquid per month (2.3%) where the intake of nicotine was about 20.58 mg/day. Respondents who used more e-liquid per month comprised of dual-users and used EC only. For dual-user they might be at risk to take more nicotine compared to those who use EC only. According to Mayer (2014), the lethal dose of nicotine for adult is 60 mg equivalent with ingestion of five cigarette or 10 ml of diluted-containing solution can kill an adult. Although nicotine is not categorized as a component that causes cancer, its exposure has been linked to extreme addiction and include for acute health effects in

reproductive and cardiovascular system by the International Agency for Research Cancer (IARC) (2010).

To the best of the authors' knowledge, there is no health risk assessment for exposure of nicotine of local brands e-liquid in Malaysia which has been performed. Besides, there is limited research regarding the health risk assessment arising from the usage of EC (Zulkifli et al., 2016). However, a study done by Hanh et. al. (2014) reported that nicotine is the highest risk compound in EC. For this study, they applied Margin of Exposure (MOEs) approach instead of Hazard Quotient where MOEs above 10 would be judged as acceptable while MOEs below 1 considered as high risk.

The present study is not comprehensive enough to represent the whole population in Malaysia with regards to the risk of developing non-carcinogenic health effects due to the limited number of e-liquids analysed and the limitation in the HRA calculation arising from this reason. Not all brands of e-liquids used by the respondents were included in the analysis.

CHAPTER 6

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

This study found prevalence of current EC user among male adults of smoking population in UPM were 36.9%. In addition, the most common reason for EC usage among current EC user in UPM was related to cessation of smoking which are ‘to replace the conventional cigarette usage’, ‘EC act as nicotine reduction tools’, ‘to deal with craving for tobacco’ and ‘EC was less toxic than conventional cigarette’. Generally, the concentration of nicotine in e-liquid was detected and it was not consistent with the labeling on the packaging. From the analysis, the brands that was labeled as to contain 0 mg nicotine contained nicotine at variable concentrations. Nicotine concentration was detected in the e-liquid brands with no labeling and information about the nicotine. The result in this study showed three out of 44 EC user had HQ of more than 1 where indicates that they would encounter non-carcinogenic health risk. The HQ was measured based on the usage pattern of EC among the respondents and concentration of nicotine detected from the analysis.

6.2 Recommendation

There are several limitations of this study that should be considered to improve on further research. First of all, participants in this study was not recruited through random sampling and did not involve non-smoking population. Thus is not representative of male adult population in UPM. For improvement on further research the participants should include the non-smoking and smoking population to represents the population.

As the concentration of nicotine in e-liquid was detected and it was not consistent and accurate with the labeling on the packaging. Hence, regulation of e-liquid containing nicotine should be enforced especially for accurate labeling and packaging of the products in order to prevent overdose consumption and acute health effect of nicotine to the EC user.

In addition, this present study only analyse e-liquid solution to quantify the concentration of nicotine for health risk assessment. As a suggestion, future study should analyse the nicotine concentration in the aerosol emission or vapour as well in order to determine nicotine concentration after heating and vaporization process.

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APPENDICES

Subject Information Sheet and Consent Form



**JAWATANKUASA ETIKA UNIVERSITI UNTUK
PENYELIDIKAN MELIBATKAN MANUSIA (JKEUPM)
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG,
SELANGOR, MALAYSIA**

BORANG B1: PENERANGAN DAN PERSETUJUAN RESPONDEN

Sila baca maklumat berikut dengan teliti. Sekiranya anda mempunyai sebarang pertanyaan, sila kemukakan kepada penyelidik.

1.TAJUK KAJIAN :

Penilaian risiko kesihatan terhadap nikotin didalam cecair rokok elektronik di kalangan pengguna rokok elektronik sekitar Universiti Putra Malaysia.

2.PENGENALAN:

Rokok elektronik adalah salah satu inovasi dalam produk rokok yang merupakan satu alat yang membekalkan dos nikotin dalam bentuk wap dengan memanaskan cecair campuran propylene glycol, glycerol, perasa makanan dan nikotin menjadikannya berbentuk wap dan disedut oleh pengguna. Kajian ini di jalankan bagi mengenal pasti risiko kesihatan terhadap penggunaan rokok elektronik. Kandungan nikotin di dalam cecair rokok eletronik akan diukur bagi memastikan kepekatan nikotin yang digunakan tidak melebihi kadar dos selamat yang ditetapkan.

3.APAKAH YANG PERLU ANDA LAKUKAN?

