

Smoking Cessation among Young Adult Dual Users of E-cigarettes and
Tobacco Cigarettes in a Mobile Phone Intervention: Analysis of
Data from a Randomized Controlled Trial

by

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Author's Declaration

I hereby declare that I am the sole author of the thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

Background

Dual-use of electronic (e-cigarettes) and tobacco cigarettes has increased in the past few years (Czoli et al., 2015) without evidence of it being effective as a smoking cessation aid (Manzoli et al., 2015). Understanding quitting tobacco use while using e-cigarettes continues to be a public health priority. There are limited studies, especially from Canada, that examine smoking abstinence among young adult e-cigarette users and non-users. This study examined the relationship between e-cigarette use and smoking cessation over a six-month period.

Methods

Secondary analysis of longitudinal data obtained from a randomized controlled trial survey for Crush the Crave (CTC), a smartphone-based cessation intervention, was conducted with a sample of 851 Canadian young adult smokers. Persistent e-cigarette use (within the trial) was defined as using e-cigarettes at both baseline and 6-month follow-up. Use of e-cigarettes only at baseline or at follow-up was defined as transient use. Non-users did not use e-cigarettes at either baseline or follow-up. People who ever used nicotine-containing e-cigarettes were also compared for 30 and 7-day point prevalence abstinence at 6 months. Socio-demographic, psychological and quit support usage predictors were also examined. Using logistic regression, odds ratios were calculated for the rates of cessation achieved for all e-cigarette user categories before and after controlling for potential confounders.

Results

Dual users who continued to smoke at 6-month follow-up survey (persistent e-cigarette users) had a lower 30-day cessation rate than transient or non-users (13% vs 23% and 29%, respectively). This was validated by the odds ratio, non-users being three times more likely to quit than persistent users, even after adjusting for other predictors (OR=3.2, 95% CI [1.41-7.40], $p<0.01$). Smokers with high self-efficacy were about twice as likely to quit than people with low efficacy (OR=1.92, 95% CI [1.14–3.21], $p<0.05$), even after adjusting for presumed causes of cessation. The majority of persistent e-cigarette users perceived e-cigarettes as a quit aid ($\chi^2=5.70$, $p<0.05$) and had high self-efficacy to quit at follow-up ($\chi^2=15.5$, $p<0.01$). No statistically significant results were found for other predictors.

Conclusion

Persistent use of e-cigarettes, across the course of study, was associated with a lower rate of smoking cessation while transient use of e-cigarettes and no use of e-cigarettes was associated with a higher rate of cessation for a young adult population of smokers intending to quit smoking.

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Dedication

My parents, my brother, my husband

and

The eternal memory of my beloved grandfather (Baba)

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List of Abbreviations

Abbreviations	Full Text
AOR	Adjusted Odds Ratio
CDC	Centers for Disease Control and Prevention
CONSORT-EHEALTH	Consolidated Standards of Reporting Trials of Electronic and Mobile Health Applications and Online TeleHealth
CPD	Cigarettes Per Day
CPTI	Countering Pro-Tobacco Influences
CTADS	Canadian Tobacco, Alcohol and Drugs Survey
CTC	Crush the Crave
EC	E-cigarettes
ENDS	Electronic Nicotine
FDA	Food and Drugs Act
FTCS	Federal Tobacco Control Strategy
FTND	Fagerström Test for Nicotine Dependence
GDP	Gross Domestic Product
HESA	House of Commons Standing Committee on Health, Environment, and Social Affairs
HPA	Healthcare Professional's Advice
HSI	Heaviness of Smoking Index
ITC	International Tobacco Control Policy Evaluation Project
mHealth	Mobile Health
NAQC	North American Quitline Consortium
NRT	Nicotine Replacement Products
OMSC	Ottawa Model for Smoking Cessation
OR	Odds Ratio
ORE	Office of Research Ethics
OTRU	Ontario Tobacco Research Unit
PROPEL	Propel Centre for Population Health Impact
RCT	Randomized Controlled Trial
SASEQ	Smoking Abstinence Self-efficacy Questionnaire
SCT	Social Cognitive Theory
SHS	Second Hand Smoke
SDH	Social Determinants of Health
SRNT	Society for Research on Nicotine and Tobacco
TPLR-CLC	The Tobacco Product Labeling Regulations (cigarettes and little cigars)
TTFC	Time to First Cigarette

Chapter I

Introduction

A. Tobacco use and control in Canada and Internationally

Despite ongoing efforts to lower smoking rates, tobacco use still remains a highly prevalent cause of death in Canada (Czoli et al., 2015; Government of Canada, 2017). Although overall rates of smoking cessation among ever users have changed from 52% in 2001 to 63% now, 4.6 million people still use tobacco, and amongst them, young adults (19-29 years) smoking at 20 percent prevalence still remains an important public health challenge (Government of Canada, 2014; Government of Canada, 2017). The detrimental effects of tobacco use have been widely seen, in the form of diseases such as cancers, respiratory illness and heart diseases (US Department of Health and Human Services, 2014), proportionately causing a huge national economic burden. Over 3% of Canadian and the USA annual gross domestic products (GDP) represent the total expenditure towards smoking-attributable diseases, which is just next to Europe, where the costs reach up to 3.6% of the total GDP (Goodchild, Nargis, & Tursan, 2017). The addictive power of nicotine poses barriers to smoking cessation and thus tobacco dependence has been considered a disorder that could be treated by a number of cessation support resources (Health Canada, 2012a). Currently, support is provided for people intending to quit in the form of pharmacotherapy, motivational therapies or health professional's advice (Saitta, Ferro, & Polosa, 2014). However, too often these interventions eventually lead to relapse and are, therefore, considered inefficacious in real-life settings (Casella, Caponnetto, & Polosa, 2010). Thus, the search for more effective alternatives for cessation and harm reduction from cigarette smoking remains necessary.

E-cigarettes have been claimed to be an effective alternative but are a source of considerable debate. Two knowledge synthesis projects were conducted in order to consolidate the research on e-cigarettes. The Clearing the Air Project, University of Victoria, and the Ontario Tobacco Research Unit (OTRU) both studied e-cigarettes as cessation aids, transitions in tobacco use, health effects, second-hand vapor and patterns of use (McDonald, O'Leary, Stockwell, & Reist, 2016; OTRU, 2016). Both projects conclude that further research is needed in areas of long-term health effects, and value as cessation aids, and that regulations should limit uptake by

youth while acknowledging their potential use in harm reduction and cessation programs. Dual-use has shown to reduce the number of cigarettes people use daily (Manzoli et al., 2016). However, additional health problems have also been attributed to the "dual-use" of tobacco products (Manzoli et al., 2015). Evidence suggests that dual-use is not associated with reducing smoking cessation rates (Zhuang, Cummins, Sun, & Zhu, 2016). The use of e-cigarettes (EC) may make people feel better. However, the research shows the opposite effect (Khoury et al., 2016; Stanbrook, 2016). Thus, complete cessation may not be considered by smokers and maintenance of cigarette smoking occurs.

Since 2001, Canada has taken a number of steps towards tobacco control through the Federal Tobacco Control Strategy (FTCS). It works towards the goals of prevention, protection, cessation and product regulation. The *Tobacco Act*, which came into effect in 1997, is the key measure of the FTCS which governs the sales, manufacturing, labeling, and promotion of tobacco products (Government of Canada, 2017). The Tobacco Control Directorate of the Healthy Environments and Consumer Safety Branch oversees the administration of the *Act* whereas the Regulatory Operations and Regions Branch manages the investigation issues (Government of Canada, 2017). In 2005, in response to the global tobacco epidemic, Canada collaborated with 179 other jurisdictions to form the World Health Organization Framework Convention on Tobacco Control (Government of Canada, 2017). Health Canada actively monitors tobacco manufacturers, importers, and retailers' compliance with the *Tobacco Act*. Health Canada is also responsible for enforcement activities, such as health warnings and labelling, based on the *Tobacco Products Labelling Regulations (Cigarettes and Little Cigars)* (2011) (Government of Canada, 2017). Canada has also provided the public with cessation support services such as the Quit4Life program and provincial and territorial quitlines (Government of Canada, 2015). Additionally, Health Canada supports a clinical model, known as Ottawa Model for Smoking Cessation (OMSC) in hospital settings. It works on the principles of identification, documentation, treatment (in the form of pharmacotherapy and counselling), follow-ups and referrals. OMSC shows a promising role in increasing cessation rates and has been adopted by 144 healthcare organizations between 2006 and 2012 (Ottawa Model, 2012). Since 2012, it has also been integrated into primary care settings.

Apart from Canada, more than 70 countries have national or federal laws regulating the sale, advertisement, promotion, sponsorship, taxation, use and classification of e-cigarettes (Institute for Global Tobacco Control, 2016). Of 71 countries, 56 have regulations that prohibit or restrict the sale of e-cigarettes; 18 countries regulate e-cigarettes as medicinal products; 26 countries regulate e-cigarettes as tobacco products; and, four countries regulate nicotine-containing e-cigarettes as poisons (Institute for Global Tobacco Control, 2016). Since 2016, the UK has introduced a regulation which licenses e-cigarettes as a medicine (Olov & Bridgman, 2014). However, Canada shows distinct features in marketing nicotine-free products and nicotine containing e-cigarette brands, at least when compared to the United States due to the latest policy framework (discussed further below) (Hammond et al., 2015).

B. Rise of electronic cigarettes

Over the past few years, the electronic cigarette market has seen an exponential growth. According to Euromonitor International, global e-cigarette sales reached \$6 billion USD in 2014, outweighing the market value of nicotine replacement therapy (NRT) products (Pepper & Brewer, 2013). Furthermore, the e-cigarette market is expected to exceed US\$23 billion by 2019 (MacGuill et al., 2014; Modi, Schmid, & Miller, 2013; Pepper & Brewer, 2013; Saitta et al., 2014). Analysts estimate that the e-cigarette market will grow larger than of the market for conventional cigarettes by 2023 (Herzog & Gerberi, 2013). Therefore, the government would benefit from evidence that would support their policy analyses as to whether Canadian policies should either promote, restrict or prohibit electronic cigarette markets.

E-cigarettes are a major cause of concern due to their high rates of use. Almost 20% of young adults, aged 20-24, have ever used or are currently using them (Czoli et al., 2015). There has been an ongoing debate concerning e-cigarette use and the growing number of dual users in Canada. Regardless of the absence of compelling evidence on their effectiveness (McRobbie, Bullen, Hartmann-Boyce, & Hajek, 2014) and absence of any examination of their long-term health effects (Grana, Benowitz, & Glantz, 2014), these devices are being sold in the markets as potential cessation aids and/or as safer alternatives to conventional tobacco (Adkison et al., 2013; Benowitz & Goniewicz, 2013; Centre for Disease Control, 2014; Czoli, Hammond, & White, 2014; King, Alam, Promoff, Arrazola, & Dube, 2013). Hence, EC's overall safety and its role in

smoking cessation is the topic of ongoing debate (Cobb, Byron, Abrams, & Shields, 2010) which needs further study.

According to 2013 Canadian Tobacco, Alcohol and Drugs Survey (CTADS) data, the majority (78%) of e-cigarette users also reported smoking tobacco cigarettes (Czoli et al., 2015). People, who otherwise might have quit, generally give preference to e-cigarette smoking (including in smoke-free places) leading to sustained smoking behavior (Grana et al., 2014). With age, the proportion of people using e-cigarettes has been found to increase (Czoli et al., 2015). Despite the high prevalence of dual-use in Canada, evidence regarding dual-use behaviors and their impact on cessation is very scarce. Some population surveys have been successful in examining e-cigarette use among Canadians (Czoli, Hammond, Reid, Cole, & Leatherdale, 2015; Hamilton, Ferrence, Boak, Schwartz, Mann, O'Connor & Adlaf, 2015; Hammond et al., 2015; Shiplo, Czoli, & Hammond, 2015). However, these studies did not examine the rates of cessation among dual users as a distinct category. For example, the International Tobacco Control Four-Country Survey 2010-2011 results from four different nations stated the reasons for e-cigarette use but did not consider dual-use as a separate group (Adkison et al., 2013). The extent to which "dual-use" of e-cigarettes leads to smoking cessation or support future smoking remains unclear.

C. Policy Context

Within Canada, several provinces have placed restrictions on e-cigarette use, while municipalities, local school boards and boards of health have enacted their own bylaws and regulations to address this issue. In effect of the recommendations provided by the House of Commons Standing Committee on Health, Environment, and Social Affairs (HESA) to amend the previous legislation or develop a new legislation altogether, the Bill S-5 was introduced in November 2016, which amends the *Tobacco Act* and *Non-Smoker's Health Act*, by prohibiting the sale of e-cigarettes or ENDS to minors (Norris, 2017). While Big Tobacco companies are promoting dual-use instead of harm reduction, the bill prohibits the promotion and advertising of flavored devices (Norris, 2017). The *Act* also mandates manufacturers to provide detailed information about the vaping products to the Minister of Health before selling them (Norris, 2017). Compared to the previous legislation, it imposes higher penalties for tobacco-related offences. Further, e-cigarettes are regulated by the *Food and Drugs Act* (FDA) and the *Food and Drug Regulations*, in a condition when the nicotine content is found to be more than the limit

specified by Health Canada, which is 4 mg per dosage unit (Health Canada, 2017). The new legislation also complements provincial regulations established across eight provinces (excluding Alberta and Saskatchewan) (Government of Canada, 2016b; Norris, 2017).

The purpose of this thesis was to use an available RCT data source which enrolled young adults through an online survey conducted across Canada to check for the effectiveness of a smartphone cessation application in smoking cessation (Baskerville et al., 2015). More specifically, this thesis focuses on understanding the differences in the rates of cessation achieved between dual users (consuming both e-cigarettes and conventional tobacco cigarettes) and non-users of e-cigarettes. Second, it was further designed to understand the relationship of cessation with e-cigarette use when other proximal and distal factors such as self-efficacy, the level of nicotine addiction, social norms, quit attempts, use of other cessation resources and other socio-demographics are taken into consideration. Bivariate and multivariable regression models were developed to examine the rates of smoking cessation among independent variable measures of e-cigarette use, nicotine containing e-cigarette use separately, and then subsequently including socio-demographic, psychological and quit supports usage characteristics.

The thesis is organized by first providing a brief review of what is currently known about e-cigarettes and dual-use and their relation to smoking cessation. Following that, the literature pertaining to other factors potentially causally associated with cessation is reviewed briefly. Based on the review of the literature, research questions are then outlined. Further, the methods used to answer the research questions will be explained. Results follow and the discussion section will summarize the findings, importance of the findings, and future directions.

Chapter II

Literature Review

E-cigarettes (ECs) are rising in popularity among smokers and may reinforce the concept of smoking (Chapman & Wakefield, 2013). However, the evidence that e-cigarettes could harm or help smokers quit smoking is not very well-established (Kandel et al, 2015). Despite the ongoing debate on e-cigarettes' effectiveness for cessation, not many studies provide compelling evidence (Malas et al., 2016; Manzoli et al., 2016). Based on 12 primarily moderate-to-weak quality reviews, there is a widespread view that ECs may be less harmful to smokers, but evidence in support of ECs as a smoking cessation aid is uncertain. The literature covered by these reviews is limited and of low quality, and authors caution about insufficient research on the efficacy of ECs in cessation (McRobbie et al., 2014). Evaluating potential long-term health effects of EC use is an important research priority (Andrade & Hastings, 2013; Environmental, Committee, & Committee, 2014).

A. E-cigarettes and dual-use

1. E-cigarettes

Electronic nicotine delivery systems (ENDS), popularly known as electronic cigarettes or e-cigarettes (ECs) are battery-operated products designed to deliver nicotine, flavor (for example; classic tobacco and menthol) or other chemicals such as propylene glycol and glycerine water, that are attached to a glowing light-emitting diode tip. These products work through an inhalation-activated system that heats a solution to create an inhalable aerosol, often known as vapor (McNeill et al., 2015; Pepper & Brewer, 2013). Alternatively, nicotine-free solutions are also available, known as 'e-liquid' or 'e-juice' (McNeill et al., 2015). E-cigarettes come in four different forms: mini or 'cig-a-like' that look like conventional cigarettes and can be disposed of or reused with disposable solution cartridges; mid-size or 'vape pen' which are recommended for heavy smokers; 'tank-style' e-cigarettes that are refillable with solution and do not resemble conventional cigarettes; and 'variable power EC' systems of variable appearance with user control to change the electronic output (Bass, 2016; McNeill et al., 2015).

E-cigarettes were first developed by a Chinese pharmacist, Hon Lik, in 2003 and their use rose globally after 2004. The disposable forms of EC first appeared in the Canadian market in 2007 (Torjesen, 2013) and following that, Health Canada in 2009 issued an advisory against the nicotine-containing products due to a lack of evidence to support the safety of the devices (Health Canada, 2009). ECs have been heralded by manufacturers and in advertising as a completely harmless alternative to smoking (Bass, 2016). The popularity of ECs as a smoking cessation aid rose during the periods when globally, only individual manufacturers of these new products were available (Hajek, Etter, Benowitz, Eissenberg, & McRobbie, 2014; McRobbie et al., 2014). Later the tobacco industry overtook independent stakeholders of ECs and developed their own patents (Kamerow, 2013). As compared to the US, the Canadian market excels in providing distinct varieties of nicotine-free products and many e-cigarette brands (Hammond et al., 2015) such as 'vapor' and 'South Beach Smoke'. Currently, e-cigarettes are being sold in Canada as a potential smoking cessation aid or as an alternative to smoking in restricted places such as restaurants, airports, public parks, patios etc. (Benowitz & Goniewicz, 2013; Henningfield & Zaatari, 2010; Volesky et al., 2016). Studies mention that e-cigarettes reinforce the attraction of cigarette smoking all over again due to various factors. Some of these influencers, in relation to ECs, include their enhanced appeal, exhalable vapor, frequent public display of the hand-to-mouth gestures, and risk associated nature (Chapman & Wakefield, 2013). These very cigarette-like factors permit users to mimic smokers, which is more than other cessation aids (Chapman & Wakefield, 2013).

In 2015, HESA released a health report, *Vaping: Towards a Regulatory Framework for E-cigarettes* that recommended the government to either amend the previous legislations or form a new legislation as the committee identified a lack of clear evidence around the health effects of ECs (Lobb, 2015). In effect of that, Bill S-5 was introduced in November 2016, to implement a policy framework for vaping products. The Bill proposes to amend the *Tobacco Act* and *Non-Smoker's Health Act*, by prohibiting the sale of e-cigarettes or ENDS to minors and prohibiting the promotion and advertising of flavored devices (Norris, 2017). In addition to that, the bill mandates manufacturers to provide detailed information about the vaping products to the Minister of Health before selling them (Norris, 2017). Compared to previous legislation, it imposes higher penalties for tobacco-related offences. Further, e-cigarettes are regulated by the

FDA and *the Food and Drug Regulations*, when the nicotine content is found to be more than the limit specified by Health Canada, which is 4 mg per dosage unit (Health Canada, 2017).

2. Dual-use of E-cigarettes and tobacco cigarettes

The Centers for Disease Control and Prevention (CDC) defines "dual-use" as the use of an additional tobacco product by someone intending to reduce cigarette consumption and harm to health (CDC, 2017). Data from the 2013 CTADS describe the prevalence of dual-use in the Canadian context. Dual-use appears to be common, given that the majority (78%) of e-cigarettes users also reported smoking tobacco cigarettes concurrently (Czoli et al, 2015). The proportion of dual users was lowest among youth aged 15-19 years (47%). The proportion of dual users generally increased with age: 79% of young adults aged 20-24, 78% of adults aged 25-44, and 89% of adults aged 45+ years were found to be using both the forms (Czoli et al, 2015). In addition to CTADS, the data from other population survey studies also highlight the simultaneous use of conventional cigarettes as being the most common behavior among young EC users (Czoli et al., 2015; Grana et al., 2014; Hamilton et al., 2015; Shiplo et al., 2015). However, these population studies did not examine smoking cessation behaviors among dual users as a distinct subpopulation.

A recent study suggests that ECs are not a substitute for cigarettes but a complement to smoking (Khoury et al., 2016; Stanbrook, 2016). The study found that the odds of EC use was 12-times higher for youth who smoked cigarettes. An International Tobacco Control Four-Country Survey from 2010-2011 reported rates of and reasons for use of e-cigarettes among former and current smokers, but their pooled results from across four countries' study population are not representative of Canada (Canada, the US, the United Kingdom, and Australia) (Adkison et al., 2013). Therefore, despite the high prevalence of dual-use in Canada and some potential evidence of greater EC use among tobacco smokers, evidence regarding dual-use behaviors and effectiveness of dual-use in smoking cessation is very scarce.

There are factors significantly associated with dual-use: education, the number of cigarettes smoked per day and some EC-associated factors such as product choice, EC consumption, reasons for usage and health risk perception (Farsalinos, Romagna, & Voudris, 2015). These factors causing dual-use are important issues that warrant public health attention

because of their potential to yield both positive (smoking reduction or cessation) and negative (delay of cessation) impacts (Benowitz & Goniewicz, 2013; Rass, Pacek, Johnson, & Johnson, 2015). One study found a positive association between rising dual-use and lower smoking cessation intentions that could further have implications for public health practice and cessation clinic services (Huang et al., 2016). Concerns have also been raised about dual-use exposing people to greater health risks, in the form of elevated nicotine levels in the body. A study established that both tobacco cigarette-only users and the dual users had similar levels of tobacco-specific N-nitrosamines (TSNAs), and volatile organic compounds (VOCs) signifying that there was no reduction in the levels of carcinogens and toxins among dual users (Shahab et al., 2017). It has been found that smokers like to maintain stable blood nicotine levels and hence takes nicotine from an alternative source, such as ECs, that might have the potential to reduce nicotine intake from cigarettes, followed by a reduction in smoke and toxin intake (Russell, 1990). Another study found an effective action of dual-use while assessing the biochemical changes, supported by the evidence of a significant decrease in cotinine and exhaled carbon monoxide levels (McRobbie et al., 2014). Apart from that, a prospective cohort study also found that e-cigarette use might benefit tobacco quitters to remain abstinent from smoking (Manzoli et al., 2016). Therefore, the research done so far suggests an ambivalent relationship between dual-use and smoking cessation.

3. Prevalence of dual-use in young adults

A smoking rate of 20% among young adults remains a public health challenge (Government of Canada, 2014). The proportion of dual users, who are both current cigarette users and e-cigarette users has been found to be 79% for young adults aged 20-24, higher than for youth aged 15-19 (47%), and adults aged 25-44 (78%) and lower than adults aged 45 and above (89%) (Czoli et al., 2015). Young adulthood deserve special attention because it is a period of risk as well as opportunity (Oesterle, 2013). In Canada, the young adult period begins for most with high school graduation around age 19 and lasts into the late 20s and early 30s. The transition of age from 19 to 29 years has been suggested, by many researchers, to have potential implications for health, well-being and quality of life in later adulthood (Arnett, 2000; George, 1993; Hogan & Astone, 1986; Macmillan & Eliason, 2003; Shanahan, 2000). People in transition age, generally continue and reinforce developmental and behavioral patterns already established in their early life (Elder

& Caspi, 1988). Alternatively, they could change from negative to more positive attitudes. There is also a chance of interrupting and disrupting a healthy life trajectory (Feinstein & Bynner, 2004; Schulenberg & Maggs, 2002). The success of early life preventive interventions may be crucial for later health and well-being, although very little is known about how to intervene during the transition to adulthood (Oesterle, 2013).