Anda diminta untuk menandatangani borang penerangan dan persetujuan responden sekiranya anda menyertai dalam kajian ini. Borang ini haruslah dikembalikan kepada penyelidik sebelum anda menjawab soal selidik berkaitan dengan kajian ini. Sekiranya terdapat sebarang kemusykilan, anda boleh meminta bantuan daripada penyelidik untuk penerangan yang lebih lanjut.

4.SIAPA YANG TIDAK BOLEH MENYERTAI KAJIAN INI?

Kajian ini tidak melibatkan mereka yang buta huruf dan bukan warganegara Malaysia.

5.APAKAH FAEDAH MENYERTAI KAJIAN INI?**a)KEPADA ANDA SEBAGAI PESERTA?**

Memberi kesedaran mengenai potensi risiko kesihatan terhdap penggunaan rokok elektronik

b)KEPADA PENYELIDIK?

9. PERSETUJUAN

Saya..... No Kad Pengenalan.....
beralamat.....
.....dengan ini bersetuju untuk mengambil bahagian secara sukarela dalam penyelidikan yang tersebut di atas *(kajian klinikal/percubaan ubat-ubatan/rakaman video/kumpulan sasaran/temuduga/ soal selidik).

Saya telah diberi penjelasan secara menyeluruh mengenai penyelidikan ini dari segi metodologi, risiko dan komplikasi (seperti tertulis pada Helaian Penerangan Responden). Saya memahami bahawa saya berhak menarik diri dari penyelidikan ini pada bila-bila masa tanpa memberi sebarang alasan. Saya juga memahami bahawa sebarang maklumat yang berkaitan identiti saya akan dirahsiakan.

Saya* berminat / tidak berminat untuk mengetahui keputusan kajian yang melibatkan saya.

I setuju/tidak bersetuju untuk imei/gambar/rakaman video/ rakaman suara digunakan dalam apa jua bentuk penerbitan atau pembentangan. (sekiranya berkaitan).

*potong yang tidak berkenaan

Tandatangan Tandatangan
(Responden) (Saksi)

Tarikh : Nama :
No. K/P:

Saya mengesahkan bahawa saya telah menerangkan kepada responden ini sifat dan tujuan penyelidikan yang tersebut di atas.

Tarikh Tandatangan
(Penyelidik)

Permission Letter to Conduct Survey

Ruj. Kami: UPM/FPSK/JKPP/600-3/1/6-EOH4999A&B
Tarikh: 7 JANUARI 2016

Dekan,
Fakulti Pertanian
Fakulti Perhutanan
Fakulti Perubatan Veterinar
Fakulti Ekonomi dan Pengurusan
Fakulti Kejuruteraan
Fakulti Pengajian Pendidikan
Fakulti Sains
Fakulti Sains dan Teknologi Makanan
Fakulti Ekologi Manusia
Fakulti Bahasa Moden dan Komunikasi
Fakulti Rekabentuk dan Senibina
Fakulti Perubatan dan Sains Kesihatan
Fakulti Sains Komputer dan Teknologi Maklumat
Fakulti Bioteknologi dan Sains Biomolekul
Fakulti Pengajian Alam Sekitar

Universiti Putra Malaysia,
43400 UPM Serdang,
Selangor Darul Ehsan

Tuan/Puan,

MEMOHON KEBENARAN UNTUK MENGEDARKAN BORANG KAJI SELIDIK DALAM KALANGAN STAF DAN PELAJAR UPM BAGI MENJALANKAN PENYELIDIKAN TAHUN AKHIR KURSUS EOH4999A&B (PROJEK ILMIAH TAHUN AKHIR)

Dengan hormatnya perkara di atas adalah dirujuk.

2. Sukacita dimaklumkan bahawa pelajar Tahun 4 program Bachelo Sains (Kesihatan Persekitaran dan Pekerjaan), Fakulti Perubatan dan Sains Kesihatan, UPM, ingin memohon kebenaran untuk mengedarkan borang kaji selidik mengenai corak penggunaan rokok elektronik dalam kalangan staf dan para pelajar Universiti Putra Malaysia (Pelajar Ijazah Sarjana Muda) bagi menjalankan Projek Ilmiah Tahun Akhir.

3. Tujuan Projek Ilmiah Tahun Akhir ini dijalankan adalah bagi memenuhi salah satu syarat untuk pelajar bergraduati. Bersama-sama ini dilampirkan maklumat lanjut pelajar yang akan menjalankan penyelidikan tersebut (**silalah rujuk LAMPIRAN I**). Untuk makluman pihak tuan/puan, pelajar tahun akhir ini telah mendapat kelulusan daripada Jawatankuasa Etika UPM (JKEUPM) bagi menjalankan penyelidikan.

LAMPIRAN I

Berikut adalah butir-butir pelajar dan Projek Ilmiah Tahun Akhir yang akan dijalankan:

1. Nama Pelajar : **Nur Fadhilah Binti Zulkipli**
No. Matrik/ Kad Pengenalan : 167762/ 930204-08-5968
Emel : dhila93@gmail.com
No. Tel./HP : 019-4212443
Tajuk Kajian : *Health Risk Assessment Of Propylene Glycol In E-Liquid Among E-Cigarette Users (Vapers) In Universiti Putra Malaysia.*
Tempoh Penyelidikan : **01/01/2016 hingga 31/04/2016**
Bahan Kajian : Borang Soal Selidik
No. Rujukan JKEUPM : FPSK (EXP15-OSH) U019

2. Nama Pelajar : **Zuraidah Binti Musbah**
No. Matrik/ Kad Pengenalan : 169356/ 920712-01-5588
Emel : zbm1207@yahoo.com
No. Tel./HP : 017-2718672
Tajuk Kajian : *Health Risk Assessment Of Nicotine In E-Liquid Among E-Cigarette Users (Vapers) In Universiti Putra Malaysia.*
Tempoh Penyelidikan : **01/01/2016 hingga 31/04/2016**
Bahan Kajian : Borang Soal Selidik
No. Rujukan JKEUPM : FPSK (EXP15-OSH) U018



JABATAN KESIHATAN PERSEKITARAN & PEKERJAAN
FAKULTI PERUBATAN DAN SAINS KESIHATAN
UNIVERSITI PUTRA MALAYSIA

**SOAL SELIDIK PENGGUNAAN ROKOK ELEKTRONIK DALAM KALANGAN
ORANG DEWASA DI UNIVERSITI PUTRA MALAYSIA.**

Adalah dimaklumkan bahawa satu kajian mengenai penggunaan rokok elektronik dalam kalangan orang dewasa yang berumur 18 tahun ke atas sedang dijalankan di sekitar Universiti Putra Malaysia. Sehubungan dengan itu, anda dijemput untuk menyertai kajian ini secara sukarela dengan menjawab beberapa soalan yang dikemukakan seperti arahan yang telah diberikan. Segala maklumat akan dirahsiakan dan hanya akan digunakan untuk kajian ini. Terima kasih di atas kerjasama yang diberikan.

Tarikh kajian:

ID

--	--	--

Responden:

KOD RESPONDEN ID:

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A: Ciri-ciri sosio-demografik responden

- 1.1 Jantina: Lelaki Perempuan
- 1.2 Etnik: Melayu Cina India Lain-lain
- 1.3 Umur: _____ Tahun
- 1.4 Berat badan (kg): _____ kilogram
- 1.5 Status perkahwinan; Bujang Berkahwin
 Ibu/bapa tunggal
- 1.6 Taraf pendidikan: UPSR PMR
 SPM STPM/setaraf
 Ijazah Sarjana/ Doktor falsafah
- 1.7 Pendapatan isi rumah (RM): _____ sebulan
- 1.8 Berapakah ahli rumah anda yang merokok (termasuk anda)?
_____ Orang

B: Status merokok

- 2.1 Adakah anda sekarang seorang perokok (rokok komersial)?
 Tidak, saya tidak pernah menjadi perokok
 Tidak, saya seorang bekas perokok
 Ya, kadang-kadang (bukan setiap hari)
 Ya, saya merokok setiap hari
- 2.2 Adakah anda merokok mana-mana produk tembakau (walau hanya satu sedutan rokok komersial) atau menggunakan rokok tidak berasap pada 7 hari yang lepas?
Tidak Ya
- 2.3 Dalam tempoh 31 hari yang lalu, berapa harikah anda merokok atau menggunakan rokok tidak berasap?
 hari/31 hari