As an at-risk group, young adults might be exposed to various other addictions. A recent study found that dual users have a higher prevalence for other tobacco products as well, such as snus, chew or hookah (Cooper, Case, Loukas, Creamer, & Perry, 2011). The California Tobacco Control Program has rated the importance of adults as important role models in a youth's lives (Zhang, Cowling & Tang, 2010). Furthermore, adults are policy makers that determine community-wide exposure to second-hand smoke (SHS), tobacco industry promotions and the enforcement of laws (Zhang et al., 2010). As almost 79% of the young adult smokers in Canada are dual users, they likely need special attention and care, to prevent further increase.

4. E-cigarettes and Public Health

Public health policy makers need a clear understanding of both the positive and negative aspects of e-cigarettes so that interventions they apply can promote population health. Effective legislation and policies get impeded by the lack of empirical evidence to guide decision making. The potential positive effect of ECs is to decrease tobacco use and ultimately reduce the harm caused by tobacco chemicals. Few Cochrane reviews further assessed whether nicotine-containing ECs help smokers to stop smoking in the long run (more than six months) as compared to placebos (McNeill et al., 2015; McRobbie et al., 2014; Rahman, Hann, Wilson, Mnatzaganian, & Worrall-Carter, 2015). According to a 2015 Public Health England report, young adults' smoking rates have dropped, while the use of e-cigarettes has risen sharply among those trying to quit (35%). The report also predicts that by 2025, nicotine-containing ECs will make a significant impact in reducing the tobacco epidemic (Public Health England, 2015).

Considering the negative aspect, the public health is concerned about the increased risk of smoking initiation in e-cigarette users and nonsmokers who might later transition to dual-use or only cigarette use (Primack, Soneji, Stoolmiller, Fine, & Sargent, 2015). Canada has achieved some success in tobacco control efforts through “denormalization” of cigarette smoking, a

nationally recognized reason for the continued decrease in the smoking prevalence (Health Canada, 1999; U.S. Department of Health and Human Services, 2012). Nevertheless, the factors such as an increased social acceptability of e-cigarette, easy accessibility, the belief that ECs are safer than tobacco cigarettes, and a rising EC use could potentially lead to social “normalization” of smoking behaviours (Fairchild, Bayer, & Colgrove, 2014; Peters, Meshack, Lin, Hill, 2013). The association of ECs and normalization has been supported by a cross-sectional study that recognizes people's psychosocial environment, social acceptability of e-cigarettes (including friends' use and attitudes toward the use of e-cigarettes), to be strongly associated with cigarette smoking among never cigarette smokers (Barrington-Trimis et al., 2015). Additionally, EC's design mimicking conventional cigarettes might contribute to habitual smoking. An economically-oriented perspective still needs to be explored as to whether e-cigarettes need to be considered as a true substitute for cigarette use or as a complementary product (Doyle, Ronayne, & Sgroi, 2015). The extent to which e-cigarettes are substitutes or complements will have significant implications for the design and execution of public health policy.

Many researchers have explored the claims about the increased likelihood of tobacco smoking due to e-cigarette use (Bam et al., 2014; Dutra & Glantz, 2014). A recent causal hypothesis proposed that EC may act as a "catalyst" (Schneider & Diehl, 2015), supporting Kandel's hypothesis. E-cigarettes have been consolidated by some to be a mediator to nicotine addiction and subsequent cigarette use, either through a pharmacologic pathway, or one involving social renormalization (or both). This may apply to adolescents or young adults who may otherwise never have tried cigarettes (Barrington-Trimis et al., 2016; Bell & Keane, 2014; Kandel & Kandel, 2015). A cross-sectional study also showed that nonsmoking Canadian youth who use e-cigarettes have about twice the susceptibility to cigarette smoking when compared with youth who do not use ECs (Azagba, Baskerville, & Foley, 2017). However, no causal relations could be inferred from these studies. All of these debatable points raise important public health issues that need to be addressed.

The vulnerability of adolescent's developing brain to the negative effects of the nicotine neurotoxin and nicotine dependence is also an issue of concern (McRobbie et al., 2014; Walley & Jenssen, 2015). Findings from a recent study recognize that nearly half of the physicians are “somewhat” or “very uncomfortable” discussing ECs with their patients as an alternative to

tobacco and about one-fourth of them did not agree with the statement that “E-cigarette could be a gateway to other tobacco use” (Pepper, McRee, & Gilkey, 2014). EC screening is yet not a part of routine medical practice. The longitudinal evidence predicts that early emerging dependence symptoms in adolescence lead to a greater predisposition for continued smoking behavior in young adulthood (Bunnell et al., 2015). E-cigarettes might also increase the likelihood of relapse among former smokers, although no empirical evidence is currently available (Rass et al., 2015). Having a better understanding of the relationship between dual-use, i.e. e-cigarette use among smokers, and smoking cessation behaviours among adolescents and young adults can help inform FDA on e-cigarette's harmful effects on health and correct misperceptions about their role in smoking cessation and nicotine addiction, hence providing users with adequate cessation support services.

5. Harm reduction in Canada

Harm reduction is a public health strategy used to reduce the health risks associated with using nicotine (THRA, 2016). However, among adults, nicotine itself does not cause the harm (Olov & Bridgman, 2014). Harm reduction focuses on reducing or eliminating the use of combustible forms of tobacco by switching to other nicotine products, decreasing the amount of smoking, inducing temporary abstinence, while using alternative non-tobacco nicotine containing products (such as pharmaceutical NRTs or e-cigarettes), or switching to other smokeless products (THRA, 2016). Thus, harm reduction policies could help in reducing smoking rates which could result in a lower total population risk when compared with pursuing abstinence-only policies (NICE, 2013). It is widely acknowledged that an ideal pathway to tobacco harm reduction is smoking cessation. However, majority of the smoking cessation methods have been found to be unsuccessful, when used as directed (Nitzkin, 2014). Moreover, the majority of smokers are unwilling to quit completely (Rodu & Godshall, 2006). Harm reduction is likely of substantial benefit to these unwilling smokers and public health (Nitzkin, 2014; Olov & Bridgman, 2014).

Despite the fact that smoking prevalence in Canada has significantly decreased during the last 40 years, the magnitude of tobacco-related diseases indicates that new strategies to reduce smoking prevalence are greatly in need. The e-cigarette has the capability to be accepted as a harm reduction tool (Franck, Filion, Kimmelman, Grad, & Eisenberg, 2016). Apart from their

ability to deliver nicotine, they hold another "advantage" of being a close resemblance to conventional tobacco cigarette smoking (Franck et al., 2016). This additional "benefit" can be helpful in undoing the effects of psychological addiction (Anthopoulou, 2016). It has been predicted the use of e-cigarettes to substantially reduce tobacco-related illness resulting in an estimated 4.8 million saved lives in the next 20 years in the USA (Nitzkin, 2014). Thus, considering the potential of e-cigarettes as smoking cessation aids, the harmful effects of tobacco smoking and the need for new smoking strategies, it becomes imperative for the government to ascertain whether e-cigarettes are effective and safe for health (Anthopoulou, 2016).

In 2015, the report released by Public Health England suggests that e-cigarettes are 95% less harmful than smoking (McNeill et al., 2015). In addition to reducing harm, they focussed on EC use in leading a long-term goal of stopping smoking completely (McNeill et al., 2015). The report also promotes the use of e-cigarettes, NRTs, and other non-tobacco nicotine products in the best interests of public health. In Canada, the current electronic cigarette regulatory framework has been developed on weak grounds with no strong evidence on its long-term effectiveness. ECs are increasing in popularity, and there is a need for new tobacco harm reduction strategies and generation of integrated regulatory policies. E-cigarettes are widely used and the preliminary findings on safety and efficacy, in combination with the need for new tobacco harm reduction strategies, suggest that the investigation of e-cigarettes' potential as a smoking cessation aid is important (Anthopoulou, 2016).

B. Factors associated with successful cessation of tobacco use

1. Self-efficacy

The performance of a behavior that comprises of feelings, thoughts, and actions, are influenced by the perception of self-efficacy or simply "self-efficacy" (Bandura, 1986; Gandoy-Crego, Clemente, Gomez-Cantorna, Gonzalez-Rodriguez, & Reig-Botella, 2016). According to Bandura, self-efficacy is a personal assessment of one's ability to engage in a specific behavior in order to produce a favorable outcome (Bandura, 1978, 1997, 2004). It has been well established that high self-efficacy individuals succeed often in achieving intended outcomes, better than individuals with low self-efficacy (Mitchell, Hopper, Daniels, George-Falvy, & James, 1994). Other people's performance could aid in the vicarious development of high or low self-efficacy

(Redmond, 2016). For example in a smoking cessation program, people failing to quit undermines other participants' self-efficacy weakening their own chances of success (Redmond, 2016). The perception of self-efficacy facilitates cognition concerning one's own abilities, with thoughts acting as motivators of action. Finally, with regard to action, people who feel efficacious choose more challenging tasks, set higher goals, and persist more in their goals (Redmond, 2016). Social Cognitive Theory (SCT) emphasizes on the interaction of cognitive, behavioral, personal, and environmental factors to determine motivation and behavior (Crothers, Hughes, & Morine, 2008), as embodied in the Triadic Reciprocal Determinism model (Wood & Bandura, 1989). Self-efficacy, one of the processes under SCT, has been found to have an effect on motivation and goal attainment (Redmond, 2016). Apart from being related to quitting, self-efficacy for cessation and abstinence continuation has been linked to relapse behavior also (Shiffman et al., 2000). Due to the high influence of self-efficacy in various smoking cessation and relapse models, most cognitive-behavioural smoking cessation supports aim for increasing participant's self-efficacy (Model, 1999).

There are situations that lead people to smoke such as; when out with friends, while getting up in the morning, under situations of stress and anxiety, while drinking coffee or while talking, when in need of energy boost, when in anger, when in a company of a smoker (Etter, Bergman, Humair, & Perneger, 2000). Previous surveys have evaluated "how tempted" smokers were to smoke in each situation. The questions asked in the survey used the five-point scale, known as Smoking Abstinence Self-efficacy Questionnaire (SASEQ) which shows a high predictive validity (Bandura, 1997; Spek et al., 2013; Williams & Rhodes, 2016).

The likeliness of EC use as a smoking cessation aid depends on self-efficacy, smoking cues and people's beliefs about EC use as a smoking cessation aid (Sherratt, Newson, Marcus, Field, & Robinson, 2016). The concept of self-efficacy is an important psychological construct which is specifically relevant to smoking cessation as evaluated in previous studies. Due to this relevance, it becomes a unique aspect to be measured while conducting surveys. Previous studies, for instance, showed that smokers with high confidence in their ability to quit smoking are often more successful in cessation (Baldwin et al., 2006; Chouinard & Robichaud-Ekstrand, 2007). In addition, the studies on smoking cue reactivity and public service announcements, also acknowledge abstinence self-efficacy to be a predictor of smoking cessation (Gwaltney, Metrik,

& Shiffman, 2013; Lee, Cappella, Lerman, & Strasser, 2013). It has been found that exposure to certain smoking cues such as EC's advertisements might increase self-efficacy to quit smoking or continue abstaining, or on the contrary produce cravings for a tobacco cigarette (Maloney & Cappella, 2016). Further, a paper determined that the biggest reason for EC use among dual users in addiction treatment populations was its apparent use as a tool for cessation (Gubner, Le, Tajima, Andrews, & Passalacqua, 2015). However, this paper did not assess the level of addiction and self-efficacy of the people at the treatment center (Gubner et al., 2015). A recent study concluded that vapers were significantly more motivated to abstain from cigarettes and quit smoking than dual and cigarette-only users (Rüther et al., 2015). Hence, it can be seen that very limited studies provide evidence on the attitudes of dual, EC-only and non-EC users. On these grounds, the present work investigated the significant relationships between self-efficacy and smoking cessation.

2. Social norms, beliefs, and attitudes

Various studies have contributed evidence on societal norms, people's beliefs and attitudes regarding EC, dual and tobacco use. EC-only users were found to be more positively influenced by their social environment than dual users and non-EC users (Rüther et al., 2015). More friends, family, and colleagues preferred the use of EC rather than cigarettes (Rüther et al., 2015). A recent qualitative study analyzed the perceptions and beliefs of college students about smoking cessation in relation to e-cigarettes using verbatim transcripts and thematic analysis (Camenga et al., 2015). All the participants, regardless of age and smoking status, were aware that e-cigarettes could be used for smoking cessation. However, overall, participants did not regard EC to be a cessation promoter (Camenga et al., 2015). Maintenance of smoking actions, "healthier" alternative to cigarettes, and parental approval were described as a positive attribute while persistence of cravings and maintenance of addiction were regarded as negative attributes of EC's role in smoking cessation. Some college students expressed distrust of marketing of e-cigarettes for smoking cessation (Camenga et al., 2015). Future quantitative research is needed to determine the role of e-cigarettes for smoking cessation in this population. A study compared the strength of the relationship between the social norms, attitudes, and smoking behavioral outcomes (Zhang et al., 2010). The study included perceptions on second-hand smoke (SHS); on the basis of smoke-free worksites and the reasons of causing lung cancer and harm to children.

The study also included countering pro-tobacco influences (CPTI) norms such as bans in sports advertisement, ban on promotion item etc.. The results demonstrated a dose–response relationship with quit attempts (Zhang et al., 2010). The smokers who showed high values on both these constructs of SHS and CPTI were almost 70% more likely to make a quit attempt. Hence, it concluded that smokers with more positive attitudes towards CPTI and SHS reported more quit attempts and intentions (Zhang et al., 2010).

A qualitative study conducted among young straight-to-work young adults demonstrated the influence of family, friends, and society on e-cigarette use. Families encouraged e-cigarette smoking through positive comments and some parents preferred to offer e-cigarette to their young adult child in order to stop smoking (Cheney, Gowin, & Wann, 2016; Pokhrel, Herzog, Muranaka, Regmi, & Fagan, 2015). Friends also played a supportive role in young adult e-cigarette use by providing positive reinforcement, sharing and gifting them. Moreover, these young adults felt that they were viewed positively by others when they were using e-cigarettes (Cheney et al., 2016). Smokers commonly report smoking cigarettes as a means of coping with stress (Pokhrel et al., 2015). Dual users might prefer cigarettes over e-cigarettes to relieve stress due to the probable reason of cigarettes' better nicotine delivery efficiency (Pokhrel et al., 2015). Although the evidence does not hold much support. This qualitative study indicated that dual-use is influenced by certain activities such as during strong craving or need for stimulation (e.g., in response to stress) (Pokhrel et al., 2015). EC use was found to be more conducive to physical activity. Moreover, co-workers too were tolerant of other people's EC use (Pokhrel et al., 2015).

3. Level of addiction

The level of nicotine addiction or dependence holds a central role in tobacco use. Some strong measures have been used to predict the validity of this measurement strategy. One of them was developed by Fagerström and his colleagues. His initial attempt developing the Fagerström Tolerance Questionnaire was later converted into the Fagerström Test for Nicotine Dependence (FTND) (Heatherton, Kozlowski, Frecker, & Fagerström, 1991). Later research concluded that time to first cigarette (TTFC) and cigarettes per day (CPD) are the two measures that are most predictive of quitting outcomes (Baker et al., 2007; Borland, Yong, O'Connor, Hyland, & Thompson, 2010). The two measures have further been combined into an index known as Heaviness of Smoking Index (HSI) (Heatherton, Kozlowski, Frecker, Rickert, & Robinson,

1989). HSI was created from items 1 and 4 of FTND; namely, “How soon after you wake up do you smoke your first cigarette?” and “How many cigarettes do you smoke a day?” (Borland et al., 2010).

Early studies from 2007 demonstrated a release of very little nicotine from ECs, however, the newer generation ECs are showing higher plasma nicotine levels when used by experienced vapers, similar to cigarettes (Farsalinos et al., 2014). While comparing the practice of using ECs at baseline and 4-week follow-up, the overall nicotine intake was found to be increased by 79% (Hajek et al., 2015). These escalated nicotine levels might cause some concerns among researchers and health professionals. The literature describes the relationship between the level of addiction and quit attempts by measures of FTCD, HSI, and self-efficacy to stop smoking. A secondary data analysis was done amongst 864 highly dependent treatment-seeking smokers making a quit attempt (Michael Ussher, 2016). The assessment was done at 4, 6 and 48 months post-quit date for the continuous smoking abstinence (Ussher, Kakar, Hajek, & West, 2016). The results indicated that cigarette dependence, whether measured by the FTND, or by HSI or non-HSI components, significantly predicted transient and medium-term smoking abstinence and hence shows predictive validity (Borland & Cummings, 2008; Hyland et al., 2006; Ussher et al., 2016). Four of the studies provided evidence for a negative association between higher dependence and a quit attempt (Adkison et al., 2013; Hagimoto, Nakamura, Morita, Masui, & Oshima, 2010; Vangeli, Stapleton, Smit, Borland, & West, 2011; Zhou et al., 2009) while two of the UK studies that examined the influence of time to first cigarette did not show any relationship (West, McEwen, Bolling, & Owen, 2001). Dual users and e-cigarette only users indicated less craving for nicotine and dual users reported a higher level of addiction than conventional cigarette-only users on FTND scale (Rüther et al., 2015). In addition to the above evidence in support of level of addiction scale, a hardening hypothesis also supports evidence for EC use. This hypothesis states that when the smoking prevalence moves towards and below 10%, the remaining smokers become deeply addicted, and therefore, lose the abilities to stop smoking without moving into alternative forms of ‘clean’ nicotine addiction such as e-cigarettes (Chapman & Wakefield, 2013).

The total number of cigarettes smoked per day is a predictor of cessation, as stated before, and has been tested in various studies that established evidence for CPD changes among

EC users. Two studies reported a significant decline in the self-reported number of tobacco cigarettes smoked per day among dual users since the initiation of e-cigarette use. Etter and his colleagues found a CPD reduction from a mean of 23 to a mean of 9 and Farsalinos and colleagues found a reduction in median CPD reduction from 20 to 4 (Etter & Eissenberg, 2015; Farsalinos et al., 2015). Two US-based surveys reported changes in CPD among dual users since the initiation of e-cigarette user (Rass et al., 2015; Rutten et al., 2015). Both found a remarkable CPD reduction of 50% and 54%; no change was found in 45% and 41%; and only a few presented an increase in CPD (5% and 2%) in both studies (Rass et al., 2015; Rutten et al., 2015) with an additional 30% reduction in CPD median. Furthermore, among dual users sample, when compared to non-daily users, daily e-cigarette users had a greater reduction in CPD (Rass et al., 2015). Research evidence also shows specific patterns associated with frequency (Farsalinos et al., 2015). A daily intake and a higher frequency of ECs have been shown to be strongly associated with quitting when compared with the intermittent use of ECs similarly to any other therapeutic or substitute product (Biener & Hargraves, 2015; Siegel, Tanwar, & Wood, 2011). Moreover, TTFC has also been found to be helpful in evaluating the harm reduction associated with e-cigarette use (Dawkins, Turner, Roberts, & Soar, 2013). Thus, so far the literature focused on the level of addiction and CPD among EC-only users without considering the effects on dual users. Also, the effect of TTFC has only been studied for tobacco users and not among EC or dual users. This study investigated the relationships between the unexplored concepts.

4. Socio-demographics

The World Health Organization defines social determinants of health (SDH) as “the conditions in which people are born, grow, live, work and age” and “the fundamental drivers of these conditions” (Commission on Social Determinants of Health, 2008). In order to achieve equity and eliminate tobacco-related disparities, tobacco prevention and control approaches seek out for interventions that incorporate SDH. A substantial correlation exists between these social factors and health behaviours (Fuchs, 2017). A description of the research findings on the prevalence of EC use in different conditions and its relationship with cessation has been listed below.

a) Age

Young adults between the age group of 18-24 years were more likely to smoke ECs for a prolonged duration (26.5%), while those aged 25 and above were more likely to be non-users of ECs (40%) (Zhuang et al., 2016). Generally, the mean age to start smoking has been found to be 17 years among post treatment e-cigarette users and 18 years among non-EC users (Curry et al., 2017).

b) Gender

The rates of smoking cessation differ among males and females. The risk of mortality from the smoking-attributable diseases has been found to be more common among women (Thun et al., 2013). Moreover, women exhibit greater reluctance to quit than men (Smith et al, 2016). No significant differences have been found in EC use among Canadian males and females of age 15 years and above. The past 30-day use of e-cigarette was found to be the same for both groups (1.8% of Canadians for both sexes) (Czoli et al., 2015). The rate of ever-use of ECs was more for males (8.9%) as compared to females (8.1%). However, when calculated within age groups, more significant differences were found. For example, a higher prevalence was observed among males aged 15-19, and young adults of age 20-24 (23.9% and 24.5 % respectively) who had tried e-cigarettes, while only 15.5% and 15.6% of females in both age groups used ECs (Czoli et al., 2015). This difference could be due to the fact that men tend to engage in risky behaviors more than women (Harris, Jenkins, & Glaser, 2006). In contrast, a higher prevalence of EC use was observed among females of 25-44 years of age group. Dual-use of cigarettes and EC has also been found to be high, as stated earlier, 63.6% of ever-users and 77.7% of past 30-day EC user among young adults were found to be smoking tobacco cigarettes simultaneously; whereas only 15.5% of ever-users and 12.4% of past 30-day users were former cigarette smokers (Czoli et al., 2015). One of the recent studies show that women are more likely to be persistent EC users (51.5%) than men (48.5%), and less likely to be transient or non-users when compared to their male counterparts, however, no significant differences were found (Zhuang et al., 2016).

c) Marital Status

A recent study evaluated the odds ratio for the survey participants who were also smokers. 61.4% of the participants who considered ECs as harmless were married (Volesky et al., 2016).