- 2.4 Pada umur berapakah anda mula merokok?
_____ tahun
- 2.5 Adakah anda tahu mengenai rokok elektronik?
- Tidak, saya tidak pernah terbaca tentangnya dan tiada siapa yang memberitahu saya mengenainya.
 - Ya, saya terbaca sedikit mengenainya atau seseorang telah memberitahu mengenainya kepada saya.
 - Ya, saya diberitahu tentangnya, tetapi saya tidak pernah menggunakannya.
 - Ya, dan saya telah menggunakannya.
- 2.6 Adakah anda sekarang seorang pengguna rokok elektronik?
- Tidak, saya tidak pernah menggunakannya
 - Tidak, tetapi saya pernah menggunakannya dahulu.
 - Ya, kadang-kadang (bukan harian)
 - Ya, saya menggunakannya setiap hari
- 2.7 Pada masa akan datang, adakah anda bercadang untuk menggunakan rokok elektronik?
- Saya tidak tahu
 - Saya tidak bercadang untuk menggunakannya
 - Saya bercadang untuk menggunakannya
 - Saya bertekad untuk menggunakannya
- 2.8 Sebelum anda menjadi pengguna rokok elektronik, adakah anda seorang perokok (rokok konvensional)?
- Saya tidak pernah merokok
 - Saya seorang bekas perokok
 - Saya adalah perokok bukan harian
 - Saya adalah perokok harian

Soalan-soalan untuk perokok:

- 2.9 Pada masa sekarang, secara purata, berapa batang rokok yang anda hisap dalam sehari?
 Batang/sehari
- 3.0 Sila anggarkan kadar ketagihan anda kepada rokok dalam skala 0 hingga 10: (0=saya tidak langsung ketagih kepada rokok; 10=saya sangat ketagih kepada rokok)
 Skala
- 3.1 Jika anda pernah mencuba untuk berhenti merokok baru-baru ini;
- 3.1.1 Berapa lamakah tempoh masa yang paling pendek anda mampu bertahan untuk tidak merokok?
_____Jam/hari
- 3.1.2 Berapa lamakah tempoh masa yang paling panjang anda mampu bertahan untuk tidak merokok?
_____Jam/hari
- 3.2 Adakah anda sekarang mencuba untuk berhenti merokok?
 Tidak Ya
- 3.3 Adakah anda sekarang sedang mencuba untuk mengurangkan tabiat merokok anda?
 Tidak Ya
- 3.4 Adakah anda berniat untuk berhenti merokok?
 Saya tidak berniat untuk berhenti merokok
 Saya bercadang untuk berhenti merokok, tapi saya tidak menetapkan tarikh untuk saya berhenti merokok.
 Saya bercadang untuk berhenti merokok dalam tempoh 6 bulan dari sekarang
 Saya telah mengambil keputusan untuk berhenti merokok dalam tempoh 30 hari dari sekarang.

Saya telah mengambil keputusan untuk berhenti merokok serta-merta.

C: Corak penggunaan rokok elektronik (Soalan untuk pengguna rokok elektronik)

- 4.0 Bilakah kali pertama anda menggunakan rokok elektronik?
_____ Hari/bulan/tahun
- 4.1 Bilakah kali terakhir anda menggunakan rokok elektronik?
_____ Hari/bulan/tahun
- 4.2 Secara keseluruhan, sepanjang hidup anda, berapa lamakah anda telah menggunakan rokok elektronik?
_____ Minggu/bulan/tahun
- 4.3 Pada masa sekarang, berapa harikah dalam seminggu anda telah menggunakan rokok elektronik?
_____ Hari/seminggu
- 4.4 Pada masa sekarang, secara purata, berapa sedutan dalam sehari yang terhasil daripada rokok elektronik anda?
_____ Sedutan/ sehari
- 4.5 Pada masa sekarang, jenis rokok elektronik yang manakah anda gunakan?
 Rokok elektronik pakai buang (tidak boleh dicas semula)
 Rokok elektronik komersial (berserta bateri yang boleh dicas semula)
 Sistem modular (saya menggunakan gabungan alatan yang berasingan; bateri, atomizer, dan lain-lain)
- 4.6 Sila nyatakan jenama, model dan kualiti rokok elektronik yang anda sedang gunakan?
a) Jenama: _____ b) Model: _____
c) Kualiti:
 Sangat buruk Sederhana Buruk
 Sangat baik Baik
- 4.7 Berapakah harga rokok elektronik yang anda gunakan sekarang?
RM _____

4.8 Sila pilih jenis *catridge* rokok elektronik yang anda gunakan:

catridge yang sedia untuk digunakan

sistem tangki

titisan cecair

4.9 Sila nyatakan jenama e-liquid yang anda gunakan pada rokok elektronik anda?

4.10 Adakah e-liquid yang anda gunakan sekarang mengandungi kandungan nikotin?

saya tidak tahu (sila terus ke soalan 4.12)

tidak, ianya tidak mengandungi nikotin (sila terus ke soalan 4.12)

Ya, ianya mengandungi nikotin

4.11 Nyatakan kandungan nikotin di dalam e-liquid yang anda gunakan?

_____ mg/ml

4.12 Nyatakan kadar kepuasan penggunaan e-liquid yang anda gunakan pada rokok elektronik anda:

Sangat tidak berpuas hati

Berpuas hati

Tidak berpuas hati

Sangat berpuas hati

Neutral

4.13 Berapa banyakkah jenama e-liquid yang berbeza yang pernah anda gunakan?

_____ jenama

4.14 Sebulan yang lepas, adakah anda menggunakan jenama e-liquid yang sama seperti yang anda gunakan pada hari ini?

Tidak

Ya

4.15 Untuk *e-liquid* atau *catridge* rokok elektronik anda, perisa apakah yang anda selalu gunakan?

Tembakau

Pudina/menthol

Buah-buahan

Kopi

Vanilla

Coklat

Kanabis

Karamel/toffee

Kulit kayu manis

Alkohol

Bunga cengkih

Teh

Cola

Lain-lain _____

- 4.16 Apakah kesan penggunaan perisa *e-liquid* yang anda nyatakan diatas kepada tabiat merokok anda?
- Perisa ini tidak memberi kesan kepada tabiat merokok saya.
- Perisa ini mencetuskan keinginan saya untuk merokok.
- Perisa ini membantu saya untuk berhenti atau mengurangkan tabiat merokok.
- 4.17 Secara purata, berapa mililiter (ml) *e-liquid* yang anda gunakan dalam sebulan?
 _____ Mililiter (ml) sebulan
- 4.18 Adakah *e-liquid* atau *catridge* yang anda gunakan mengandungi kandungan bahan-bahan tersebut:
- Propylene glycol (PG)
- Vegetal glycerine (glycerol) (VG)
- Campuran kedua-dua bahan di atas
- 4.19 Kebiasaannya, berapa mililiter (ml) *e-liquid/catridge* yang anda gunakan pada rokok elektronik anda?
 _____ Mililiter (ml)
- 4.20 Pada masa sekarang, secara purata, berapa kali dalam sehari anda menambah kembali *e-liquid* / menukar *catridge* baru ke dalam *e-cigarette* anda?
 _____ Kali sehari
- 4.21 Secara purata, berapa sedutan yang mampu terhasil daripada satu *e-liquid/catridge* daripada rokok elektronik anda?
 _____ Sedutan
- 4.22 Kebiasaannya, berapa lamakah *e-liquid/catridge* rokok elektronik anda mampu bertahan sebelum anda perlu menambahkan/menukarkannya kepada yang baru?
 Selepas _____ minit sedutan
- 4.23 Kebiasaannya, berapa lama sedutan yang mampu terhasil sebelum *e-liquid* rokok elektronik anda perlu diisi semula?
E-liquidn akan ditukar selepas _____ jam sedutan

4.24 Kebiasaannya, secara purata, berapa jumlah sedutan yang mampu terhasil sebelum bateri rokok elektronik anda dicas semula?

_____ Sedutan per bateri

4.25 Kebiasaannya, secara purata, berapa lama bateri rokok elektronik anda mampu bertahan sebelum bateri rokok elektronik anda dicas semula?

_____ Jam sedutan

4.26 Dimanakah anda selalu mendapatkan/membeli rokok elektronik anda?

Internet

Farmasi

Kedai Serbaguna

Lain-

lain: _____

4.27 Berapa lama jangka masa anda bercadang untuk menggunakan rokok elektronik?

_____ Hari/minggu/bulan/tahun lagi

4.28 Adakah anda pernah menggunakan rokok elektronik dan rokok konvensional pada hari yang sama?

Tidak

Ya

4.29 Jika ya, sila tandakan sebab kenapa anda menggunakan rokok elektronik dan rokok komersial pada hari yang sama.

Sebab	Tidak	Ya
a) Untuk mengurangkan tabiat merokok		
b) Saya akan menggunakan rokok elektronik apabila berada dikawasan larangan merokok		
c) Kerana saya menyukai kedua-duanya		

4.30 Pernahkah anda mengubahsuai rokok elektronik anda?

Tidak

Ya

4.31 Pernahkah anda menukarkan bateri asal rokok elektronik anda dengan bateri lain yang berlainan jenis atau berbeza kapasiti (mAh)?