Similar rates were found for the respondents who were not married. Therefore, more single and married people considered ECs to be harmless (Volesky et al., 2016). Whereas, an equal number of participants, who were either separated, divorced or widowed, agreed on both harmless and harmful perspective (Volesky et al., 2016). While considering the number of people using EC, a US-based study found less number of married people using it in the past 30 days when compared to others (Rigotti et al., 2015).

d) Education

In the aforementioned study, 67.9% of the participants who perceived EC as harmless and 64.5% who regarded EC use as harmful were post-secondary educated (Volesky et al., 2016). Thirty-two percent of the participants who were less than post-secondary educated, in contrast, regarded e-cigarettes to be harmless and 35.5% considered EC to be the likely cause of harm (Volesky et al., 2016). It was further demonstrated that 26.2% of the former smokers who also had ever used e-cigarettes were moderately educated (Czoli et al., 2014). The total number of people, who were both current smokers and ever users of ECs, with low education was found to be the highest, whereas the number was low for respondents with high education (Czoli et al., 2014). The US study established that 15.6% of educated people (with a college degree or more) had used EC in the past 30 days as compared to people with less than high-school education (10.2%) (Rigotti et al., 2015). Moreover, the people with lower education have lagged behind their higher education counterparts in cessation (Zhuang et al., 2015).

e) Income

The smoking rates have been found to be twice as high for the lower income groups as for the higher income groups in Canada (Government of Canada, 2016c). While looking at the perspectives, overall, 46% of the people who regarded ECs to be harmless were having a middle income range of \$40,000- \$79,000 followed by 38% with a high income of more than \$80,000 and 31% with an income of less than \$40,000 (Volesky et al., 2016). Similar rates were also found for the people with harmful perspective. However, the study captured smoking histories but did not assess current smoking status and thus the dual-use component was left unexplored (Volesky et al., 2016).

f) Occupation

Among people considering the harmless perspective, 15.7% were unemployed and 84.3% were employed, whereas among the people who regarded EC as causing deleterious effects, 17.2% were unemployed and the rest 82.8% were employed. Hence, from this study, it was established that more employed people think e-cigarettes to be a harmless alternative (Volesky et al., 2016). A report further declared that there is no relationship between income and the motivation for e-cigarette usage. All smokers as participants in the study had a mean household annual income of \$51,300 and 17.2% among them who were dual users had a mean household income of 48,200 (Doyle et al., 2015).

g) Ethnicity

The examination of the ethnic factors associated with EC awareness in a study sample found a less likelihood of EC awareness among non-White population (South Asian, Chinese, Black, Filipino, Latin American, Arab, Southeast Asian, West Asian, Korean, Japanese, Aboriginal or multiracial) when compared with White ethnic group's respondents (Shiplo et al., 2015). Ever and current use of EC among current smokers was found to be higher among White population groups than non-White groups (Czoli et al., 2014). Moreover, the percentage of people in the White ethnic population was also found to be high among the sample of former smokers who had ever used EC than current EC user (Czoli et al., 2014).

h) Region

According to 2013 tobacco use report, smoking rates reveal smoking prevalence of 11.4% in British Columbia and of nearly 20% in New Brunswick, Newfoundland & Labrador, and Nova Scotia (Reid et al., 2015). All provinces except Ontario and British Columbia had smoking rates above the national average of 14.6%. A significant difference was exhibited in ever users of ECs when categorized by province ($p < 0.01$) (Czoli et al., 2015). The prevalence range varies significantly from as low as 5.6% in Ontario to a high of 13.4% in Nova Scotia (Czoli et al., 2015). Use of e-cigarettes in the past 30 days does not vary remarkably.

C. Cessation interventions

1. E-cigarettes as cessation aids

ECs have potentially contrasting functions in controlling the rates of tobacco use. These functions could further be examined through the lens of cessation, prevention, protection, and industry interventions. This section will focus on the role and effectiveness of ECs in cigarette smoking cessation. The evidence is still premature regarding the overall potential risks and advantages associated with e-cigarettes. The safety concerns of ECs are still uncertain, and therefore, this fact should not be neglected. The currently available evidence suggests that ECs have around 4% of the relative harm of cigarettes overall (including social harm) and 5% of the harm to users (McNeill et al., 2015).

Two reviews give strong evidence in support of EC as a tool to stop smoking in the long-term (>6 months) compared to placebo as per a Cochrane review involving meta-analysis (McRobbie et al., 2014; Rahman et al., 2015). Seven percent of the smokers who used nicotine ECs were found to quit, in contrast to 6% of the smokers who used nicotine patch and 4% who used placebo ECs respectively. However, ECs are not as effective as nicotine patch (McRobbie et al., 2014). McRobbie and colleagues also established that ECs are responsible for reducing smoker's cigarette consumption by at least half when compared to placebo ECs (ECs without nicotine) (95% CI [1.02-1.68]) and nicotine patch. Another study also found ECs to be positively associated with smoking cessation (95% CI [0.11-0.28]) (Rahman et al., 2015). Individual studies within the remaining reviews reported similar findings (Hajek et al., 2014). Further, keeping in context the debate around ECs, a study found 54.8% of smokers who used ECs as a substitute were more likely to quit, whereas only 39.6% of the smokers quit who used ECs as a complementary aid (Doyle et al., 2015). In addition, the desire to smoke also decreased when ECs with or without nicotine were used (Gualano et al., 2015; Hajek et al., 2014).

There is evidence suggesting that smoking cessation might get impeded by the use of ECs. For instance, Grana and his colleagues claim that EC use is associated with significantly lower odds of quitting smoking (OR=0.61, 95% CI [0.50 to 0.75]) (Grana et al., 2014). The results are, in fact, different when following different approaches, especially with RCTs. The nicotine-containing ECs show more effect in cessation than placebo ECs, although inferior to

NRTs, while population studies suggest ECs decreasing the likelihood to quit smoking. Nonetheless, these contrasting studies had limited review of the literature and hence authors caution about insufficient research on the efficacy of e-cigarettes in smoking cessation. Other reviews were generally of moderate to poor quality and lacked appropriate evidence to prove EC's effectiveness (Grana et al., 2014; Gualano et al., 2015; Manzoli et al., 2015; Rahman et al., 2015). Thus, more literature review is needed to make definitive conclusions.

2. Other quit resources

Although e-cigarettes have not been approved by FDA as a smoking cessation aid, there are other approved safe and effective measures that could help people quit. Five types of nicotine replacement therapy such as patch, gum, lozenge, inhaler, nasal spray and two non-nicotine medications; bupropion and varenicline demonstrate healthy effects (CDC, 2017). Along with pharmacological interventions, individual, group, and telephone counseling have also been found to be effective in helping smokers quit (Perera & Lancaster, 2013; Stead & Lancaster, 2017; Ucar et al., 2014). While cessation counseling and FDA-approved cessation medications are each effective alone, they are even more effective when used in combination (CDC, 2017). Cessation counseling is available free through provincial quitlines (Government of Canada, 2015). Quit smoking medications may be available free or at a discount through provincial quitlines, health insurance agencies or clinics. 13 provincial and territorial health insurance plans cover quit-smoking treatments (Government of Canada, 2016a). While the coverage varies by state, all states cover some treatments for at least some enrollees.

The effect of a simple brief advice to tobacco smokers does not show a profound effect on cessation rates as found in a study (Stead, Bergson, & Lancaster, 2013). An additional 1 to 3 % increase of quitting was found if unassisted cessation rate of 2 to 3% is assumed (Stead et al., 2013). Follow-up visits also provide a beneficial effect on cessation rates (Stead et al., 2013). Therefore, more intensive counseling interventions are needed to support smokers. A qualitative analysis reveals some of the considerations of health care providers about e-cigarettes. The professionals see them as a substitute of one negative health behavior for another. The involvement of the healthcare providers to address EC use in preventive measures is thus important (Hiratsuka, Avey, Trinidad, Beans, & Robinson, 2015). The healthcare providers need to refocus their efforts on smoking cessation. Moreover, they are in an urgent need for answers to

the questions raised in favor or against EC use, in order to provide appropriate advice to people who smoke (McRobbie et al., 2014). In a recent research, it was found that most family physicians do not recommend ECs for cessation due to lack of evidence on the long and short-term impacts (Ofei-Dodoo, Kellerman, Nilsen, Nutting, & Lewis, 2017).

Other quit aids such as quit contests hold a promising role at an international level but lack a population-level impact (Cahill & Perera, 2008). Acupuncture, laser therapy have not been found to be associated with persistent cessation when compared to NRTs. Although they are popular interventions and safe when correctly applied. However, they show a low success rate in quitting when compared with other evidence-based interventions (White, Rampes, Liu, Stead, & Campbell, 2014).

3. Mobile interventions

Many studies have successfully evaluated the role of mobile phone-based technologies in supporting smoking cessation. However, most of this evidence did not consider mobile phone application rather was limited to evaluating the efficacy of mobile phone SMS text messaging interventions for smoking cessation (Ghorai et al., 2014). Young adults, in fact, have reported an interest in more intense mobile-based smoking cessation interventions, such as smart-phone applications (apps), compared to other text messages (Naughton et al., 2013; Ybarra et al., 2014). Smart-phone apps have the ability to enrich the user experience with more information, components, and functionality (Bindhim et al., 2014). Moreover, smoking cessation smart-phone apps now have enormous reach compared to quit lines and SMS text messaging interventions (Bricker et al., 2014). A high acceptance rate of mobile application in smoking cessation has been identified among hospital patients (Finkelstein & Cha, 2016). For these reasons, exploring the effectiveness of smart-phone apps is critical. Only two RCTs were found to evaluate the efficacy of a smoking cessation mobile phone app. One of them compared a mobile phone application to an SMS text messaging intervention for smoking cessation (Baskerville et al., 2015). One of the factors that are encouraging young adults to use e-cigarettes is the popular electronic technology (Stanbrook, 2016). The same factor could be attributed to the increased use of smart-phones. Over 90% of the American young adult population own a smart-phone (Smith, 2015). The CTC study is one of the first studies that conducted a rigorous evaluation of the effect of a smart-phone cessation application on smoking cessation, among a large sample of young

adult smokers (Whittaker, McRobbie, Bullen, Rodgers, & Gu, 2016). The present study, therefore, would be the first to analyze this rich data with a purpose to achieve the dual user's patterns of cessation. Further, no study evaluated the smart-phone application data set to describe dual or e-cigarette user's smoking cessation patterns. The present study, therefore, determined the prospects mobile applications hold in quitting smoking among dual users of both e-cigarette and conventional tobacco cigarettes.

Chapter III

Study Rationale and Research Questions

Dual-use of ECs and tobacco cigarettes has been found to be common in population studies (Czoli et al., 2015; Shiplo et al., 2015). However, they lacked a comparison group of non-EC, transient and persistent EC users. They also did not consider these groups as a distinct subpopulation. In addition to that, not many studies have explored the impact of prolonged EC use on smoking cessation. Overall, 79% of young adult smokers, of 19-29 years of age, are dual users (Czoli et al., 2015). This transitional age to adulthood needs further research to target adequate opportunities for preventive actions. The extent to which e-cigarettes could function as substitutes or complements will have significant implications for the design and execution of policy. Moreover, ECs in studies have been associated with a major challenge of tobacco harm reduction (Anthopoulou, 2016). Studies conclude that almost 90% of the smoking cessation methods turn out unsuccessful when used as directed (Nitzkin, 2014).

Additionally, not much attention has been given to understanding the motivational factors, such as social norms, attitudes, self-efficacy, nicotine addiction and cessation support services in relation to dual-use and no EC use. The present study, therefore, aided in filling the gaps in literature by finding the odds of cessation among these groups and describing the role of dual-use in smoking cessation, providing policy makers with a supplement on current premature evidence on this controversial issue.

The methods chapter discusses the appropriate methodology employed in the study. Following that, the results chapter presents the findings of the data analysis. For consistency, the research questions were examined in the order given below throughout this dissertation mainly focussing on the 30-day cessation outcome. Last, the discussion chapter examines the results while making comparisons with previous studies and explains benefits and limitations of the study, suggests recommendations for future and provides a final conclusion. The words, 'abstinence' and 'cessation' have been used interchangeably to define outcome measures. Using data from the intake and 6-month follow-up phase of the RCT survey, this dissertation aimed to address the following questions and hypotheses among e-cigarette users and non-EC users:

➤ *Research Question 1:* Do the rates of smoking cessation (no smoking in last 30 and 7 days) differ among persistent, transient and non users of e-cigarettes among young adult smokers across Canada?

- Null hypothesis: There is no association between persistent, transient, non users of e-cigarettes and smoking cessation rates (30-day and 7-day smoking abstinence).

- Alternate hypothesis: There is a significant association between persistent, transient, non users of e-cigarettes and smoking cessation rates.

➤ *Research Question 2 :* Do the rates of smoking cessation (no smoking in the last 30 and 7 days) among persistent, transient and non users of e-cigarettes differ after adjustments for other presumed causes of cessation, including self-efficacy, level of tobacco dependence, perceived social norms, use of other quit aids and other socio-demographics.

- Null hypothesis: There is no association between persistent, transient, non users of e-cigarettes and smoking cessation rates (30-day and 7-day smoking abstinence) after adjusting for presumed causes of cessation.

- Alternate hypothesis: There is a significant association between persistent, transient, non users of e-cigarettes and smoking cessation rates (30-day and 7-day smoking abstinence) after adjusting for presumed causes of cessation.

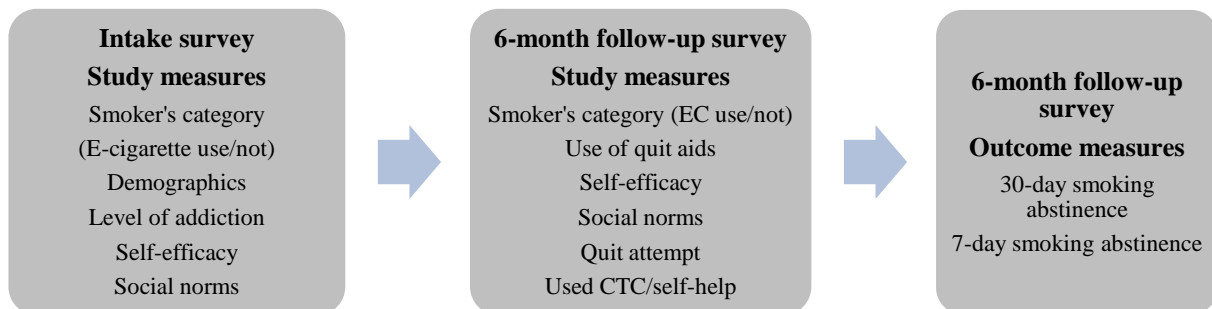
Chapter IV

Methods

A. Overview

This study involved the secondary analysis of self-reported, longitudinal data collected from young adult smokers across Canada. The participants were part of the Crush the Crave (CTC) mobile smoking cessation application randomized controlled trial. Briefly, the Crush the Crave RCT is one of the few longitudinal surveys which examined the rates of cessation using a smart-phone application (Whittaker et al., 2016). As a result of the design of the survey, it was possible to examine information about smokers before and after they quit, thus enabling examination of the research questions pertaining to who quits amongst e-cigarette and non-e-cigarette users, and how their social and economic characteristics, personal quit aids usage, and psychological characteristics were related to cessation rates over a period of 6-months. Figure 1 illustrates the conceptual design of the study and highlights the key measures of interest. It should be noted that this study involved an experimenter delivered intervention and randomization of individuals to two different treatment conditions (self-help materials and CTC mobile application). A detailed description of the CTC study, including study sample, measures and analyses is provided in the sections that follow. The study received ethics clearance from the Office of Research Ethics (ORE #22215), the University of Waterloo on April 25, 2017.

Figure 1 - Study design



B. Crush the Crave application

Crush the Crave (CTC) is a smartphone-based smoking cessation application that was first developed in the year 2012 by a group of population health researchers, computer programmers and experts in social media at the Propel Centre for Population Health Impact, located at the University of Waterloo, Ontario. It is a mobile Health (mHealth) intervention which has been designed as an evidence-informed smoking cessation application that could easily be used by young adult smokers (Baskerville et al., 2015). Following its introduction, the first pilot test was conducted on 300 smokers that revealed positive results for its application in terms of engagement and use. CTC enables users to choose a quit date or customize their quit plan by either quitting completely or reducing their cigarettes smoked per day and also allow users to track their health improvement status and financial expenditures saved. Reinforcement in the form of rewards is provided to the users for their successful quit attempts, and success may be shared with friends or family through social networks and other communities formed on media websites. The application also provides support to the users in evaluating their craving triggers and psychosocial characteristics through the use of graphs and tables. Moreover, it includes features such as notifications, reminders to facilitate real-time monitoring of the data about the use of the app and other functions which help smokers to successfully quit. These properties make it a suitable and promising intervention to increase user engagement (Baskerville et al., 2015; Bricker et al., 2014) and have been documented to be associated with successful quitting (Civljak, Stead, Hartmann-Boyce, Sheikh, & Car, 2013).

C. Crush the Crave Study Design and Intended Outcomes

A 6-month, two-arm, parallel randomized controlled trial was conducted for the purpose of evaluating the mHealth intervention, Crush the Crave, for young adult smokers (Baskerville et al., 2015). For the purpose of assessing the effectiveness of the CTC application, the participants were randomly assigned into two groups. Half of the participants were allotted to a group that used CTC application and the other half used other self-help guide materials, "On the Road to Quitting" (Health Canada, 2012b). Investigators, data collectors, as well as the participants, were all blinded to the group assignments. The high-quality RCT design and well-assessed structure of the surveys were designed in order to test whether the mHealth technology is a cost-effective

smoking cessation intervention for young adult smokers. The participants in both groups were first asked to complete the baseline or intake questionnaire. The baseline survey first included questions about individual socio-demographic characteristics; age, sex, marital status, ethnicity, education, income and employment status (Refer to Appendix A1). In addition to these socio-demographics, smoking behavior information (including amount smoked, the number of quit attempts, time to first cigarette) was also collected from the consented participants. Information about psychosocial variables (self-efficacy, social norms, attitudes) was also included. Further, other cessation support service questions included whether they used e-cigarettes or any other quit aid.

After 3 and 6 months, participants were followed and were asked a similar set of questions. However, these were more detailed and incorporated questions about past 3-month and 6-month smoking history respectively. The 6-month survey included questions on smoking abstinence in the last 30 and 7-days (Refer to Appendix A2-A3). Additionally, the final survey asked in-depth questions about e-cigarette use that included EC use history, ever use of EC with nicotine, amount smoked, the frequency of use, and reasons for use. A modified Dillman method (Hartmann-Boyce, Lancaster, & Stead, 2014) for the online survey questionnaires was used. If the participants did not complete the online questionnaire within 2 weeks of the 3-month and 6-month survey, then they were followed for up to 10 attempts (email and telephone). Questionnaires were also pilot-tested with a convenience sample of young adult smokers.

The randomized controlled trial used the 30-day point prevalence abstinence as the primary outcome measure to assess the effectiveness of CTC app in smoking cessation after 6 months of use. It was assumed that the intervention group would have high 30-day point prevalence smoking cessation as compared to the people in the control group using self-help materials (Baskerville et al., 2015). The secondary measures that were examined included a set of behaviors: 7-day point prevalence abstinence, CPD reduction, the number of quit attempts, use of the app at 3 and 6 months intervals, the effectiveness of CTC in promoting the use of other cessation supports. The study also examined possible mediators to cessation, including psychosocial factors such as self-efficacy, social norms, attitudes, social support and stress (Baskerville et al., 2015). Overall, the study primarily focused on the effectiveness of the population level intervention of smart-phone application on people's quitting behaviors. The

present study is based on CTC study and performs an in-depth analysis of the dual users, e-cigarette and non-e-cigarette users and measures the odds of quitting amongst those groups.

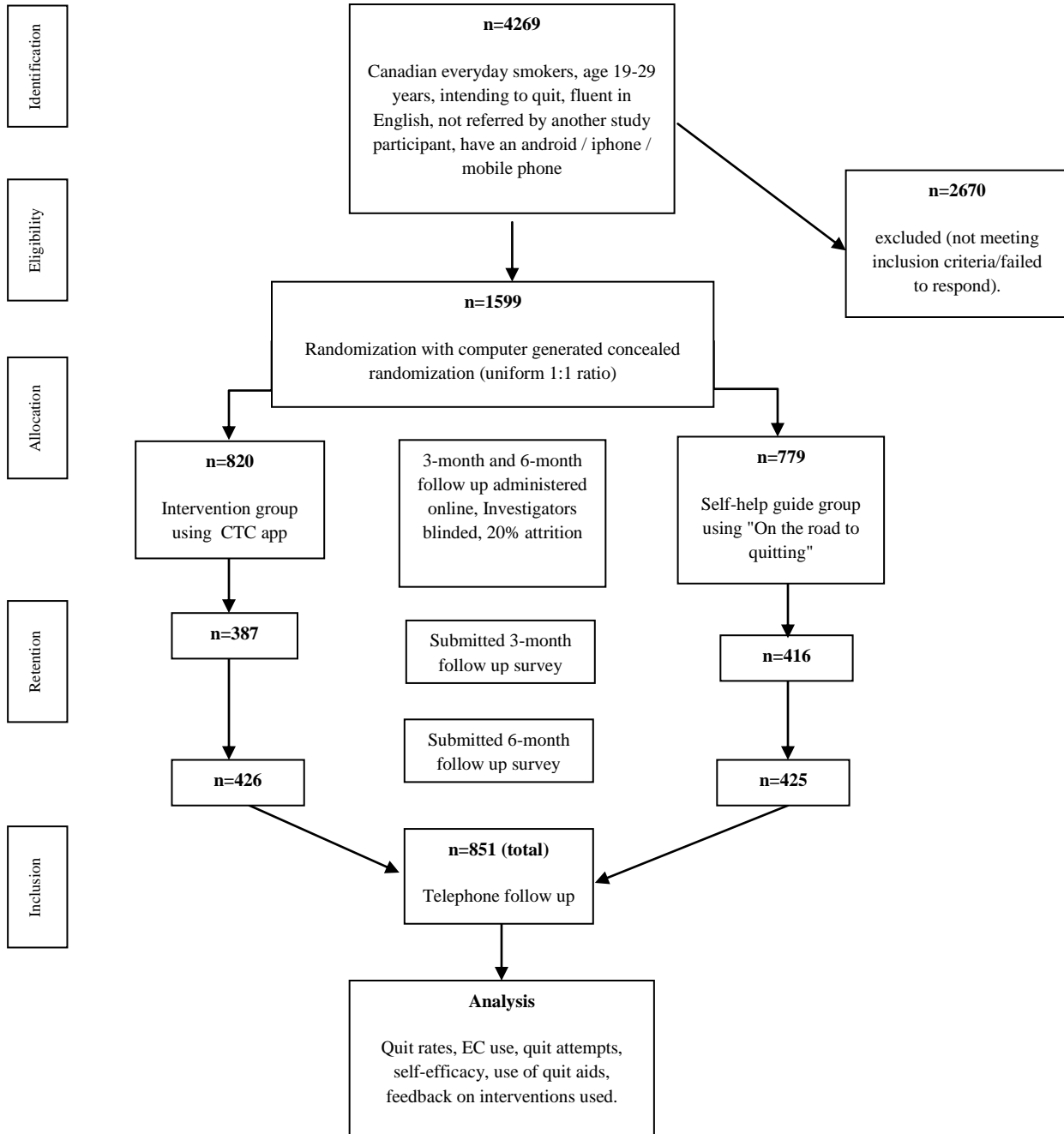
The CTC data provides a fairly comprehensive picture of the young adult smoker's characteristics and their individual level responses. One of the assets of each survey phase is that it amasses a rich dataset useful for describing complex behavior. Moreover, the longitudinal measurement of smokers allows the establishment of temporal relationships between measures otherwise not observable with cross-sectional designs. Further, the RCT is one of the few longitudinal studies analyzing the rates of cessation among young adult smokers Canada-wide using a smart-phone intervention, making the data useful for exploring the role of dual-use of e-cigarettes and tobacco cigarettes in smoking cessation.

In order to ensure adequate reporting and to evaluate validity and applicability, a CONSORT-EHEALTH (Consolidated Standards of Reporting Trials of Electronic and Mobile Health Applications and onLine TeleHealth) checklist was developed (Eysenbach & CONSORT-EHEALTH Group, 2011). The RCT protocol was implemented in conformity with expectations of the checklist. Refer to Figure 2 for a CONSORT-EHEALTH diagram of the study design.

D. Participants and Recruitment

Young adult male and female smokers across Canada were selected for the RCT study (Baskerville et al., 2015). Participants were enrolled into the study if they were between the ages of 19 and 29, were current smokers, residents of Canada, had intended to quit smoking in the next 30 days, had an Android or iPhone OS mobile phone, were able to provide informed consent and were able to comprehend English language. In order to avoid any incidence of an unintended exposure of participants to either the intervention or control group, it was determined that the respondents were not referred to the study by an existing study participant (for example by a friend or family member already participating in the study). This criterion thus avoided possible contamination bias which, if incorporated, may have minimized or accounted the differences in outcomes between the two groups. The complete CTC data intake form is provided in Appendix A1.