0 Tidak

1 Ya

D: Sebab penggunaan rokok elektronik

5.0 Apakah sebab anda memilih untuk menggunakan rokok elektronik?				
Saya memilih untuk menggunakan rokok elektronik kerana:	Tidak benar sama sekali	Sangat tidak benar	Agak benar	Sangat benar
a) Saya menikmatinya.				
b) Saya ingin mengatasi keinginan saya kepada tembakau.				
c) saya ingin berhenti merokok atau mengelak kembali merokok				
d) Pengaruh rakan sebaya				
e) Saya ingin mengatasi situasi dimana saya tidak boleh merokok dikawasan larangan merokok.				
f) Ingin mengelakkan daripada saya terpaksa keluar ke kawasan lain untuk merokok.				
g) Untuk mengelakkan gangguan asap rokok kepada orang lain disekeliling.				
h) Untuk mengurangkan tabiat merokok saya tanpa niat untuk berhenti merokok.				
i) Untuk mengurangkan tabiat merokok saya sebagai persediaan untuk berhenti merokok.				
j) Rokok elektronik kurang merbahaya kepada kesihatan berbanding rokok komersial.				
k) Ianya lebih murah berbanding rokok komersial.				
l) Kerana walaupun telah berusaha, saya masih belum dapat berhenti menggunakan rokok elektronik.				
m) Tidak selesa dengan bau asap rokok komersial.				
n) Semua cara berhenti merokok tidak berkesan.				
o) Untuk menggantikan rokok komersial.				

p) Kerana saya ada masalah kesihatan yang tidak membolehkan saya untuk merokok.				
q) Rokok elektronik adalah alat untuk mengurangkan pengambilan nikotin, secara beransur-ansur kepada 0mg nikotin				
r) Sebagai alat menggantikan rokok komersial dengan tidak berniat untuk berhenti mengambil nikotin				
s) Saya ketagih dengan rokok elektronik				
t) Saya ingin atasi masalah stress.				
u) Rokok elektronik membantu saya mengawal berat badan saya.				

E: Kesan penggunaan rokok elektronik terhadap kesihatan dan tabiat merokok

- 6.0 Adakah rokok elektronik membantu anda untuk berhenti merokok?
- Tidak, tidak sama sekali Ya, sedikit sebanyak
- Tidak, tidak banyak Ya, banyak
- Mungkin Ya, semestinya
- 6.1 Adakah rokok elektronik membantu anda untuk mengurangkan tabiat merokok?
- Tidak, tidak sama sekali Ya, sedikit sebanyak
- Tidak, tidak banyak Ya, banyak
- Mungkin Ya, semestinya
- 6.2 Adakah anda pernah menyarankan penggunaan rokok elektronik kepada orang lain? (ahli keluarga, rakan, rakan sekerja)?
- Tidak, tidak pernah Ya, kepada 3-5 orang
- Ya, kepada 1-2 orang Ya, kepada 6 dan lebih orang
- 6.3 Adakah anda berpuas hati dengan penggunaan rokok elektronik anda?
- Sangat tidak berpuas hati Berpuas hati
- Tidak berpuas hati Sangat berpuas hati

6.4 Adakah rokok elektronik menyebabkan iritasi (merengsakan) pada tekak anda?

Ianya tidak menyebabkan iritasi pada tekak saya

Ianya sedikit sebanyak menyebabkan iritasi pada tekak saya.

Ianya sangat menyebabkan iritasi pada tekak saya

6.5 Jika ya, adakah iritasi itu akan jadi teruk disebabkan oleh *e-liquid* yang mengandungi nikotin atau *e-liquid* tanpa nikotin?

Saya tidak dapat bezakan kedua-dua jenis ini (*e-liquid* yang mengandungi nikotin atau *e-liquid* tanpa nikotin)

E-liquid yang mengandungi nikotin

E-liquid tanpa nikotin

6.6 Jika ya, adakah iritasi itu akan jadi teruk apabila menggunakan *e-liquid* yang mengandungi propylene glycol (PG), *e-liquid* yang mengandungi vegetal glycerine/glycerol (VG) atau campuran?

E-liquid yang mengandungi propylene glycol (PG)

E-liquid yang mengandungi vegetal glycerine/glycerol (VG)

Campuran PG dan VG

6.7 Adakah rokok elektronik pernah menyebabkan anda hidung berdarah?

Tidak pernah

Ya, kerap

Ya, kadang-kadang

6.8 Sila nyatakan jika terdapat sebarang kesan kesihatan yang tidak diinginkan daripada penggunaan rokok elektronik anda?

Tiada

Ada, _____