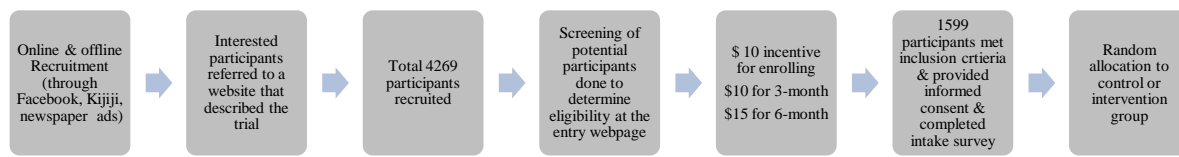
Figure 2 - CONSORT-EHEALTH diagram of the original CTC study design



Source - (Baskerville et al., 2015)

The eligibility criteria questions included: 'In the last 30 days, how often did you smoke cigarettes?', 'On average, how many cigarettes do you smoke each day?', 'When was the last time you smoked a cigarette, even a puff?', 'Do you intend to quit smoking within the next 30 days?', 'What is your date of birth?' (to check whether they fall within 19 to 29 years age group), current age, 'Are you comfortable understanding, reading, and speaking English?', 'Are you aware of anyone in your household (besides yourself) who is participating in this study?'

Figure 3 - Illustration of the recruitment process



Source - (Baskerville et al., 2015)

Participants were recruited over a period of 32 weeks using both online and offline media channels such as Facebook, Kijiji advertisements and classified newspaper ads respectively (Refer to Figure 3). The enrolled young adults were referred to a website that explained the trial and also screened for their eligibility. A total incentive of \$35 was provided for participation and completion of the surveys. In addition, the participant's name was entered into a draw at the end of the study (Spring 2015), for an iPad 2 Air 64GB. An informed consent was acquired during the intake survey wherein 1599 young adult smokers got screened. They were randomly allocated to either the CTC (intervention) or self-help intervention (control) (Refer to Figure 2-3).

Randomization was done using a 1:1 allocation ratio and a computer-generated procedure. The groups, however, were balanced based on sex, age and cigarette consumption. As the participants were unaware of the intervention group allocation, they were blinded until the completion in addition to the data collectors and investigators. After completing the initial survey, smokers were re-contacted every three months for up to 6 months to complete follow-up surveys. Longitudinal survey respondents lost to attrition were not compensated.

All RCT recruitment and data collection procedures were reviewed and cleared by the Ethics Review Boards at the University of Waterloo on October 29, 2013, ORE No. 19275.

E. Survey Inclusion and Retention Rates

A total of 4,269 participants were found to be eligible for the study. Out of these, 2,670 (62.5%) participants were excluded due to various reasons; non-compliance with the inclusion criteria, incomplete intake surveys, participation refusal, multiple participation attempts or absence of contact information. Recruitment retention rates across the three phases of the RCT have been described in Table 1. Amongst all the eligible participants recruited in the RCT, more than thirty-five percent (1,599) met the eligibility criteria. The cohort submitted either intake, 3-month or 6-month follow-up survey. This research is limited to those 53% people who successfully submitted their surveys during the intake and 6-month survey. Thus 851 is considered as the total sample of the current study (Refer to Table 1).

Table 1 - Total number of respondents across the three phases of the survey

Survey	# People who started the survey	# People who submitted the survey	Retention % age ^a
Intake	1599	1599	100%
3-month follow-up	853	803	50.2%
6-month follow-up	936	851	53.2%
Intake + 6-month follow-up survey (Total study sample)	936	851	53.2%

^aPercentage of people who started as well as completed the survey successfully.

F. Measures

Selected CTC measures used in the present study are described below, beginning with how the smoking cessation was defined, followed by a description of the e-cigarette use exposure variable, and socio-demographics, personal usage and psychological variables (covariates anticipated to affect the relationship between the outcome measure and independent variable). The following theoretical and operational definitions of the variables were used in this study. Refer to Table 2 for the list of concise definitions used in the study.

Table 2 - Theoretical and operational definitions of dependent and independent variables

Category	Variable name	Scale	Theoretical definition	Operational definition
Primary outcome measure	Self-reported 30-day point prevalence abstinence	Dichotomous (0,1)	The proportion of former smokers who have not smoked in the last 30 days, typically at the time of assessment.	Participants not having smoked any cigarettes, even a puff, or used other tobacco products in the last 30 days.
Secondary outcome measure	7-day point prevalence abstinence	Dichotomous (0,1)	The proportion of former smokers who have not smoked in the last 7 days, typically at the time of assessment.	Participants not having smoked any cigarettes, even a puff, or used other tobacco products in the last 7 days.
Independent variables	E-cigarette users	Categorical (0,1,2)	People using e-cigarettes	Current users of either nicotine-containing or nicotine-free e-cigarette (daily, once in a week or once in the last 30 days) during the 6-month survey.
			Persistent EC users	Participants who were current users of e-cigarettes at both intake and follow-up survey.
			Transient EC users	Participants who were current users of e-cigarettes only at intake or only at follow-up.
			Non users	Participants who did not use e-cigarettes at either intake or follow-up.
	E-cigarette with nicotine users	Categorical (0,1,2)	People who ever tried or used e-cigarettes containing nicotine in their life.	Participants who ever tried or used e-cigarettes with or without nicotine.
			Ever EC but no nicotine	Participants who ever used EC that did not contain nicotine.
			Ever EC with nicotine	Participants who ever tried or used e-cigarettes that contained nicotine.
			Never EC users	Participants who never used ECs.

Note- Each independent variable was regressed separately with other predictors to check for any association in Bivariate and Multivariable regression models (refer to Table 5-7).

1. Outcome measures

(a) Primary outcome measure

Self-reported 30-day smoking abstinence (non-smoking) at 6-month follow-up was considered as the primary outcome measure. The current study examined the longitudinal effects of e-cigarette use on smoking cessation, therefore, only responses from the 6-month (final) phase of the survey were considered in the analysis. The definition of "non-smoking" was operationalized as not having smoked any cigarettes, even a puff, or used other tobacco products in the last 30 days (Campbell, Ossip-Klein, Bailey, & Saul, 2007). The dual user's groups; e-cigarette and non-e-

cigarette users were compared separately for their smoking abstinence rates. The primary outcome measure for the original study was also self-reported (Baskerville, Struik, & al, 2015). The response to the final survey question, 'Have you smoked any cigarettes or used other tobacco, even a puff, in the last 30 days?' (final_q3), was used to identify individuals who quit tobacco cigarettes and those who did not (Refer to Appendix A3). People answering 'No' to the question were coded as quitters and the others as smokers. People answering 'Don't know' or 'Refused' were considered as missing.

Complying with SRNT (Society for Research on Nicotine and Tobacco) subcommittee recommendation on biochemical verification for large sample size studies involving low-intensity interventions, biochemical validation was not deemed necessary as no added benefit has been found in terms of determining the smoking status (Benowitz et al., 2002).

(b) Secondary outcome measure

Self-reported 7-day smoking abstinence at 6-month follow-up was considered as the secondary outcome measure. 7-day smoking abstinence was determined using responses to the question, 'Have you smoked any cigarettes or used other tobacco, even a puff, in the last 7 days?' (final_q4) at 6-month follow-up survey. People who responded 'No' were defined as quitters and the others as smokers. As the people answering 'No' to 30-day smoking abstinence question stated above were also nonsmokers in the last 7 days, they were also merged with the people answering 'No' to the 7-day smoking abstinence question and hence they all were coded as 7-day quitters.

2. Independent variables

(a) E-cigarette use

E-cigarette use was determined using a combination of responses to the question asked during the baseline and 6-month follow-up survey respectively, 'Which of the following quit supports have you used in the past or are you currently using? - E-cigarettes' (intake_q30d_curr), and 'In the last 30 days, how often did you use electronic cigarettes (e-cigarettes, vaporizer)?' (final_q39) respectively. The people who marked 'using currently' for the former question and/or answered either 'everyday', 'at least once in a week' or 'at least once in the last 30 days' for the

latter were considered as E-cigarette users. Following the definition of Zhuang et al., based on the length of EC use, smokers were further subclassified into three categories:

- *Persistent e-cigarette users* were those who were current users of e-cigarettes at baseline and follow-up.
- *Transient e-cigarette users* were those who were current users of e-cigarettes only at baseline or only at follow-up.
- *Non-e-cigarette users* were those who did not use e-cigarettes at either baseline or follow-up.

Among the 6-month follow-up respondents, current EC users were further classified based on their frequency of use. The frequency of ECs was assessed by the question: 'In the last 30 days, how often did you use electronic cigarettes (e-cigarettes, vaporizer)?' (final_q39). Based on user's responses, participants were further classified as 'daily', 'once in a week', 'once in last 30 days' and 'non users'. Those answering 'not at all' and those who did not respond to this question were referred to as 'non users'.

(b) Ever E-cigarette with Nicotine users

Ever use of e-cigarettes that contained nicotine was assessed by a combination of responses to the questions; 'Have you ever tried or used an electronic cigarette (e-cigarette, vaporizer)?' (final_q33) and 'Have you ever tried or used an electronic cigarette (e-cigarette, vaporizer) that contained nicotine?' (final_q35), asked at the final phase of the survey. For the former question, people answering 'Yes' were identified as 'Ever E-cigarette users' and those responding 'No' were classified as never EC-users. People who answered 'Yes' to both the questions, then they were classified as "Nicotine EC users" (i.e. they had ever used ECs and also e-cigarettes that contained nicotine). Alternatively, if they answered 'Yes' to the former and 'No' to the latter question then they were identified as "Ever without nicotine users" (i.e. they had ever used ECs but without nicotine). The remaining people who answered 'No' for both were classified as "Never users".

3. Other independent predictors

(a) Socio-demographics - Age, Gender, Marital Status, Education, Income, Occupation, Ethnicity, and Region

Questions about participant's socio-demographics were asked in the intake survey. Respondents were asked about their age, gender, marital status, education, income, occupation, ethnicity, and region (intake_currentage, intake_q31 to intake_q37) (Refer to Appendix A1). Age included a numerical answer; gender category included male, female, transgender and 'others' responses; and, the marital status question asked for participant's current status which included options as; Single (never legally married), Married, Common Law, Separated (but still legally married), Divorced, Widowed. Later, for the purpose of analysis, age was collapsed into two groups; 19-23 and 24-29 years; gender was collapsed into male or female categories excluding transgender and 'others' as they were found to be less than 1%. Marital status was sub-classified into single and married. Married and common-law were combined into one category, 'Married'. Other options of separated, divorced, widowed were not included as they were less than 2%. For education, respondents were asked, 'What is the highest level of education you have completed?.' Respondents could choose from the following response categories: Less than high school; High school diploma, certificate, or equivalent; Some postsecondary education without a degree, certificate, or diploma; Registered apprenticeship or other trades certificate or diploma; College, CEGEP, or other certificate or diploma; University degree. This education variable was later collapsed into a variable describing individuals with some degree (diploma, college, or university) and those without.

Income categories were collapsed into four categories; less than \$15,000; \$15,000-\$44,999; \$45,000-\$79,999; \$80,000- \$120,000 for analysis. Occupation categories included Yes (full-time, part-time, on paid leave, on paid sick or disability leave, on unpaid leave), No (student, unemployed, others that included pregnancy reasons, on Ontario Disability Support Program, part-time student or do seasonal/shift work). Ethnicity question asked, 'Which population group do you identify with?' for which answers included a range of population groups such as Aboriginal, Arab, White, Chinese, South Asian, Black, Filipino, Latin American, Southeast Asian, Japanese, West Asian, Korean or Other. However, only three categories Aboriginal, White and Non-White (combining all other groups) were specified for the analysis due to the small sample size. Due to similar reasons, the region was collapsed into only two categories Ontario and other provinces (British Columbia, Alberta, Saskatchewan, Manitoba, Quebec, New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland and Yukon, Northwest Territories, Nunavut).

(b) Psychological variables - Self-efficacy, Social norms, Level of Addiction (*Cigarettes per day* and *Time to First Cigarette*) and Quit attempts

(i) Self-efficacy

Self-efficacy, as defined earlier, is the concept that an individual believes in their personal ability to perform the intended behavior (McAlister, Perry, & Parcel, 2008). This effect was assessed by the response to the following question asked both in the baseline and final survey: "On a scale from 1 to 5 with 1 being 'not at all' and 5 being 'extremely', how confident are you in your ability to quit smoking?" (intake and final_q17) (Refer to Appendix A1). Later, for the purpose of analysis, the categories were merged into 3 categories; low, moderate and high self-efficacy. Information about respondent's temptations to smoke in different situations (with friend, in the morning, in stress, over coffee, for lift, while angry, with close friend smoking, not smoked for a while, while frustrated and while over the phone) (intake and final_q18a to q18j) were collected at both the baseline and follow-up survey according to the five-point scale of SASEQ. The self-efficacy among the persistent, transient and non-users of ECs, who had not quit smoking at the final survey, were compared across both the baseline and 6-month follow-up surveys. This was done to identify differences in the levels of self-efficacy among smokers only so as to prevent any bias developed due to the presence of quitters, who might have already developed high self-efficacy at follow-up. Alternatively, the frequency analysis for different situations was only conducted for the intake survey as follow-up survey respondents also included people who had quit. For the purpose of model building, only baseline self-efficacy was included in the model as the individuals who had quit were highly motivated with high self-efficacy and whose inclusion might have biased the results.

(ii) Social Norms, Attitudes and Beliefs

Social norms, attitudes and beliefs about smoking were assessed by the response to the following question asked in the baseline survey: 'What is your overall opinion of smoking?' (intake_q19). Participants could respond with one of the following options: very positive, positive, neither positive nor negative, negative and very negative. These answers were later coded into either positive, neither or negative. For the purpose of model building, only baseline social norms and attitudes were included in the model.

Respondents were also asked to agree or disagree with some statements that indicated their opinions about smoking, such as; 'I worry that smoking will damage my health in the future', 'My friends disapprove of smoking', 'Society disapproves of smoking', 'Cigarette smoke is dangerous to nonsmokers', 'Smoking helps people stay slim', 'Smoking helps people feel more comfortable at parties and in other social situations', 'Smoking helps reduce stress', 'Smoking can help people when they are bored', 'My family disapproves of smoking' (Refer to Appendix A1, q19-28), that were later coded and frequency analysis was performed.

(iii) Level of Addiction

The level of nicotine addiction was measured by the Heaviness of Smoking Index (HSI) (Heatherton et al., 1989) which was derived from the number of cigarettes smoked per day (CPD) and time to first cigarette (TTFC).

Cigarettes per day

The number of cigarettes smoked per day (CPD) is an indicator of a person's level of addiction. At baseline, all were everyday smokers and the study calculated a CPD indicator using respondents' answers to the following questions: 'On average, how many cigarettes do you smoke each day?' (intake_q2) from the baseline questionnaire which had categorical options from '1' to '29' corresponding to the number of cigarettes consumed in a day along with the category number '30+' indicating more than 29 CPD. Four categories were formed; 1-10, 11-20, 21-29, 30 and more.

Time to First Cigarette

The time to first cigarette, an additional measure of addiction, was collected from respondents' answers to the question 'How soon after you wake up do you smoke your first cigarette?' (intake_q10) in the baseline survey with four options of 'Within 5 minutes', '6 to 30 minutes', '1 to 60 minutes', 'More than 60 minutes'. Respondents could indicate the amount of time between waking and the first cigarette from amongst these options. Short self-reported time values (within 5 minutes) have been associated with high levels of nicotine dependence, while long values of more than 60 minutes have been associated with low levels of nicotine dependence (Heatherton et al., 1991).

The heaviness of smoking index was calculated by adding CPD and TTFC. Smokers with high CPD and less than 5 minutes of TTFC were given the highest smoke-index score whereas people who smoked between 0-10 cigarettes and had high TTFC were allotted the lowest score. The level of addiction or dependency were analyzed next with four categories: lowest (with least smoke-index score), low, high, highest (with highest smoke-index score).

(iv) Quit attempts

Information about a respondent's attempts to quit smoking was collected from a combination of responses asked from the final survey: 'In the past 6 months, how many times did you stop using tobacco for 24 hours or longer?' (final_q7) which included numerical categories from 1 to 180 with each number corresponding to the number of quit attempts made in the last 6 months. This question was only asked from people who had made a quit attempt for at least 24 hours. Therefore, people who made at least one quit attempt were then further compared with people who answered 'No' to the question; 'In the past 6 months, did you stop smoking for at least 24 hours because you were trying to quit?' (final_q6). Hence, quit attempt was defined as the percentage of people who made at least one quit attempt in the last 6 months.

(v) Use of other Cessation Supports and Interventions

Participants, at intake survey, were asked about any other quit support they might have used in the past or were using currently (intake_q30a to q30o). People either marked 'using currently' or 'used in the past' for different cessation supports that included Telephone Quitline/support, Nicotine replacement therapy (NRT) products (e.g. gum, patch, inhaler), Prescription cessation medications (e.g. Wellbutrin or Champix), Health professional advice (e.g. doctor, pharmacist), Group cessation programs, Self-help materials, Quit smoking contests, Quit smoking websites, Quit smoking smartphone apps, Social media sites (Facebook/Twitter/Instagram), Hypnotherapy, Herbal therapy, Laser therapy or any other supports. People who were current users of any of the aforementioned quit aids at intake survey were defined as quit support users while others were identified as non users.

Participants were asked in the 6-month follow-up survey if they had downloaded the CTC application or used the self-help 'On the Road to Quitting' quit smoking guide (Refer to

Appendix A3, q46). Those answering 'Yes' were identified as intervention users while other were considered as non-users.

Other covariates analyzed for frequency analysis include:

(a) Reasons for using Electronic Cigarettes

The 6-month follow-up survey participants who were e-cigarette users were asked about the reasons for their current use of e-cigarettes. The reasons included 'they are affordable', 'they are fun to use', 'they taste good', 'Using e-cigarettes might help me to quit smoking', 'they might be less harmful to me than cigarettes', 'they might be less harmful to people around me than cigarettes', 'I can use e-cigarettes in places where smoking isn't allowed', 'other reason (specify)' (Refer to Appendix A3, final_q43 to q43g, final_q43i). Frequency analysis was conducted among EC users for the different reasons cited that were then followed by the assessment of persistent and transient EC users' perceptions.

G. Sample Size and Power Calculations

Power and sample size calculations were done using G*Power v 3.1. Since literature has not identified the effect size for this type of study, sample size calculations were calculated assuming an α of .05, β =.95, and using Cohen's effect size convention for a medium effect of 0.15 for multiple regression. The required sample size was found to be 845 participants. Hence, the current study sample of 851 participants provided sufficient power to detect a medium-sized effect regarding the association between e-cigarette use and smoking cessation rates while adjusting for covariates (Kraemer & Kupfer, 2006). The value of 0.15 for effect size is a moderate, reasonable and conservative size based on other research (Szucs & Ioannidis, 2017) and was sufficient for other analyses.

H. Analysis

All analyses were conducted using SAS software, Version 9.3 of the SAS Studio, University Edition System for Windows. Copyright © 2012-2016 SAS Institute Inc. Prior to analysis, the survey data was cleaned and reviewed for any unusual values or patterns which could affect the quality of the data or analysis. As the primary dataset comprised of all the 1599 participants who

had submitted the three phases of the RCT survey, it was further filtered to get only the participants of the intake and 6-month follow-up survey. Following which variables were developed to perform in-depth analysis. SAS automatically dropped the missing values for the outcome measures out from the analysis. As multiple imputation method could only be applied to larger missing data samples (Bennett, 2001; Schafer, 1999), it was not applied in this study.

Frequency analysis was conducted for all the aforementioned predictors. Group comparisons were also made amongst persistent, transient and non-e-cigarette users to determine any level of association with cessation. Odds ratios, associated confidence intervals, and p-values were calculated for all covariates included in the model. Significance levels for both the initial bivariable and multivariable logistic regression analysis were fixed at a level of significance (α) of 0.05 and a confidence interval (CI) of 95%. The analyses consisted of four steps.

1. Descriptive Statistics – Univariable and Bivariable analysis

Frequency tables were generated as a first step, to describe the distribution of data in terms of socio-demographics (i.e. age, gender, marital status, education, occupation, income, region, and ethnicity) and baseline personal usage characteristics (use of quit aids and CTC/self-help intervention) and psychological variables (self-efficacy, social norms, level of nicotine addiction, quit attempts). The frequency distribution was obtained for each e-cigarette user category (persistent, transient and non-users). Using contingency tabulations and the Pearson chi-square (χ^2) test, socio-demographics, personal usage and psychological variables were explored to identify any level of association.

2. Bivariable Logistic Regression Analysis

To test study hypotheses, a series of logistic regression models were run. The data was analyzed using bivariable logistic models between the dependent variable (30-day smoking abstinence) and the primary independent variable of e-cigarette use. Along with this model, other series of models were generated for nicotine containing EC use category and for other covariates separately to examine the relationships with 30-day smoking abstinence (Refer to Table 5-7 for results). In order to avoid any overlapping, each of the e-cigarette user's category was modelled separately. The unadjusted odds ratios (OR), the 95% confidence intervals (CI) along with their p-values were examined.

A categorical set of variables were defined for e-cigarette use as persistent, transient and non-users with 0 for non-users and 1 for transient and 2 for persistent users. Dummy variables were also specified for the outcome variable of quitting (0,1); 0 for people who did not quit and 1 for people who quit smoking.

3. Multivariable Logistic Regression Analysis

A multivariable logistic regression model was specified to examine the unique combination of factors for identifying the most significant variables in explaining smoking cessation. This full entry model included all psychological and quit support usage variables and only significantly associated socio-demographic variables that were found to be conceptually relevant (Refer to Figure 8) with quitting ($p < 0.05$) from bivariable analyses for any level of the variable. Adjusted odds ratio (AOR), 95% CI and p-values were examined to assess the significance of the relationships.

Bivariate and multivariable regression analyses were conducted separately for EC users at 6-month follow-up survey based on the frequency of its use. Four dummy variables were created for the people using ECs daily, once in a week, once in the last 30 days and non-users.

4. Sensitivity analysis of the Predicted Models

PROC LOGISTIC was used to calculate concordance index (c-statistic) and construct Receiver Operating Characteristics curves (ROC curves), which are useful for evaluating the accuracy of predicted models: the larger the area under the curve of the ROC curve the more predictive the model is (Hajian-Tilaki, 2013). ROC curves were constructed for both the bivariable and multivariable models and then were compared for accuracy.

I. Resources and Funding

The University of Waterloo and the Propel Centre for Population Health Impact provided assistance with the required resources and detailed information about the RCT study. In addition, the School of Public Health and Health Systems at the University provided assistance with installing a well-equipped software for data analysis. The preliminary study received funding from Health Canada, Federal Tobacco Control Strategy (Agreement No. 6549-15-

2011/8300125), the Canadian Institutes of Health Research (Grant No. MOP-130303), and the Canadian Cancer Society Research Institute (Grant No. 2011-701019) (Baskerville et al., 2015).

Chapter V

Results

A total of 851 (53.2%) respondents from both the intake and 6-month follow-up cohorts successfully completed the online survey questionnaire and were included in the preliminary frequency analysis. Of these respondents, 837 (98.4%) answered the question on quitting smoking in the last 30 days. Therefore, for the purpose of evaluating smoking abstinence, those 14 participants (1.6%) were excluded from this analysis because their quitting response was either "don't know" or "refused" which could not be classified with confidence as quitting smoking. Therefore, for model building, the final sample consisted of 837 participants who had either responded 'Yes' or 'No' to the question on whether they had smoked any tobacco cigarettes, even a puff, in the last 30 days.

A. Missing Data

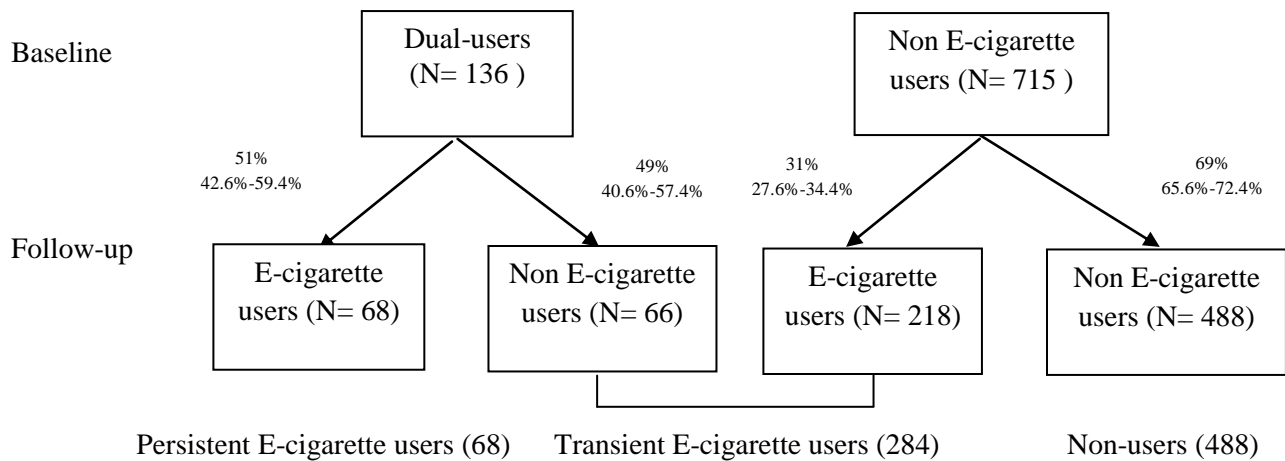
About 2% of the complete dataset under study was considered missing as participants either responded "don't know" or "refused" to the question on quitting smoking. For the secondary outcome measure similarly, about 2% of the data was missing (including don't know/refused). Among covariates, although some variables such as income, occupation and ethnicity had more than 2.5% missing data values, for others the total percentage of missing responses was very low (less than 2%). All missing frequency and percentages for both the baseline and 6-month follow-up survey variables are presented in Appendix B1.

All 851 respondents were included in the frequency analysis but for the purpose of finding answers to study's research questions, only 837 people were included in the models. Although the literature does not provide any limiting value regarding an acceptable missing percentage for producing valid statistical inferences, it has been claimed that missing data of less than 5% is insignificant (Schafer, 1999) and others have suggested that a missing percentage of more than 10% may lead to biased results (Bennett, 2001). Therefore, with only 2% missing data for the outcome measures, bias was insignificant and there are unlikely to be systematic differences between the missing values and the observed values.

B. Proportion of Dual, E-cigarette and Non E-cigarette users

The results of one-way frequency analysis for e-cigarette and non-e-cigarette users are presented in Figure 4. At intake, of the total sample size, there were 16% ($n=136$) dual users and 84% ($n=715$) of non-EC users. The total number of dual users continuing to smoke e-cigarettes and non-EC users taking up e-cigarettes when followed from baseline to 6-month follow-up survey has been presented in Figure 4. The total number of people using e-cigarettes increased to 286 (34%) at 6-month follow-up survey.

Figure 4 - E-cigarette status at baseline and 6-month follow-up and corresponding proportions



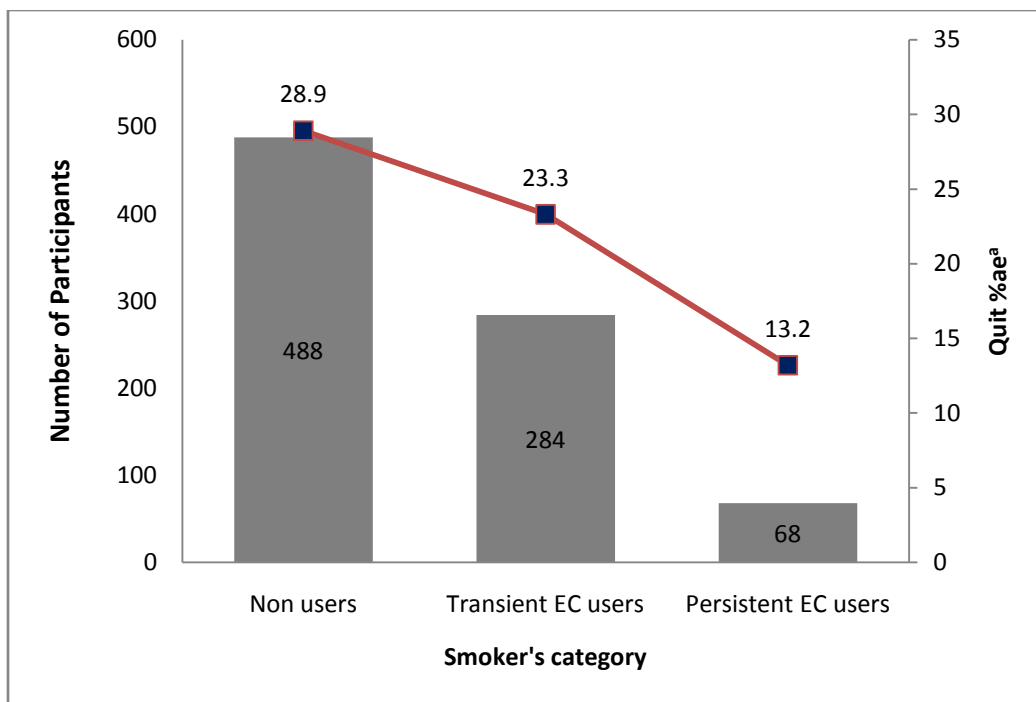
Note: 95% CI is shown in parenthesis for each estimate.

At follow-up, EC use was defined by the frequency of use either daily, once a week or once in the last 30 days, as practiced by Westling and colleagues (Westling et al. 2017). More than half of the baseline dual users continued to smoke e-cigarettes at follow-up (CI [42.6%-59.4%]). These respondents formed almost 8% of the total sample ($n=68$) and were considered as persistent users. Thirty-one percent of those who consumed only cigarettes at intake survey started using e-cigarettes by 6-month follow-up survey (CI [27.6%-34.4%]). Hence, 33.4% of the total sample who were using e-cigarettes at follow-up and not at intake, and who were not using e-cigarettes at intake and not at follow-up were defined as transient e-cigarette users ($n=284$). The other 57.3% of the total sample ($n=488$) were referred to as non-e-cigarette users.

The proportion of people quitting (30-day smoking abstinence) among all the three groups, has been described in the bar graph (Refer to Figure 5). Thirteen percent ($n=9$) of the

persistent users quit smoking at 6-month follow-up survey while 23% of the transient EC users ($n=66$) did not smoke even a puff in the last 30 days. In comparison, almost 29% of non-users of e-cigarettes quit at 6-month follow-up. A significant association was found between e-cigarette smoker's categories and 30-day smoking abstinence ($\chi^2=8.73, p<0.05$). Therefore, when the quit rates among the three smoker's categories are defined in an ascending order; persistent EC users come first, followed by transient EC users, and lastly non-users who had the highest quit rate of 29%.

Figure 5 - Distribution of 30-day smoking abstinence among e-cigarette users and non-users



^a= significant at $\chi^2=8.73, p\text{-value}=0.013$

The chi-square tests also revealed statistically significant differences between overall EC users (that combined both persistent and transient users) and non EC users for the rates of 30-day smoking abstinence ($\chi^2=6.16, p<0.05$), with 21.3% of the EC users and 29% of the non users quitting at 6-month follow-up survey.

A weak association was found between 7-day point prevalence abstinence and dual-use. Thirty-one percent ($n=21$) of the persistent e-cigarette users quit for the last 7 days at 6-month

follow-up survey whereas 68% did not quit. More than 34% ($n=97$) of the transient EC users did not smoke cigarettes (even a puff) for the last 7 days. Amongst non-users, a slightly higher percentage of almost 39% quit smoking and 61% did not quit in the last 7 days (Refer to Appendix E2). However, no significant results were found between groups for 7-day abstinence ($\chi^2=2.43$, $p=0.29$).

C. Socio-demographics of E-cigarette and Non E-cigarette users

Personal attributes of the final sample by e-cigarette use are presented in Table 3. The mean age of 24 years was similar across all the three groups of persistent, transient and non users. On average, persistent EC users had smoked 13 cigarettes per day ($SD=6.61$) whereas transient e-cigarette users had smoked 14 cigarettes per day ($SD=8.4$) and non-users had smoked 12 CPD ($SD=7.4$).

A strong association was found between age and e-cigarette smoker category. More than half of the e-cigarette users (53%) were more likely to be in the younger age group of 19 to 23 years when compared with non-e-cigarette users who had a higher percentage of people in the age group of 24 to 29 years (57%) ($p<0.05$) (Refer to Table 3). For both EC and non-EC users, more than half were male and approximately two-thirds of the sample were not married. Persistent EC users had more people (63%) with a university degree than transient and non-EC users. A quarter of the persistent users had a higher income of \$80,000 or more. More than a third of the participants in all three groups had an income of \$15,000-\$49,999. Employment status was almost the same across all the groups with almost 70% being employed and the other 30% unemployed. Furthermore, it was found that more than three-quarter of e-cigarette users belonged to the white ethnic group (77%) as compared to the non-user group with 72.3%. Nonetheless, no notable association was found between the socio-demographics described above except age and region. More than 80% of the persistent users lived in regions outside of Ontario and a χ^2 test revealed a significant relationship between region and smoker categories ($\chi^2=20.47$, $p<0.01$) (Refer to Table 3).

Table 3 - Personal characteristics of e-cigarette and non-e-cigarette users

Characteristic	Persistent E-cig users ^a	Transient E-cig users ^a	Non-E-cig users ^a	² χ , p-value ^b
Number of respondents n (%)	68 (8%)	284 (33.4%)	488 (57.3%)	
<i>Age</i>				
19-23 years	36 (53%)	147 (51.8%)	209 (43%)	6.93
24-29 years	32 (47.1%)	137 (48.2%)	279 (57%)	<0.05
<i>Gender</i>				
Male	35 (51.5%)	153 (53.9%)	257 (53%)	0.13
Female	33 (48.5%)	131 (46.1%)	225 (47%)	0.94
<i>Marital status</i>				
Single	41 (60.3%)	183 (64.9%)	309 (63.5)	0.53
Married/others	27 (39.7%)	99 (35.1%)	178 (37%)	0.77
<i>Education</i>				
No university/college degree	25 (36.8%)	121 (43.1%)	197 (40.5%)	1.06
University degree	43 (63.2%)	160 (57%)	290 (60%)	0.59
<i>Income</i>				
less than \$15,000	12 (19%)	49 (19.5%)	78 (17.6%)	6.52
\$15,000-\$44,999	21 (33.3%)	111 (44.2%)	199 (44.8%)	0.37
\$45,000-\$79,999	14 (22.2%)	48 (19.1%)	100 (22.52%)	
\$80,000- \$120,000	16 (25.4%)	43 (17.1%)	67 (15%)	
<i>Occupation</i>				
Employed	47 (70%)	182 (66.42%)	331 (69.5%)	0.87
Unemployed	20 (30%)	92 (33.58%)	145 (30.1%)	0.65
<i>Ethnicity</i>				
Aboriginal	6 (9.2%)	25 (9.2%)	58 (12.1%)	2.93
White	51 (78.5%)	211 (77.3%)	347 (72.4%)	0.57
Non-White	8 (12.3%)	37 (13.5%)	74 (15.5%)	
<i>Region</i>				
Ontario	13 (19.1%)	116 (41%)	232 (47.5%)	20.47
Others	55 (80.9%)	168 (59%)	256 (52.5%)	<0.01
<i>Self-efficacy at intake</i>				
Low	8 (12.1%)	51 (18.1%)	83 (17.3%)	1.40
Moderate	30 (45.5%)	120 (42.5%)	203 (42.3%)	0.85
High	28 (42.4%)	111 (39.4%)	194 (40.4%)	
<i>Social Norms at intake</i>				
Positive	3 (4.5%)	5 (1.8%)	13 (2.7%)	3.24
Neither	21 (31.3%)	71 (25.5%)	136 (28.3%)	0.52
Negative	43 (64.2%)	203 (72.8%)	332 (69%)	
<i>Level of Addiction at intake</i>				
Low	47 (70%)	196 (70%)	377 (78%)	7.23
High	20 (30%)	85 (30%)	106 (22%)	<0.05
<i>Quit attempt (in last 6 months)</i>				
No	9 (13.2%)	22 (7.9%)	50 (10.4%)	2.30
Yes	59 (86.8%)	258 (92.1%)	431 (89.6%)	0.32
<i>Current user of quit aid at intake</i>				
No	43 (63%)	234 (82.4%)	395 (81%)	13.20
Yes	25 (37%)	50 (17.6%)	93 (19.1%)	<0.05
<i>Intervention use</i>				
No	8 (12%)	45 (16.7%)	85 (17.6%)	1.41
Yes	59 (88%)	230 (83.6%)	397 (82.4%)	0.5
<i>Ever EC with nicotine</i>	56 (85%)	222 (80%)	188 (39.7%)	135.90 <0.01

Note. The values presented have been derived from the participants who completed intake and 6-month follow-up survey, N=851.

^a Not all totals are the same because of missing data on some variables

^b Comparison made using χ tests, between participants who were persistent, transient and non-users at 6-month follow-up survey. p-value (level of significance=0.05).

D. Self-efficacy and Social norms among E-cigarette and Non-E-cigarette users

At baseline, almost half of the participants had a moderate self-efficacy. Comparisons made between high and low self-efficacy shows that more persistent EC users (42.4%) had a high confidence to quit smoking. More people under transient EC user group category (18%) showed to have low self-efficacy to quit smoking whereas very few people amongst persistent users (12%) had low self-efficacy.

Considering only people who were smokers at 6-month follow-up survey, significant results for self-efficacy were found for e-cigarette users categories (Refer to Table 4). Twenty-seven percent of the persistent users at baseline survey had high self-efficacy to quit smoking, 9% had low self-efficacy and the others had moderate self-efficacy to quit smoking. Whereas, the percentage of persistent users having high confidence to quit escalated to 68% at 6-month follow-up survey ($\chi^2=15.5, p<0.01$). Alternatively, transient EC users (45%) and non-users (42%) had more people having low self-efficacy at follow-up survey ($\chi^2=13.5, p<0.01$ and $\chi^2=30.6, p<0.01$ respectively).

Table 4 - Self-efficacy among e-cigarette and non-e-cigarette users who smoked daily at baseline and 6-month follow-up survey

Smoker's category ^a (Self-efficacy level)	Baseline n (%)	6-month follow-up n (%)	χ^2 , p-value ^b
Persistent users (n=21)			
High	6 (27.3%)	15 (68.0%)	15.5
Low	2 (9.0%)	5 (22.6%)	0.0005
Transient users (n=107)			
High	38 (33.6%)	17 (15.0%)	13.5
Low	30 (26.5%)	51 (45.4%)	0.0002
Non-users (n=201)			
High	64 (31.0%)	25 (12.4%)	30.6
Low	44 (22.0%)	86 (42.4%)	<0.0001

^aNot all totals are the same because moderate self-efficacy values have not been presented.

^bComparisons made separately among dual users (persistent, transient EC users) and non-users, for high, moderate and low self-efficacy, using χ^2 tests, between intake and 6-month follow-up survey. p-value at $\alpha=0.0$.

A frequency analysis was conducted to check for the proportion of people with high or low temptations for smoking in a particular situation at intake survey. It was found that more than half of the participants, in situations (Refer to Appendix C1); when out with friends, in stress, when angry or frustrated and when out with a spouse or close friends, were more tempted to smoke cigarettes. When group comparisons were made across persistent, transient and non-users, it was found that non-users were highly tempted to smoke when out with friends. However, more persistent EC users had high temptations to smoke in the morning ($\chi^2=10.34$, $p<0.05$), in stress, over coffee, in need of lift ($\chi^2=10.90$, $p<0.05$), when angry, with spouse/close friend, when not smoked for a while, frustrated and while over phone, than non-users and transient EC users. However, only associations with 'morning' and 'in need of lift' situations were found to be significant.

For the social norms among participants at intake survey, a weak association was found across all the three groups. An overall negative opinion of smoking was found to exist among all groups but this number was the least among people using ECs for a prolonged period of time (64%) when compared to transient users (73%) and non-users (69%). However, no statistical significance was found ($\chi^2=3.24$, $p=0.52$). The frequency analysis for different statements defining social norms (Refer to Appendix C2), revealed that the majority of the participants believed in smoking damaging their health in the future with more than 91% of participants in all the three groups agreeing to the statement. Around 85% percent of the participants across the three groups held an opinion that cigarette smoking is dangerous to non-smokers. Almost 25% of the participants believed that 'smoking helps people stay slim' and more than two-thirds agreed with the statement that 'smoking helps reduce stress'. While 28% of the non-EC users believed that their friends had a negative opinion about smoking, 59% of them believed that smoking makes them feel more comfortable at parties and social situations. More than 60% of the people believed that 'smoking can help people when they are bored'. Additionally, 63% of the non-users had a strong opinion about their family disapproving smoking. However, amongst all the statements, only one significant relation was found to exist when examined in a contingency table between the three smoker's categories and the beliefs (agree, neither and disagree) about 'society disapproves of smoking' statement, with over 66% of non-users agreeing to the

statement, and 56% and 61% respectively of long and transient EC users agreeing to the statement ($\chi^2=11.4, p<0.05$).

E. Ever E-cigarette use with Nicotine, Level of Dependence and Quit attempts

The follow-up survey found a total of 472 (56%) participants who had ever used e-cigarettes containing nicotine while 128 (15%) participants had ever tried or used e-cigarettes without nicotine. Moreover, there were 2% ever EC users who did not know whether they used nicotine-containing ECs or not. These results might be biased as the answers were self-reported and the respondents might be unaware of their e-cigarette's composition. Twenty-seven percent ($n=227$) of the respondents had never used e-cigarettes in their life.

The level of nicotine dependence was determined by the sum of cigarettes per day (CPD) and time to first cigarette (TTFC) at baseline. Overall, almost a quarter of all the smokers at baseline showed a lower level of dependence to nicotine cigarettes ($n=626, 74.4%$) whereas only 25.7% showed to have a higher dependency. Most participants among EC users reported being less addicted to cigarettes (70%). However, when compared to non-users (22%), more EC users (30%) were found to have a higher addiction ($\chi^2=7.23, p<0.05$).

The mean number of cigarettes smoked per day (CPD) was found to decline among smokers ($n=619$) from baseline ($M=13.2, SD=8.1$) to 6-month follow-up survey ($M=8.1, SD=8.9$). A paired t-test revealed a statistically significant two-tailed p-value of less than 0.01. Similarly, significant results were found for all the smoker's category. All smokers under groups of persistent, transient EC users and non-EC-users showed to have a statistically significant reduction in their cigarettes smoked per day (Refer to Appendix B2).

One-way frequency analysis found a relatively weak association to show that over 92% transient EC users had made at least one quit attempt in the last 6 months followed by non-users (90%) and persistent users (87%) ($\chi^2=2.30, p=0.32$).

F. Use of Other Cessation Supports

In one way frequency analysis, it was found that more than three-quarter of the sample had used either of the cessation supports at intake, that included; telephone quit-line, NRTs, prescription medications, health professional's advice, group programs, self-help materials, quit contests, websites, smartphone applications, social media sites, hypnotherapy, herbal therapy and laser therapy. A strong association was found between persistent EC use and use of other cessation supports ($\chi^2=13.2$, $p<0.05$). More persistent users were using other quit supports (37%) when compared to transient (17.6%) and non-users (19%).

Taking a deeper look into the most prevailing quit aid used among the different smoker's categories, it was found that NRT use was most prevalent among transient EC users with more than 6% using them at baseline. Only 2% of persistent e-cigarette users used NRT ($\chi^2=10.4$, $p<0.01$) (Refer to Appendix D). Similarly, the use of health professional's advice (HPA) was also statistically significant across the three groups. More persistent users (10.3%) were users of HPA at baseline when compared to transient and non-users (both 3%) ($\chi^2=9.7$, $p<0.01$). Among those who quit in the last 30 days, use of e-cigarette (26.5%) surpassed that of NRT (12.4%) ($\chi^2=13.2$, $p<0.01$). However, other cessation supports of self-help materials, contests, medicines, websites, group cessation programs, applications, hypnotherapy, herbal therapy, and social groups did not reveal any statistically significant association.

G. Abstinence among E-cigarette and Non-E-cigarette users

The frequency analysis of primary and secondary outcome measures showed that there were 218 (26%) participants in total who reported 30-day point prevalence abstinence from smoking tobacco cigarettes. An additional 11% ($n=309$, 37%) were found to represent 7-day abstinent from smoking. The frequency and percentage of reported abstinence lasting at least 30 days and one week are presented in Appendix B3.

30-day abstinence

Bivariate and multivariable logistic regression analysis established significant relationships between 30-day smoking abstinence and smoker's categories of e-cigarette use, and e-cigarette with nicotine use separately. Results of the logistic regression analyses predicting 30-day

smoking abstinence are presented in Table 5 for the sample of people who completed intake and the 6-month follow-up survey. The table presents the total number and percentage of participants who remained abstinent from smoking. In addition to that, it also describes both bivariable and multivariable models for the significant rates of cessation by smoker's category, and by other predictors of socio-demographic, psychological and quit aid/intervention usage variables that have further been defined by odds ratio (point estimates), confidence interval and p-value.

The results of the logistic regression analyses for the 30-day smoking abstinence have been described more in detail in the following sections, starting with a description of the bivariable and multivariable model results for all the eight socio-demographic, four psychological and two quit supports usage characteristics, followed by a detailed explanation of the findings from the regression analysis of the e-cigarette user categories (smoker's category).

Socio-demographics

Twenty-seven percent of the young adults, between 19 to 23 years of age, were found to remain abstinent from smoking in the last 30 days and 24% of the young adults, belonging to 24 to 29 years of age, remained abstinent. Three percent more females (27%) than males abstained from smoking. Similarly, 3% more people with no university degree compared to people with a university education, were found to quit smoking in the last 30 days at 6-month follow-up survey. However, no significant association for the 30-day smoking abstinence was found with age, sex, education, marital status, income, occupation or region (Refer to Table 5). The models assessing individual predictors (bivariable association) found a weak association for respondents belonging to the Aboriginal and other ethnic groups. Aboriginal people were 1.5 times more likely to quit than White ethnic group (OR=1.44, 95% CI [0.88-2.35], $p=0.16$). However, no significance was achieved in either of the models. Thus, ethnicity was the only variable (amongst socio-demographics) that was included in the final model, when establishing associations with the smoker's category defined in Table 5, as all the other characteristic variables were found to have a statistically insignificant association in the preliminary bivariable model.

The full set model (multivariable) included only statistically significant socio-demographic variables and not others as they are distal factors and would not directly influence the rates of cessation.

Psychological variables

Thirty percent of the people with high self-efficacy at intake survey remained abstinent for 30-days at 6-month follow-up survey ($n=101$). On bivariable logistic regression analysis, a statistically significant relationship was found between 30-day quitting (30-day smoking abstinence) and baseline self-efficacy. Smokers with high self-efficacy were almost 2 times more likely to quit (OR=1.73, 95% CI [1.08-2.8], $p<0.05$) (Refer to Table 5). Thus, being a strong predictor, the variable of self-efficacy was carried forward to the final model. The multivariable model, that adjusted for ethnicity, and all other predictor variables (social norms, quit support use, nicotine dependence, quit attempt and intervention use), revealed a strong statistically significant association between high self-efficacy and quitting (AOR=1.92, 95% CI [1.14-3.21], $p<0.05$).

In either of the models, no statistically significant association was found between baseline social norms and quitting (Refer to Table 5). An overall positive or negative opinion about smoking did not show any significant association with quitting rates (OR=1.05, 95% CI [0.37-2.9], $p=0.93$). With a weak association, people who did not make any quit attempts were 1.3 times more likely to quit (OR=1.33, 95% CI [0.81-2.2], $p=0.26$). Moreover, the level of dependence also did not show any sign of association with the primary outcome measure of interest. For the purpose of evaluating relationships between independent variables and outcome measures, the multivariable model included all the four psychological variables irrespective of their significance levels due to the reason of their possible proximity to the outcome (Refer to Figure 8).

Use of intervention or quit aids

In both bivariable and multivariable models, the odds ratio was found to be the same for the people using any quit support, CTC intervention or self-help intervention. No statistically significant relationship was found between abstinence and use of quit supports or the intervention. The multivariable model controlled for all the predictors that defined the use of intervention or quit aid (Refer to Table 5).

Table 5- Bivariate and multivariable logistic regression for the association between e-cigarette users' categories, other predictors and odds of 30-day smoking abstinence

Variable	Abstinent n ^a (%)	Bivariate ^b Involving Single Predictor			Multivariable ^c Involving Multiple Predictors		
		OR crude	95% C.I.	p-value	OR adjusted ^c	95% C.I.	p-value
(a) Smoker's category							
(i) E-cigarette users ¹							
Persistent ^d	9 (13.2)	1.00	--	--	1.00	--	--
Transient	66 (23.3)	1.95	0.92--4.2	0.08	2.34	0.99--5.90	0.005
Non-users	141 (28.9)	2.62	1.26-5.43	0.0097	3.23	1.41--7.40	0.006
(b) Socio-demographics							
(i) Age [#]							
19-23 ^d	107 (27.0)	1.00	--	--	--	--	--
24-29	111 (24.5)	0.86	0.63--1.18	0.35	--	--	--
(ii) Gender [#]							
Male ^d	108 (24.1)	1.00	--	--	--	--	--
Female	109 (27.5)	1.22	0.89--1.66	0.21	--	--	--
(iii) Marital status [#]							
Single ^d	131 (24.8)	1.00	--	--	--	--	--
Married/others	87 (28.5)	1.21	0.88--1.67	0.23	--	--	--
(iv) Education [#]							
No university/college degree ^d	95 (27.3)	1.00	--	--	--	--	--
University degree	122 (24.5)	0.85	0.62--1.16	0.30	--	--	--
(v) Income [#]							
less than \$15,000 ^d	36 (26.1)	1.00	--	--	--	--	--
\$15,000-\$44,999	83 (25.3)	0.96	0.61--1.51	0.86	--	--	--
\$45,000-\$79,999	48 (29.6)	1.19	0.72--1.98	0.50	--	--	--
\$80,000- \$120,000	30 (23.8)	0.89	0.51--1.55	0.67	--	--	--
(vi) Occupation [#]							
Employed ^d	149 (26.6)	1.00	--	--	--	--	--
Unemployed	61 (24.0)	0.87	0.62--1.23	0.44	--	--	--
(vii) Ethnicity							
White ^d	147 (23.8)	1.00	--	--	1.00	--	--
Aboriginal	27 (30.0)	1.44	0.88--2.35	0.15	1.24	0.73--2.12	0.43
Others	36 (30.0)	1.36	0.88--2.10	0.16	1.29	0.81--2.01	0.30
(viii) Region [#]							
Ontario ^d	99 (27.5)	1.00	--	--	--	--	--
Others	119 (25.0)	0.88	0.64--1.20	0.41	--	--	--
(c) Psychological predictors							
(i) Self-efficacy_base [*]							
Low ^d	29 (20.0)	1.00	--	--	1.00	--	--
High	101 (30.0)	1.73	1.08--2.8	0.03	1.92	1.14--3.21	0.014
(ii) Social norms_base							
Negative ^d	140 (23.9)	1.00	--	--	1.00	--	--
Positive	5 (23.8)	1.05	0.37--2.93	0.93	0.91	0.28--2.90	0.87
(iii) Level of dependence							
High ^d	52 (24.1)	1.00	--	--	1.00	--	--
Low	164 (26.2)	1.13	0.79--1.61	0.52	0.98	0.66--1.45	0.91
(iv) Quit attempt							
Yes ^d	187 (24.8)	1.00	--	--	1.00	--	--
No	25 (30.0)	1.33	0.81--2.2	0.26	1.18	0.65--2.12	0.58
(d) Quit aid and Intervention use							
(i) Quit aid user_intake							
Non-users ^d	173 (25.4)	1.00	--	--	1.00	--	--
Current users	45 (26.3)	1.05	0.72--1.54	0.81	1.05	0.70--1.61	0.81
(ii) App / Intervention user							
Yes ^d	179 (25.8)	1.00	--	--	1.00	--	--
No	38 (27.4)	1.10	0.73--1.67	0.63	0.92	0.58--1.46	0.73

CI = Confidence Interval; OR = Odds Ratio, p-value at 0.05 level of significance.

^aNumber and percent of participants who were abstinent at 30 days at 6-month follow-up in each category.

^bBivariable analysis: series of models that assessed association of e-cigarette user category, all socio-demographics, psychological and usage characteristics individually with 30-day smoking abstinence.

^cConfounders included in Multivariable analysis: ethnicity, baseline variables (quit aid_current use, self-efficacy, social norms, nicotine dependence) and 6-month variables (quit attempt, intervention user)

Following regression equation in PROC LOGISTIC: $Y = x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8 + \beta_0$ (constant), where Y= 30-day smoking abstinence and x_1 = EC use, x_2 = ethnicity, x_3 = self-efficacy, x_4 = social norms, x_5 = nicotine dependence, x_6 = quit attempt, x_7 = quit aid, x_8 = intervention use.

$$\ln\{p/(1-p)\} = \ln\left\{\frac{e^{\beta_0 + \beta_1}}{1 - e^{\beta_0 + \beta_1}} / \frac{1 + e^{\beta_0 + \beta_1}}{1 + e^{\beta_0 + \beta_1}}\right\} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \beta_8 x_8$$

Variables not included in the final Multivariable model.

* Variables remained significant after model adjustments.

^dReference group.

Smoker's category

E-cigarette use

Over 29% of the non-users of e-cigarettes quit smoking for the last 30 days when compared to only 13% of the persistent EC users and 23% of the transient EC users quitting. A significant relationship was found between this independent variable of EC use and 30-day smoking abstinence. People not using e-cigarettes were 2.6 times more likely to quit than people using e-cigarettes for a longer duration (OR=2.62, 95% CI [1.26-5.43], $p<0.01$). However, a relatively weak association was found between transient and persistent EC use and 30-day quitting (OR=1.95, 95% CI [0.92-4.2], $p=0.08$).

The multivariable analysis found a strong association between quitting and EC use, with people not using ECs being 3 times more likely to quit smoking than persistent users (AOR=3.2, 95% CI [1.4-7.4], $p<0.01$). Moreover, transient users were also two times more likely to quit than prolonged EC users (AOR=2.4, 95% CI [0.99-5.9], $p<0.01$).

The comparisons made for the rates of cessation based on the frequency of e-cigarette use among 6-month follow-up current e-cigarette users, found that non-users were almost three times more likely to quit than people who used e-cigarettes within the last 30 days (OR=2.64, 95% CI [1.5-4.6], $p<0.01$). While people who used e-cigarettes daily or once a week were two times more likely to quit than people who used e-cigarettes once in last 30 days ($p<0.05$ for both). Similar results with a high level of significance were found after controlling for other predictors (ethnicity, psychological, quit aids usage factors) (Refer to Appendix E1).

Ever EC with nicotine use

Only 19% of the young adult ever users of nicotine containing e-cigarettes, remained abstinent from smoking compared to 30% and 37% respectively of the non-nicotine EC and never EC users.

Table 6 - Bivariate and multivariable logistic regression for the association between e-cigarette with nicotine use, other predictors and odds of 30-day smoking abstinence

Variable	Abstinent ^a n (%)	Bivariate ^b Involving Single Predictor	Multivariable ^c Involving Multiple Predictors
		OR crude (95% CI) p-value	OR adjusted (95% CI) p-value
Ever Nicotine EC use			
Nicotine EC user ^d	89 (18.9)	1.00	1.00
Ever without nicotine user	38 (29.7)	1.85 (1.18--2.88) 0.0071	2.01 (1.24--3.30) 0.00472
Never user	83 (37.1)	2.54 (1.78--3.63) <0.0001	2.92 (1.98--4.30) <0.0001

CI = Confidence Interval; OR = Odds Ratio, p-value at 0.05 level of significance.

^aNumber and percent of participants who were abstinent at 30 days at 6-month follow-up in each category.

^bBivariable analysis: series of models that assessed association of e-cigarette with nicotine use, all socio-demographics, psychological and usage characteristics individually with 30-day smoking abstinence.

^cConfounders included in Multivariable analysis: ethnicity, baseline variables (quit aid_current use, self-efficacy, social norms, nicotine dependence) and 6-month variables (quit attempt, intervention user)

Following regression equation in PROC LOGISTIC: $Y = x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8 + \beta_0$ (constant), where Y= 30-day smoking abstinence and x_1 = EC use with nicotine use, x_2 = ethnicity, x_3 = self-efficacy, x_4 = social norms, x_5 = nicotine dependence, x_6 = quit attempt, x_7 = quit aid, x_8 = intervention use.

$$\ln\{p/(1-p)\} = \ln\left\{\frac{e^{\beta_0 + \beta_1}}{1 - e^{\beta_0 + \beta_1}} / \frac{1 + e^{\beta_0 + \beta_1}}{1 + e^{\beta_0 + \beta_1}}\right\} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \beta_8 x_8$$

^dReference group.

The odds ratios for quitting as predicted by each of the EC with nicotine user types are presented in Table 6. When looking at the single effects in bivariable modeling, PROC LOGISTIC produced statistically significant results between quitting and never EC users and, between quitting and EC without nicotine users. The bivariable logistic regression analyses revealed a strong relationship for those who had never used e-cigarettes with odds of being abstinent 2.5 times more than those who had ever used or tried e-cigarettes containing nicotine (OR=2.54, 95% CI [1.78-3.63], $p < 0.01$). Similarly, the results of PROC LOGISTIC bivariable regression models indicated that ever EC users (that did not contain nicotine) had odds twice that of nicotine EC users for quitting (OR=1.85, 95% CI [1.82-2.88], $p < 0.01$).

The multivariable logistic regression also established significant results between never EC use and 30-day smoking abstinence (AOR=2.92, 95% CI [1.98-4.30], $p < 0.01$), implying that never-users are three times more likely to quit smoking than ever nicotine EC uses, after adjusting for all the other relevant predictors. Likewise, ever non-nicotine EC users were also two times more likely to quit than ever nicotine EC users (AOR=2.01, 95% CI [1.24-3.30], $p < 0.01$).

Table 7 - Association between e-cigarette user category and smoking cessation outcomes

Outcomes	Favorable outcome ^a n (%)	OR crude ^b (95% CI)	OR adjusted ^c (95% CI)
<i>Primary outcome</i>			
30-day abstinence			
Persistent users ^d	9 (13.2)	1.00	1.00
Transient users	66 (23.3)	1.95 (0.92--4.20)	2.34 (0.99--5.90)
Non-users	141 (28.9)	2.62 (1.26-5.43)	3.23 (1.41--7.40)
<i>Secondary outcome</i>			
7-day abstinence			
Persistent users ^d	21 (30.9)	1.00	1.00
Transient users	97 (34.2)	1.14 (0.64--2.03)	1.26 (0.67--2.37)
Non-users	189 (38.7)	1.38 (0.79--2.40)	1.48 (0.81--2.72)

CI = Confidence Interval; OR = Odds Ratio.

^aNumber and percent of participants who obtained favorable outcomes at 6-months follow-up survey in each group.

^bBivariable model that assessed association of EC use (persistent, transient and non-users) individually with 30-day smoking abstinence.

^cConfounders included in adjusted model: ethnicity, baseline variables (quit aid_current use, self-efficacy, social norms, nicotine dependence) and 6-month variables (quit attempt, intervention use)

^dReference group.

7-day abstinence

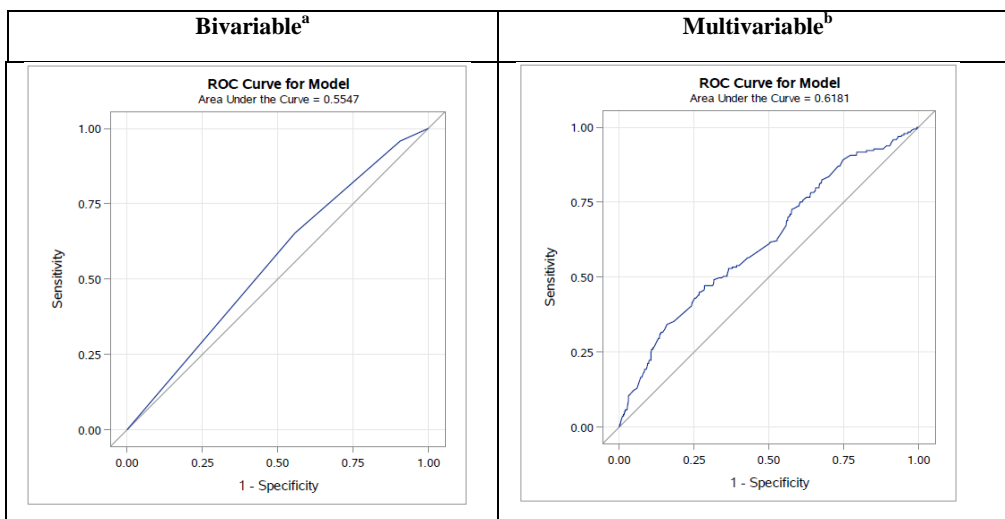
Bivariable and multivariable logistic regression analysis produced significant relationships between e-cigarette with nicotine use and 7-day smoking cessation. However, no statistically significant results were produced with either persistent or transient users. For all the other predictors, similar results were obtained as for the 30-day smoking abstinence (Refer to Appendix E2). The summary of the findings from the logistic regression analyses predicting 7-day smoking abstinence along with 30-day abstinence is presented in Table 7 for the sample of people who completed intake and follow-up 6-month survey. The detailed results of the bivariable and multivariable regression analysis are presented in Appendix E2.

H. Goodness of fit in Logistic Regression

The concordance statistic is a measure of goodness of fit for binary outcomes in logistic regression. The values are presented in Figure 6 which provides information about the area under the ROC curves. C-statistic, as in clinical studies, gives the probability that a randomly selected participant who quit had a higher odds score than a participant who had not quit. This measure is useful for evaluating the accuracy of predicted models. The larger the area under the curve of the ROC curve the better predictive power the model has (Hajian-Tilaki, 2013). ROC curves were constructed for the EC user smoker's categories separately for both the models and then were

compared for accuracy. As shown in Figure 6, the multivariable model for EC use category has the largest area under the curve value (c-statistic) signifying that is it the most accurate model amongst both the models defined. Only the primary outcome measure of 30-day smoking abstinence was assessed for sensitivity analysis.

Figure 6 - ROC curves for e-cigarette user category



^aBivariable associations established associations between E-cigarette use and 30-day smoking abstinence.

^bConfounders included in Adjusted model: ethnicity, baseline variables (quit aid_current use, self-efficacy, social norms, nicotine dependence) and 6-month variables (quit attempt, intervention use)

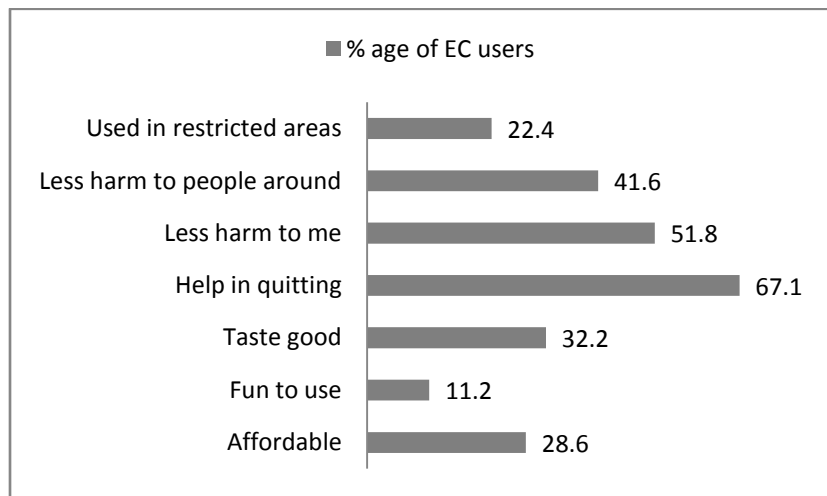
Further statistics to measure the usefulness of the model is the generalized R^2 (coefficient of determination) value. The value for the final multivariable model was found to be 0.43. The maximum value that R^2 attains is less than 1 (Bewick, Cheek, & Ball, 2005). The R^2 statistics do not measure the goodness of fit of the model but indicate how useful the explanatory variables are in predicting the response variable. The value of 0.43 indicates that the model is useful in predicting the quitting outcome.

I. Reasons for E-cigarette use

People who were current users of e-cigarette at 6-month follow-up survey answered the question about their perceptions on e-cigarette use. As illustrated in Figure 7, out of 286 (33.6%) people who were current users of e-cigarettes, the most important reason cited for use of ECs was the perception that it helped in quitting smoking (67%); other frequent reasons for the use were the perceptions that it causes less harm to them (51.8%) and causes less harm to people around (41.6%). 32% believed that EC tastes good and 28.6% believed that they are affordable.

When comparing the perceptions of persistent and transient e-cigarette users, it was found that 71% of the persistent users and 66% of the transient EC users perceived e-cigarettes as a quit aid ($\chi^2=5.70, p<0.05$). Similarly, 62% of the persistent users and 49% of the transient users believed that ECs causes less harm to them ($\chi^2=10.7, p<0.01$). Therefore, the persistent users were more likely to believe that e-cigarettes help in quitting and pose less harm. Similarly, significant associations were found for the reasons of ECs being 'tasty' ($\chi^2=4.0, p<0.05$) and 'affordable' ($\chi^2=3.7, p<0.05$). No level of significance was achieved with 2x2 contingency tables for other reasons. It should be noted here that no question was asked about perceptions at baseline, therefore, transient users that are considered here are the ones who were not using e-cigarettes at baseline but were using at 6-month follow-up survey ($n=218$) (Refer to Appendix C3).

Figure 7 - Percentage of e-cigarette users stating reasons for its use (at 6-month follow-up survey)



Chapter VI

Discussion

The aim of the current study was to better understand e-cigarette use among young adult smokers in the context of smoking cessation and also to find any potential association of cessation with socio-demographic, psychological and other quit aids usage characteristics. E-cigarette use has been found to be controversial in promoting or preventing quitting (Curry et al., 2017; Zawertailo et al., 2017, Zhuang et al., 2016). According to several strong studies (McRobbie et al., 2014; Rahman et al., 2015) , e-cigarette use should increase the likelihood of quitting, in this case, 30 and 7-day abstinence. Although this is not the first study to examine the prevalence of e-cigarette use and quitting, this longitudinal study to my knowledge, is the first to examine the persistent use of e-cigarettes and its association with quitting outcomes in a sample of Canadian smokers.

The results show that dual users who continued to use ECs persistently across the course of study, were less likely to quit smoking in the last 30 days when compared to non-users even after controlling for other relevant predictors. This study examined data from the longitudinal component of Crush the Crave RCT Survey - a Canadian survey of young adult smokers, to identify the rates of 30-day and 7-day point prevalence abstinence, along with examining proximal outcome measures of cessation behavior.

A. Summary and Interpretation of key findings

Descriptive analysis

Overall, 12.4% of young adult Canada-wide smokers who quit for the last 30 days were found to have been using both e-cigarettes and conventional tobacco cigarettes. Further, 34.4% of people who quit in the 6-month follow-up survey were either long or transient e-cigarette users. More than half of the baseline dual users were still using e-cigarettes six months later and 31% of those who consumed only cigarettes at the intake survey started using e-cigarettes by 6-month follow-up survey. These findings are consistent with previous research findings (Curry et al., 2017; Zhuang et al., 2016). This increased uptake of e-cigarettes among smokers needs further attention. Despite an increasing number of reports suggesting that there are health risks

associated with using e-cigarettes (Yu et al., 2016), the majority of the persistent users (57%) perceived e-cigarettes as a quit aid and perceived them to be posing less harm to them. These EC perceptions, as mentioned in previous studies, could potentially lead to social “normalization” of smoking behaviours (Fairchild, Bayer, & Colgrove, 2014; Peters, Meshack, Lin, Hill, 2013). The proportion for the age of study participants was somewhat similar to CTADS results. The present study had 47% of the smokers in the 19-23 years of age group and 38% of the smokers in the 24-29 years of age group were found to be using e-cigarettes. The majority of the persistent users belonged to regions outside of Ontario. The study had a higher percentage (56%) of ever-EC with nicotine users when compared to only 26% from the Statistics Canada report (Statistics Canada, 2017). However, the percentage of people who were unsure about the nicotine content was less (only 2%) in the current study. The study results were also consistent with a recent study (Rüther et al., 2015) about the level of self-efficacy and level of addiction showing that people using ECs had a high self-efficacy to abstain from smoking but at the same time, they had a comparatively higher level of addiction to nicotine than non-users. However, the mean number of cigarettes smoked per day was found to decline among dual users from baseline mean of 13 to follow-up mean of 8, which is similar to some previous studies (Etter & Eissenberg, 2015; Farsalinos et al., 2015). The self-efficacy levels were found to escalate among persistent EC users whereas the levels reduced for non-users. Moreover, persistent EC users were also more likely to use other quit aids compared to transient and non-users.

Quit rates

Canada does not currently encourage smokers to use e-cigarettes to help them quit smoking due to the lack of strong evidence, whereas the situation differs in the UK where one e-cigarette company has recently received approval for marketing them as cessation aids (McKee, 2016; Olov & Bridgman, 2014). People who did not use e-cigarettes were more likely to quit smoking in the last 30 days compared to people who were using e-cigarettes. This finding adds to the growing body of evidence on EC use and cessation (Borderud, Li, Burkhalter, Sheffer, & Ostroff, 2014; Pearson et al., 2015; Vickerman, Carpenter, Altman, Nash, & Zbikowski, 2013; Zawertailo et al., 2017). The results of the present study could be a part of the other studies that links persistent use of ECs to the risk of delayed quitting. These results are similar to findings among participants enrolled in other smoking cessation studies which reported lower abstinence

among e-cigarette users (Borderud et al., 2014; Curry et al., 2017; Zawertailo et al., 2017). However, these studies included participants that were either cancer patients, only belonged to Ontario who were a part of a smoking cessation program that included behavioral counselling and use of NRTs or were the participants of a community-based cessation trial. Two studies, similar to the present study, assessed 7-day smoking abstinence at 6-month follow-up survey (Borderud et al., 2014; Zawertailo et al., 2017) and the other assessed 12-month smoking abstinence (Curry et al., 2017). The findings of the present study are also contrary to a recent study done by Zhuang et al. that assessed 3-month follow-up quit rates among the US population group of adults of more than 18 years of age (Zhuang et al., 2016). These population studies thus imply that ECs could have a significant impact on reducing the rates of quitting or they are being increasingly used by failed quitters. Unlike previous research (Doyle et al., 2015; Hajek et al., 2014; Rahman et al., 2015; Zhuang et al., 2016), a weak relationship was found between e-cigarette use and quitting in the last 7 days. Although 7-day cessation may be a useful measure for comparisons over the course of time, North American Quitline Consortium (NAQC) recommends 30-day quitting as the primary measure for reporting on outcomes (NAQC, 2010). Therefore, irrespective of the results found, the study provided additional evidence on persistent e-cigarette use and 30-day abstinence.

Thus, the significant differences in the rates of cessation between persistent, transient and non EC users answers the study's research question 1 and rejects the null hypothesis. The statistical significant differences in cessation rates between persistent, transient and non EC use, even after adjusting for presumed causes of cessation (socio-demographics, psychological and quit usage characteristics), answers the study's research question 2 and hence rejects the null hypothesis.

Past studies have been criticized for excluding people who used e-cigarettes and then successfully stopped smoking (McNeill et al., 2014; Science Media Centre, 2016). This study described e-cigarette use and cessation rates among participants who intended to quit smoking upon enrollment and took baseline and follow-up survey use into account. Dual users who continued to use ECs throughout the survey contributed to a 50% increase in the rate of smokers using other quit aids when compared to transient EC users and non-users. This suggests that smokers who do not otherwise use cessation supports were less likely to be using e-cigarettes

too. Moreover, the study represented transient users being the most predominant group giving the advantage of detecting any impact of using e-cigarettes on smoking cessation which previous studies lacked due to the unbalanced e-cigarette grouping. The likelihood of baseline e-cigarette users turning to persistent e-cigarette use seems to be high (51%). It is not clear if this rate of transition to persistent use applies to any novice e-cigarette users as we do not know what proportion of e-cigarette users at baseline survey would have qualified as persistent users already.

The study also established that people using e-cigarettes had lowered quit rates which align with previous studies (Curry et al., 2017; Grana et al., 2014; Vickerman et al., 2013). Previous studies have reported an association between higher smoking cessation rates and the intensity of e-cigarette use (i.e. daily use) (Chen, Zhuang, & Zhu, 2016; Hitchman, Brose, Brown, Robson, & McNeill, 2015). Similarly, the present study also found a positive association between daily intake of e-cigarettes and smoking cessation when compared with people who used e-cigarettes once in the last 30 days. Similarly, the number of people not using ECs at follow-up were also positively associated with quitting, however, the quitting percentage was comparatively higher when compared to people using ECs daily. Overall, non-users were significantly more likely to quit than e-cigarette users within the last 30 days. Similarly, those who used for a transient period were also more likely to quit smoking when compared with persistent EC users. This suggests that e-cigarette use for a short period promotes smoking cessation while a persistent use, overall, has a negative rather than a positive impact on cessation.

People with high baseline self-efficacy were more likely to quit at follow-up. This finding was congruent with previous studies that showed a higher success in cessation among smokers with high confidence to quit (Baldwin et al., 2006; Chouinard & Robichaud-Ekstrand, 2007). However, this was not the case for persistent EC users who had high self-efficacy at follow-up. These group of people were found to be less likely to quit smoking. These contradictory results might be due to a delayed increase in self-efficacy of people while using ECs for a prolonged duration. These persistent users might not have been ready to quit smoking at that point of time. Further longitudinal studies designed for a longer duration of more than 12 months are in need to provide a clear vision to these results. In addition to that, a comparison group of EC-only users

would be needed in future studies to confirm whether they have a higher self-efficacy to abstain than dual users and cigarette-only users, as found in a previous study (Rüther et al., 2015).

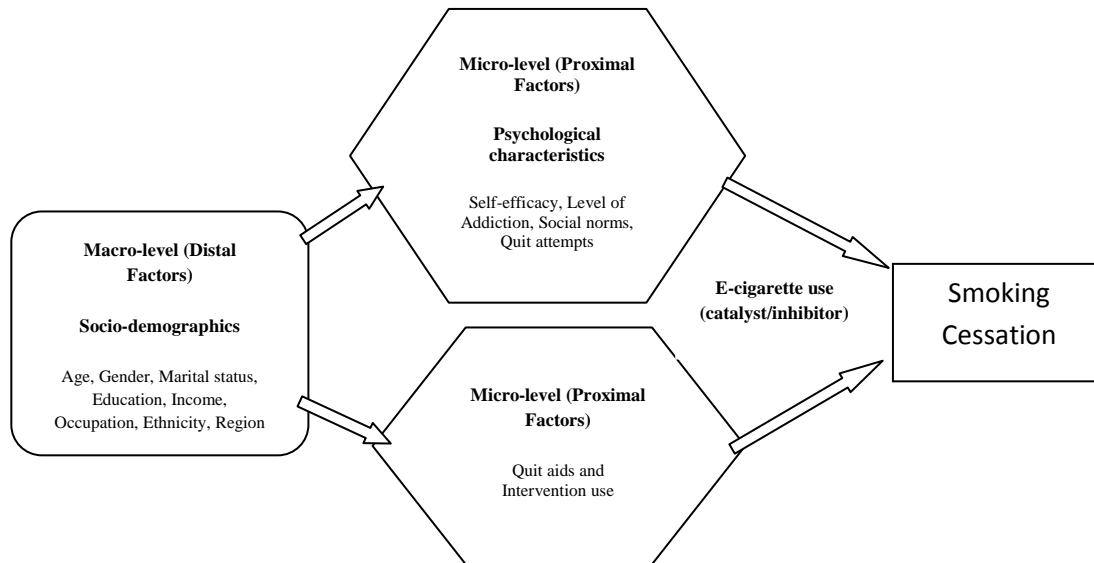
There is a need to treat e-cigarettes in a comprehensive manner that is consistent with how traditional cigarettes are approached. Considering the exponential growth of e-cigarettes as a smoking cessation aid coupled with aggressive marketing by tobacco companies, healthcare providers are increasingly engaging smokers in conversations relating to the use of e-cigarettes (Egnot, Jordan, & Elliott, 2017; Shin et al., 2017). The present study findings suggests clinicians against recommending e-cigarettes as a treatment product for tobacco dependence, which aligns with the American Academy of Pediatrics (AAP) position paper that called for stricter regulation of ECs (Farber, Walley, Groner, & Nelson, 2015). HCPs also need to make smokers aware about the current 'inconclusive' evidence on the effectiveness of ECs as a cessation tool. From the findings, the role of self-efficacy appears to be important and behavioural interventions could be helpful to increase people's self-efficacy to quit smoking.

Cohort study design and causality

The contribution of this cohort study confirms a direction for further investigation, and provides an evidence to support the association between e-cigarette use and lowered quit rates among smokers. The secondary analysis of the existing data provided a cost-effective way to assess the association of EC use with quitting. The methods developed for this study utilized the primary RCT data in the best way to identify relationships. The results, however, cannot confirm a cause-and-effect relationship between the persistent use of e-cigarettes and smoking cessation. Although the results established significant associations between no EC use and quitting even after adjusting for presumed causes of cessation, causality cannot be inferred with confidence. Due to the lack of information about e-cigarette use and due to the short duration of only six months under consideration in the longitudinal study design of the RCT, the data could not assess intensity and frequency of EC usage. The temporal relationships could have been derived from the fact that e-cigarette uptake started from the baseline survey which led to quitting after the short-term follow-up survey. Also among these transient users, it might be possible that people started using ECs after quitting at 6-month follow-up survey. Therefore, there is a need to design longitudinal studies which recruits EC users or dual users and which assess people's

frequency of use, dose and other characteristics over a longer duration of time. Another important consideration would be to biologically validate the findings for the nicotine content intake. Intentions to quit in the next six months was one of the inclusion criteria for the recruitment in the preliminary study. In order to explore motivation, new studies could incorporate an index that measures the strength of interest to quit smoking or the intention levels.

Figure 8 - Proximal and distal determinants of smoking cessation



An additional support for a causal hypothesis is evidenced by an epidemiological sensibility and analogy to other well-established relationships (Daya, 2003). There are proximal and distal factors which could affect directly and indirectly, respectively, an individual's behaviour to quit smoking (Lynch & Bonnie, 1994). The proximal factors included in the present study are psychological (self-efficacy, social norms, level of dependence, quit attempts) and quit aids usage characteristics (cessation supports and intervention use) which provide a strong influence on quitting behaviours. Whereas, the distal factors are the socio-demographic factors that are more stable (Flay, Snyder, & Petraitis, 2009) (Refer to Figure 8) that increases the relevance of the proximal factors. E-cigarette use might act as a catalyst or an inhibitor between the proximal factors and the outcome of quitting. Thus, the factors that were closely associated with the outcome were included in the final full-set model.

B. Strengths and Limitations

There are limitations related to the study method and design which need to be considered in the interpretation and application of study results. First, the data lacked depth as could be seen by the lack of detailed information about e-cigarette use in the baseline survey. The operational definition of e-cigarette use, derived from both the intake and 6-month follow-up survey, lacked detailed EC usage questions during the intake survey leading to some missing information about the frequency, nicotine content and perceptions. Moreover, people using e-cigarettes either every day, once in a week and once in last 30 days were merged into one category due to the small sample size. These definitions might have differed when considering these three categories separately. For example, persistent or transient EC users using e-cigarettes daily might have had different rates of cessation than weekly or once in last 30 days users. There might be a misclassification bias for non-users of nicotine-containing e-cigarettes. Some might be unaware of their EC's composition as the illegal marketing of e-cigarettes has also been reported in Canada, although no evidence exists for the proportion (Shiplo et al., 2015). Without knowledge of nicotine content in their e-cigarette, it is possible that a larger proportion of individuals may have inadvertently reported being non-users of nicotine ECs which might have biased the results pertinent to quit rates. However, given the large proportion of smokers who indicated ever EC use and later proceeded to report not having nicotine in their ECs, the definition of EC with nicotine amongst the respondent sample may be closer to the hypothetical operational definition.

Second, it is possible that different rates of abstinence may occur if the current respondents were observed over a longer period of time. There may be delayed effects of e-cigarette use which are currently not observable during a six-month period (Farsalinos, Tsiapas, Kyrzopoulos, Savvopoulou, & Voudris, 2014). As it is a longitudinal study, missing data is a common problem encountered which could cause a significant impact on the validity of the study and the ability to draw accurate inferences (McKnight, McKnight, Sidani, & Figueredo, 2007; Rubin, 1976). Some of the participants of the RCT study had dropped out of the study before six months and thus did not successfully complete all the three phases of the survey. Due to the low retention rate, there was missing data for certain variables of interest. As validity was of importance, the approach of analysing only complete cases was adopted for analyzing the data. In addition, ROC curves used for finding the validity of the prepared models helped in establishing a substantial agreement with respect to the direction of relationships between the variables explored and overall findings.

The study relied on self-reported answers which might have been affected by memory bias. Evidence also shows that people might give inaccurate or false answers which could pose challenges to the validity of the study, although, in a large sample study, no huge effect on the results has been found (Fan, 2006). The close-ended answers to questions on sensitive issues like EC use status, tobacco quit attempts, level of addiction and utilization of cessation services might have led to some bias in responses because of social issues and perceived stigma. There is a possibility of social desirability bias in self-reported tobacco use behaviors. Alternatively, self-reported answers in this survey offers many advantages too. It enriches the information, motivates the participant to report, engages the respondent's identity, offers practical advantages of being inexpensive and efficient (Pauhus & Vazire, 2007). Furthermore, no validation by other more objective means was done, such as measurement of cotinine levels in those who said they had quit as SRNT subcommittee has identified no added benefit in terms of determining the smoking status (Benowitz et al., 2002). These secondary data sources provided with a vast amount of information, but quantity is not synonymous with appropriateness. These limitations notwithstanding, this study adds to the limited literature that has examined smoking abstinence among dual users smoking over time.

Despite the limitations stated above, the findings of this study, with a sample of Canadian smokers and a longitudinal study design, shed light on the issue of the dual-use of cigarettes and e-cigarettes. The secondary data analysis conducted in this research will be one of a kind in the field of e-cigarette research. It offers several advantages because of its secondary nature as it saves cost, time and offers a relatively easy way to monitor change over time. Apart from that, data is rich in quality as it was funded by renowned governmental agencies of Health Canada, CIHR and CCSRI. Moreover, it included a huge number of variables, which offered considerable breadth to the study. Past studies have been criticized for excluding people who used e-cigarettes and then successfully stopped smoking (McNeill et al., 2014; Science Media Centre, 2016). However, this study with the development of e-cigarette sub-groups; persistent, transient and non-users, incorporated the advantage of observing trends in quit rates across different subgroups.

C. Recommendations for Future Research

Dual-use of e-cigarette and tobacco cigarettes continues to be a major cause of concern. For Canadians and the population globally who are trying various types of quit resources to help them quit smoking, new policies could be implemented with increasing knowledge about the proportion of persistent e-cigarette users, nicotine e-cigarette users, people having high self-efficacy to quit and their role in smoking cessation. It is noteworthy that many people using e-cigarettes relapse which is a drawback from a public health standpoint, and above all discourage smokers trying to quit. A support in the form of strong and improved research studies is an ongoing need. Although the present findings shed light on the relationship between use of e-cigarettes, socio-demographic, psychological characteristics and smoking cessation, further research is needed to clarify the contradictory results found for people with high self-efficacy and persistent users. To determine if there is a delayed effect on the levels of self-efficacy among persistent e-cigarette users, further longitudinal studies need to be designed in order to provide a clear vision to these results. In particular, there is a need to replicate the present study with greater number of people over a greater period of time to explore whether dual users who continue to smoke for a longer duration may inhibit successful abstinence for specific subpopulations, and whether this trend in the relationship between e-cigarette use and cessation is observed beyond six months. There is also a need to explore smoker's and EC user's perceptions about the use of ECs as a quitting aid. While more people perceive ECs as a cessation tool, few people actually quit. Including additional qualitative measures or developing qualitative studies to explore whether the nicotine content, advertising, or the type of e-cigarette brand and the user's perception has an impact on quitting, and on what grounds the general population of smokers switches from cigarettes to e-cigarettes or vice-versa, is recommended for future research.

There is also a need to re-examine and test quitting in the context of motivation theories. Social Cognitive theory emphasizes the importance of implementing interventions that increases self-efficacy to increase cessation outcomes (Bricker et al., 2010). It is unclear at this point precisely what combination of self-efficacy and social norms' factors best predicts quitting. Under which circumstances, the smokers are highly motivated to quit smoking and under what conditions they strongly accept smoking behaviors. Finally, what other factors contribute to

quitting warrant additional study to better understand why they may quit without using quit resources and how they can better be assisted once a quit attempt has been made. The results of the preliminary RCT study are underway which may help to address some of these questions and limitations. From a clinical practice and public policy perspective, given the less likelihood of quitting among persistent users of e-cigarettes and nicotine e-cigarette users, there is a need to develop similar studies to provide evidence for the impact of e-cigarettes in making people smoke more and quit less.

D. Conclusions

The current study contributes to the growing body of evidence regarding the dual-use of e-cigarettes and tobacco cigarettes, and smoking cessation. Consistent with previous research findings, it has shown that a majority of dual users who continued to smoke e-cigarettes for longer duration were unable to quit. Along with persistent e-cigarette users, people who had ever used nicotine-containing e-cigarettes in their life were less likely to quit smoking. Further, it has identified that majority of the EC users hold a belief that e-cigarettes help in quitting smoking. Consistent with prevailing health behavior change theories, the study findings found the psychological construct of self-efficacy to be associated with quitting . Although more research is needed, the current study contributes to the dialogue of e-cigarette use among smokers and smoking cessation practices and policies.

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Appendix

Appendix A - Surveys

Appendix A1 - Intake survey

ONLINE INTRO SCRIPT:

Thank you for your interest in the quit smoking study being conducted by the Propel Centre for Population Health Impact, University of Waterloo. The study purpose is to learn what quit smoking programs are most effective for young adult smokers.

STUDY DESCRIPTION

The study has 3 parts:

Part 1: Answering questions about yourself and your smoking behaviour to see if you are eligible for the study. It should take about 2 minutes.

Next you will be asked to confirm your agreement to participate in the study. If you agree, you will be randomly assigned to receive one of two quit smoking programs. Being randomly assigned means you have an equal chance of receiving either one of the quit smoking programs. You will be asked some additional questions which should take about 10 minutes.

Part 2: Asks you to use a quit smoking program for the next 6 months to help you in your attempts to quit

Part 3: Asks you to complete a 10-minute follow-up survey in *3 months and 6 months* from now. We will contact you by email with a link to complete the follow-up surveys.

ARE YOU ELIGIBLE?

If you are interested in participating, click the button below to answer the eligibility questions.

ELIGIBILITY CRITERIA	
Q1	<p>In the last 30 days, how often did you smoke cigarettes? (CHECK ONE)</p> <p>_____ Every day (1)</p> <p>_____ At least once a week (2)</p> <p>_____ At least once in the last 30 days (3)</p> <p>_____ Not at all (4)</p> <p>[If once/week, once/month or not at all– Thank you for your time but our study requires participants to be daily smokers. If you would like more information on quitting smoking please visit CCS-Quit Smoking].</p>
Q2	<p>[IF smoking status = 1]</p> <p>On average , how many cigarettes do you smoke each day</p> <p>_____ [enter number]</p> <p>_____ Don't know</p> <p>_____ Refused</p>
Q3	<p>When was the last time you smoked a cigarette, even a puff? (If you are unsure, just make your best guess).</p> <p>_____ Today</p> <p>_____ Yesterday</p> <p>_____ In the past week</p> <p>_____ In the past month</p> <p>_____ Don't know</p> <p>_____ Refused</p>
Q4	<p>Do you intend to quit smoking within the next 30 days?</p> <p>_____ Yes</p> <p>_____ No (INELIGIBLE - Skip to 'ineligible' script)</p> <p>_____ Don't Know/Can't say (Skip to 'ineligible' script')</p> <p>[If NO or Don't Know/Can't Say – Thank you for your time but since this study involves quitting smoking, we require individuals who would be willing to quit smoking in the next month. If you would like more information on quitting smoking please visit CCS-Quit Smoking].</p>
Q5	<p>What is your date of birth? _____ / _____ (mm/yyyy)</p> <p>We require this information to determine if participants are between the ages of 19-29, and therefore eligible for our study. This study is only suitable for young adult smokers.</p> <p>[If not between 19-29 – Thank you for your time but this study is only suitable for young adults between the ages of 18-29. If you would like more information on quitting smoking please visit CCS-Quit Smoking].</p>
Q6	<p>Are you comfortable understanding, reading, and speaking English?</p> <p>_____ Yes</p> <p>_____ No</p> <p>[If NO – Thank you for your time but this study requires that participants are able to fluently understand and speak English. If you would like more information on quitting smoking please visit</p>

	CCS-Quit Smoking].
Q7	<p>Do you currently own and use an Android or iPhone smartphone or tablet?</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No</p> <p>[If NO – Thank you for your time but this study requires that participants own an Android or iPhone smartphone or tablet for the purposes of being contacted by the research team. If you would like more information on quitting smoking please visit CCS-Quit Smoking].</p>
Q8	<p>Are you aware of anyone in your household (besides yourself) who is participating in this study?</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know/can't say</p> <p>[If YES or Don't Know/Can't Say – Thank you for your time but this study requires that only one individual per household participate in the study. If you would like more information on quitting smoking please visit CCS-Quit Smoking]</p>
Q9	<p>Were you referred to this website by a friend who is already participating in this study?</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know/can't say</p> <p>[If YES or Don't Know Can't Say– Thank you for your time but this study requires individual participants who are not acquainted with one another and who have not been referred to the study website. If you would like more information on quitting smoking please visit CCS-Quit Smoking]</p>
ELIGIBILITY – YES	
You are eligible to participate. The information below will help you decide if you want to participate.	
CONSENT PROCESS	
Participation is voluntary. You may stop using the program or withdraw at any time by contacting the research team. If you withdraw, your data will be destroyed.	
To thank you for participating you will receive \$35; \$10 now for enrolling in the study, \$10 for completing the 3 month follow-up survey, and \$15 for completing 6 month follow-up survey. In addition, your name will be entered into a draw at the end of the study (Spring 2015), for an iPad 2 Air 64GB .	
Responses are confidential. Only the research team will see your answers. Data is grouped; no individual is identified. Names, emails, and addresses are only used to contact you for the follow-up survey and to mail you \$35, and to enter your name into the draw.	
Ethics clearance has been given by a University of Waterloo Research Ethics Committee. Contact Dr. Maureen Nummelin, at 519-888-4567, Ext. 36005 or Maureen.nummelin@uwaterloo.ca if you have concerns.	
Questions about the study? Contact Laura Holtby at 519-888-4567, extension 35819 or lholtby@uwaterloo.ca .	

I understand the information and that by clicking YES, I agree to participate in the research study and accept the terms as they are outlined above.

YES

NO

Randomization

Please provide your email address and a telephone number that you would like us to use to contact you about the follow up survey 6 months from now. ***Please remember that your email and other contact information are used by research staff only to contact you for the follow-up surveys.***

Email address: _____

Telephone: [_____] [_____] [_____]

REFUSE

[Script: *Thank you but if you are unwilling to provide an email address you will not be eligible to participate in the study. We require your email address so that we may contact you for the follow up survey.*]

Please provide your address information so that we can mail you the \$10 honorarium for enrolling in the study. You will receive **\$10** for completing the follow-up survey in 3 months and \$15 for completing the final survey 6 months from now. In addition, your name will be entered into a draw at the end of the study for an **iPad Air 2 64GB**.

Please remember that your name and other contact information are used by research staff only to send you the cheques and enter your name into the draw.

Full Name: _____

Street Address (include Apt. or Unit #) : _____

City/Town: _____

Province: _____

Postal Code: _____

Thank you for enrolling in the study. Please click the 'Save and Continue' to finalize your registration for the research study and to receive your quit smoking program. **[randomize to either 1 or 2]**

1. On the Road to Quitting Self-Help Guide – Description

At the end of the survey we will provide you with a link to download a copy of the **On the Road to Quitting Self-Help** guide for quitting smoking available from Health Canada. We will also email you a copy or you may request a hard copy of the guide.

In order to participate in the study, you must use the **On the Road to Quitting** guide over the next six months to help you quit smoking. At 3 and 6 months, we will follow up with you to ask about your smoking and quitting behaviour and to collect some information about the quit smoking program that you received.

2. Crush the Crave Quit Smoking Smartphone App – Description

Q18i	When things are not going my way and I am frustrated	1	2	3	4	5
Q18j	When I am talking on the phone	1	2	3	4	5
Social norms, Attitudes and Beliefs about Smoking						
Q19	What is your overall opinion of smoking? Is it... ? <input type="checkbox"/> Very positive <input type="checkbox"/> Positive <input type="checkbox"/> Neither positive nor negative <input type="checkbox"/> Negative <input type="checkbox"/> Very negative					
Please indicate whether you agree or disagree with the following statements. There is no right or wrong answer - we are most interested in your thoughts.						
Q20	I worry that smoking will damage my health in the future <input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree					
Q21	My friends disapprove of smoking. <input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree					
Q22	Society disapproves of smoking. <input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree					
Q23	Cigarette smoke is dangerous to non-smokers. <input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree					
Q24	Smoking helps people stay slim. <input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree					

Q25	Smoking helps people feel more comfortable at parties and in other social situations <input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree
Q26	Smoking helps reduce stress <input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree
Q27	Smoking can help people when they are bored. <input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree
Q28	My family disapproves of smoking. <input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree

Stress

The questions in this scale ask you about your feelings and thoughts during the last month. In each case, please indicate, by circling your response, how often you felt or thought a certain way.

Q29a	In the last month, how often have you felt that you were unable to control the important things in your life? Never Often 0 1 2 3 4
Q29b	In the last month, how often have you felt confident about your ability to handle your personal problems? Never Often 0 1 2 3 4
Q29c	In the last month, how often have you felt that things were going your way? Never Often 0 1 2 3 4
Q29d	In the last month, how often have you felt difficulties were piling up so high that you could not

overcome them?		Never Often	Almost Never	Sometimes	Fairly Often	Very																																																
		0	1	2	3	4																																																
Quit Resources																																																						
Q30	<p>Quit Resources We are interested in learning more about what helps people quit.</p> <p>Which of the following quit supports have you used in the past or are you currently using? (Choose all that apply):</p> <table border="0"> <thead> <tr> <th></th> <th>Used in the past</th> <th>Using currently</th> </tr> </thead> <tbody> <tr> <td>Telephone quitline/support</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>Nicotine replacement therapy products (e.g. gum, patch, inhaler) <input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>Prescription cessation medications (e.g. Wellbutrin or Champix)</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>E-cigarettes</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>Health professional advice (e.g. doctor, pharmacist)</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>Group cessation programs</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>Self-help materials</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>Quit smoking contests</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>Quit smoking websites</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/> *</td> </tr> <tr> <td>Quit smoking smartphone apps</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/> *</td> </tr> <tr> <td>Social media sites (Facebook/Twitter/Instagram)</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/> *</td> </tr> <tr> <td>Hypnotherapy</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>Herbal therapy</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>Laser therapy</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>Other (Please specify) _____</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> </tbody> </table> <p><input type="checkbox"/> None of the above * Include a text box: "Please specify"</p>							Used in the past	Using currently	Telephone quitline/support	<input type="checkbox"/>	<input type="checkbox"/>	Nicotine replacement therapy products (e.g. gum, patch, inhaler) <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Prescription cessation medications (e.g. Wellbutrin or Champix)	<input type="checkbox"/>	<input type="checkbox"/>	E-cigarettes	<input type="checkbox"/>	<input type="checkbox"/>	Health professional advice (e.g. doctor, pharmacist)	<input type="checkbox"/>	<input type="checkbox"/>	Group cessation programs	<input type="checkbox"/>	<input type="checkbox"/>	Self-help materials	<input type="checkbox"/>	<input type="checkbox"/>	Quit smoking contests	<input type="checkbox"/>	<input type="checkbox"/>	Quit smoking websites	<input type="checkbox"/>	<input type="checkbox"/> *	Quit smoking smartphone apps	<input type="checkbox"/>	<input type="checkbox"/> *	Social media sites (Facebook/Twitter/Instagram)	<input type="checkbox"/>	<input type="checkbox"/> *	Hypnotherapy	<input type="checkbox"/>	<input type="checkbox"/>	Herbal therapy	<input type="checkbox"/>	<input type="checkbox"/>	Laser therapy	<input type="checkbox"/>	<input type="checkbox"/>	Other (Please specify) _____	<input type="checkbox"/>	<input type="checkbox"/>
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Demographics																																																						
Q31	<p>What is your gender?</p> <p>_____ Male _____ Female _____ Transgender _____ Other: _____ (please describe)</p>																																																					
Q32	<p>Presently, you are:</p> <p>_____ Single (never legally married) _____ Married _____ Common Law _____ Separated (but still legally married) _____ Divorced _____ Widowed _____ Prefer not to answer _____ Don't Know</p>																																																					

Q33	<p>What is the highest level of education you have completed?</p> <p><input type="checkbox"/> Less than high school</p> <p><input type="checkbox"/> High school diploma, certificate, or equivalent</p> <p><input type="checkbox"/> Some post-secondary education without degree, certificate, or diploma</p> <p><input type="checkbox"/> Registered apprenticeship or other trades certificate or diploma</p> <p><input type="checkbox"/> College, CEGEP, or other certificate or diploma</p> <p><input type="checkbox"/> University degree</p> <p><input type="checkbox"/> Refused</p> <p><input type="checkbox"/> Don't Know</p>
Q34	<p>What is your best estimate of your total household income for the last 12 months before taxes and deductions? Please include income from all household members and from all sources. Was it ...</p> <p><input type="checkbox"/> Less than \$15,000</p> <p><input type="checkbox"/> \$15,000-\$29,999</p> <p><input type="checkbox"/> \$30,000-\$44,999</p> <p><input type="checkbox"/> \$45,000-\$59,999</p> <p><input type="checkbox"/> \$60,000-\$79,999</p> <p><input type="checkbox"/> \$80,000-\$99,999</p> <p><input type="checkbox"/> \$100,000-\$119,999</p> <p><input type="checkbox"/> \$120,000 or more</p> <p><input type="checkbox"/> Don't Know</p> <p><input type="checkbox"/> Prefer not to answer</p>
Q35	<p>Do you do any <u>paid</u> work (including self-employed paid work)?</p> <p><input type="checkbox"/> Yes, full-time</p> <p><input type="checkbox"/> Yes, part-time</p> <p><input type="checkbox"/> Yes, but I am on paid leave</p> <p><input type="checkbox"/> Yes, but I am on paid sick or disability leave</p> <p><input type="checkbox"/> Yes, but I am on unpaid leave (leave of absence)</p> <p><input type="checkbox"/> No, I am a student</p> <p><input type="checkbox"/> No, I am unemployed</p> <p><input type="checkbox"/> Other(please specify) _____</p> <p><input type="checkbox"/> Don't Know</p> <p><input type="checkbox"/> Refused</p>
Q36	<p>Which population group do you identify with?</p> <p><input type="checkbox"/> Aboriginal (North American Indian, Métis, Inuit)</p> <p><input type="checkbox"/> Arab</p> <p><input type="checkbox"/> White</p> <p><input type="checkbox"/> Chinese</p> <p><input type="checkbox"/> South Asian (e.g., East Indian, Pakistani, Sri Lankan, etc.)</p> <p><input type="checkbox"/> Black</p> <p><input type="checkbox"/> Filipino</p> <p><input type="checkbox"/> Latin American</p> <p><input type="checkbox"/> Southeast Asian (e.g., Cambodian, Indonesian, Vietnamese, etc.)</p> <p><input type="checkbox"/> Japanese</p> <p><input type="checkbox"/> West Asian (e.g., Afghan, Iranian)</p> <p><input type="checkbox"/> Korean</p> <p><input type="checkbox"/> Other (please specify) _____</p>

	<input type="checkbox"/> Don't Know <input type="checkbox"/> Refused
Q37	What province or Territory do you live in? <input type="checkbox"/> British Columbia <input type="checkbox"/> Alberta <input type="checkbox"/> Saskatchewan <input type="checkbox"/> Manitoba <input type="checkbox"/> Ontario <input type="checkbox"/> Quebec <input type="checkbox"/> New Brunswick <input type="checkbox"/> Nova Scotia <input type="checkbox"/> Prince Edward Island <input type="checkbox"/> Newfoundland <input type="checkbox"/> Yukon <input type="checkbox"/> Northwest Territories <input type="checkbox"/> Nunavut
THANK YOU	
<p>THANK YOU</p> <p>You are now finished with the survey. We would like to remind you to please use the [<i>On the Road to Quitting</i> / <i>Crush the Crave smartphone app</i>] over the next six months to help you quit smoking. We will be following up with you in 3 months to collect some information from you and see how you're doing.</p> <p>If you have questions about the study you can contact Laura Holtby, Project Manager, at 519-888-4567, extension 35819 or lholtby@uwaterloo.ca</p> <p>We will be providing you with \$10 to thank you for completing this survey. This will be mailed to you within 10 business days. Thank you for your participation!</p> <p>Please click the link below to download a copy of your quit smoking program. [LINK]</p>	

Appendix A2 - 3-Month Follow-up Survey

EMAIL SCRIPT for 3-Month Follow-Up Survey

[Participants will receive this email message from the research team with a link to the 3 month Follow-up Survey]

Dear XXXX,

We are following up with you about the quit smoking study that you enrolled in 3 months ago. We asked you to use the [*On the Road to Quitting self-help quit smoking program/Crush the Crave quit smoking smartphone app*] for 6 months to help you quit smoking.

[When you first enrolled in the study we let you know that we would follow-up with you in 6 months. We are contacting at the 3 month mark to ask how you are doing in the quit smoking program]. We would like to ask you some questions about your smoking and quitting behaviour, as well as get some feedback from you on the quit smoking program you are doing. The survey should take about **10 minutes** to complete. To thank you for completing the 3 month survey, we will send you a **cheque for \$10 now**. As a reminder, when you complete the final follow-up survey, you will receive another cheque for \$15. You will also be entered into a draw for an **iPad Air 2 64GB**, at the end of the study (spring 2015).

It is important to remember:

- That all your information will be kept private and confidential.
- This national study is being conducted by the Propel Centre for Population Health Impact and has received ethics clearance through a University of Waterloo Research Ethics Committee.
- If you have any questions about the study and your participation, please contact the Project Manager, Laura Holtby at 519-888-4567, extension 35819 or lholtby@uwaterloo.ca.

Smoking Behaviour Information

1. **Do you currently smoke cigarettes or use other tobacco daily, occasionally, or not at all?**
(CHECK ONE)
 Daily
 Occasionally (if less than 7 days per week or less than 1 cigarette per day)
 Not at all

2. **In the past 3 months, when was the last time you smoked a cigarette or used tobacco, even a puff?**
 / / (dd/mm/yyyy)

3. **Have you smoked any cigarettes or used other tobacco, even a puff, in the last 30 days?**
 Yes
 No (Go to Q7 then go to go to 11)
 Don't know
 Refused

4. **Have you smoked any cigarettes or used other tobacco, even a puff, in the last 7 days?**
 Yes
 No (Go to Q7 then go to go to 11)
 Don't know
 Refused

5. **On average, how many cigarettes do you smoke per day on the days that you smoke (cigarettes per day)?**
 # of cigarettes smoked per day(range 1-30+)
 Don't know
 Refused

6. **In the past 3months, did you stop smoking for at least 24 hours because you were trying to quit?**
 Yes (go to 7)
 No (go to 8)

_____ Don't know (go to 8)

_____ Refused (go to 8)

7. **In the past 3 months, how many times did you stop using tobacco for 24 hours or longer?** (For example, if you stopped for 2 days and then started smoking again, and then stopped for a week and started smoking again, *that counts as 2 quits.*)

_____ *Number of times* you quit smoking in the past 3 months(1-90)

_____ Don't Know

_____ Refused

8. **How soon after you wake up do you smoke your first cigarette?**

_____ Within 5 minutes

_____ 6 to 30 minutes

_____ 31 to 60 minutes

_____ More than 60 minutes

9. **Do you intend to quit smoking within the next 30 days?**

_____ Yes

_____ No

_____ Don't Know/Can't say

_____ Refused

10. **Do you intend to quit smoking within the next 6 months?**

_____ Yes

_____ No

_____ Don't Know/Can't say

_____ Refused

Quit Resources

11. Since you enrolled in the study 3 months ago, which of the following did you use or are you currently using to help you quit smoking? (Choose all that apply):

	Used in the Past 3 months	Currently Using
a. Telephone quitline/support	<input type="checkbox"/>	<input type="checkbox"/>
b. Nicotine replacement therapy products (e.g.	<input type="checkbox"/>	<input type="checkbox"/>

gum, patch, inhaler)		
c. Prescription cessation medications (e.g. Wellbutrin or Champix)	<input type="checkbox"/>	<input type="checkbox"/>
d. E-cigarettes	<input type="checkbox"/>	<input type="checkbox"/>
e. Health professional advice (e.g. doctor, pharmacist)	<input type="checkbox"/>	<input type="checkbox"/>
f. Group cessation programs	<input type="checkbox"/>	<input type="checkbox"/>
g. Self-help materials	<input type="checkbox"/>	<input type="checkbox"/>
h. Quit smoking contests	<input type="checkbox"/>	<input type="checkbox"/>
i. Quit smoking websites Please Specify_____	<input type="checkbox"/>	<input type="checkbox"/>
j. Quit smoking smartphone apps Please specify_____	<input type="checkbox"/>	<input type="checkbox"/>
k. Social media sites (Facebook/Twitter/Instagram) Please specify_____	<input type="checkbox"/>	<input type="checkbox"/>
l. Hypnotherapy	<input type="checkbox"/>	<input type="checkbox"/>
m. Herbal therapy	<input type="checkbox"/>	<input type="checkbox"/>
n. Laser therapy	<input type="checkbox"/>	<input type="checkbox"/>
o. Other (Please specify) _____	<input type="checkbox"/>	<input type="checkbox"/>

-----None of the above

Nicotine Withdrawal

12. Please rate yourself for the last 7 days,for the following:

	None	Slight	Mild	Moderate	Severe
a. Angry, irritable, frustrated	0	1	2	3	4
b. Anxious, nervous	0	1	2	3	4
c. Depressed mood, sad	0	1	2	3	4
d. Desire or craving to smoke	0	1	2	3	4

e. Difficulty concentrating	0	1	2	3	4
f. Increased appetite, hungry, weight gain	0	1	2	3	4
g. Insomnia, sleep problems, awakening at night	0	1	2	3	4
h. Restless	0	1	2	3	4
i. Impatient	0	1	2	3	4
j. Constipation	0	1	2	3	4
k. Dizziness	0	1	2	3	4
l. Coughing	0	1	2	3	4
m. Dreaming or nightmares	0	1	2	3	4
n. Nausea	0	1	2	3	4
o. Sore throat	0	1	2	3	4

Intervention Use

[CTC and Quit Guide Groups]

13. Did you download the [*Crush the Crave APP/download or look at the On the Road to Quitting guide*]?

___ Yes (Go to Q15)

___ No (Go to Q14)

14. Please tell us why you did not download the [*CTC APP/download or look at the On the Road to Quitting Guide*].

[Open text field] Go to “You have completed all the questions”

15. Over the last three months, how frequently have you [*used CTC/looked at or read the On the Road to Quitting Guide*]?

___ Never

___ 1-3 times per month

___ Once a week

___ 2-3 times a week

___ Daily

16. Overall, on a scale from 1 to 5, how satisfied would you say you are with the [CTC APP/On the Road to Quitting Guide]?

Not at all satisfied 1	2	3	4	Very satisfied 5
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[CTC Group only]

17. Which features of the app, if any, did you use (check all that apply)?

- Cigarette tracker
- Craving tracker
- Distractions page (Games, Music, Videos)
- Awards page
- My Progress Page
- Health Calculators Page
- My Map feature
- Leader Board feature

Quit Help Pages:

- My Quit Plan page
- Information Pages (e.g. weight gain, alcohol & tobacco, exercise, etc.)
- Online resources (LTPB, Quit4Life, CCS, Smokers' Helpline)
- Call Quitline
- The Crave Community (facebook, twitter)
- Other: Please list: _____

None of the above

[Only items selected above will appear as options for Q18]

18. Which features, if any, did you find most helpful in your quitting process (Check all that apply)?

- Cigarette tracker
- Craving tracker
- Distractions page (Games, Music, Videos)
- Awards page
- My Progress Page
- Health Calculators Page
- My map feature
- Leader board feature

Quit Help Pages:

- My Quit Plan page
- Information Pages (e.g. weight gain, alcohol & tobacco, exercise, etc.)
- Online resources (LTPB, Quit4Life, CCS, Smokers' Helpline)
- Call Quitline
- The Crave Community (facebook, twitter)
- Other: Please list: _____

None of the above

[CTC and Quit Guide Groups]

19. On a scale from 1 to 10

How helpful was the [CTC App/On the Road to Quitting Guide] to quit smoking?

Not helpful 1	2	3	4	5	6	7	8	9	Very helpful 10
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20. Please indicate whether you agree or disagree with the following statements regarding Crush the Crave	
20.a	I use [Crush the Crave/the Quit Guide] frequently <input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree
20.b	I thought [Crush the Crave/the Quit Guide] was easy to use <input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree
20c.	I found the [various functions of Crush the Crave well laid out / Quit Guide to be well laid out.] <input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree
20d.	I felt very confident using [Crush the Crave/Quit Guide] <input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree

[CTC Group only]

21. So that we can link your *CTC APP* use information to your survey responses, could you please provide us with your CTC username? Please remember that all information you provide is private and confidential and will only be seen by project research staff.

[text field]

[] Don't know

[] Refused

22. Is there anything else you would like to tell us about the Quit Smoking Program you are doing?

[Open text field]

You have now completed all the questions.

As a reminder, we are asking you to use the [CTC APP/ On the Road to Quitting guide] for the next 3 months. Here is the link to download the [CTC APP/On the Road to Quitting Guide or if would like a copy of the Quit Guide mailed to you], please contact the Project Manager, Laura Holtby at 519-888-4567, extension 35819 or lholtby@uwaterloo.ca.

As a reminder, we will send you a **cheque for \$10 now** to thank-you for your time completing this survey. We will contact you again in 3 months to complete the final follow-up survey and you will receive another cheque for \$15. You will also be entered into a draw for an **iPad Air 2 64GB**, at the end of the study (spring 2015).

Please confirm your name and address below to make sure you receive your cheque. Don't forget to include an apartment or unit number, if applicable.

[Insert name and address information collected from baseline survey]

Please remember, only our research team will see your answers and email and contact information are used only to send you the cheque, contact you for the follow-up surveys, and enter your name into the draw.

If you have any questions about the study and your participation, please contact Laura Holtby at 519-888-4567, extension 35819 or lholtby@uwaterloo.ca.

Thank you very much for your time and help, and we will be in touch again in 3 months!

Appendix A3 - 6-Month Follow-up Survey

EMAIL SCRIPT for 6-Month Follow-Up Survey

EMAIL SCRIPT for 6-Month Follow-Up Survey

[Participants will receive this email message from the research team with a link to the 6 month Follow-up Survey]

Dear XXXX,

We are following up with you about the quit smoking study that you enrolled in 6 months ago. We asked you to use the [*On the Road to Quitting self-help quit smoking program/Crush the Crave quit smoking smartphone app*] for 6 months to help you quit smoking.

We would like to ask you some final questions about your smoking and quitting behaviour, as well as get some feedback from you on the quit smoking program that you received. The survey should take about **15 minutes** to complete. To thank you for completing the final 6 month survey, we will send you an honorarium for **\$15**. As a reminder, you will also get another entry in the draw to win an iPad Air 2 64GB. The draw will take place at the end of the study in the fall of 2015.

It is important to remember:

- That all your information will be kept private and confidential.
- This national study is being conducted by the Propel Centre for Population Health Impact and has received ethics clearance through a University of Waterloo Research Ethics Committee.
- If you have any questions about the study and your participation please contact the Project Manager, Laura Holtby at 519-888-4567, extension 35819 or lholtby@uwaterloo.ca.

Please click the link below to start the survey

[URL LINK]

Smoking Behaviour Information

Q1	<p>Do you currently smoke cigarettes or use other tobacco daily, occasionally, or not at all? (CHECK ONE)</p> <p><input type="checkbox"/> Daily</p> <p><input type="checkbox"/> Occasionally (if less than 7 days per week or less than 1 cigarette per day)</p> <p><input type="checkbox"/> Not at all</p>
Q2	<p>In the past 6 months, when was the last time you smoked a cigarette or used tobacco, even a puff or a pinch?</p> <p>_____ / _____ / _____ (dd/mm/yyyy)</p>
Q3	<p>Have you smoked any cigarettes or used other tobacco, even a puff, in the last 30 days?</p> <p><input type="checkbox"/> Yes</p> <p><input type="checkbox"/> No (Go to Q7 then go to 11)</p> <p><input type="checkbox"/> Don't know</p> <p><input type="checkbox"/> Refused</p>
Q4	<p>Have you smoked any cigarettes or used other tobacco, even a puff, in the last 7 days?</p> <p><input type="checkbox"/> Yes</p> <p><input type="checkbox"/> No (Go to Q7 then go to 11)</p> <p><input type="checkbox"/> Don't know</p> <p><input type="checkbox"/> Refused</p>
Q5	<p>On average, how many cigarettes do you smoke per day on the days that you smoke?</p> <p>_____ # of cigarettes smoked per day (range 1-30+)</p> <p><input type="checkbox"/> Don't know</p> <p><input type="checkbox"/> Refused</p>
Q6	<p>In the past 6 months, did you stop smoking for at least 24 hours because you were trying to quit?</p> <p><input type="checkbox"/> Yes (go to 7)</p> <p><input type="checkbox"/> No (go to 8)</p> <p><input type="checkbox"/> Don't know (go to 8)</p> <p><input type="checkbox"/> Refused (go to 8)</p>
Q7	<p>In the past 6 months, how many times did you stop using tobacco for 24 hours or longer? (For example, if you stopped for 2 days and then started smoking again, and then stopped for a week and started smoking again, that counts as 2 quits).</p> <p>___ Number of times you quit smoking in the past 6 months (range 1-90)</p> <p><input type="checkbox"/> Don't Know</p> <p><input type="checkbox"/> Refused</p>
Q8	<p>How soon after you wake up do you smoke your first cigarette?</p> <p><input type="checkbox"/> Within 5 minutes</p> <p><input type="checkbox"/> 6 to 30 minutes</p> <p><input type="checkbox"/> 31 to 60 minutes</p> <p><input type="checkbox"/> More than 60 minutes</p>
Q9	<p>Do you intend to quit smoking within the next 6 months?</p> <p><input type="checkbox"/> Yes</p> <p><input type="checkbox"/> No</p> <p><input type="checkbox"/> Don't Know/Can't say</p>

	_____ Refused
Q10	Do you intend to quit smoking within the next 30 days? _____ Yes _____ No _____ Don't Know/Can't say _____ Refused

Social Support	
Q11	Does your partner, spouse, or significant other currently smoke? _____ Yes _____ Yes, but stopping with me _____ No, ex-smoker _____ No, never smoked _____ NA (I do not have a partner/spouse/significant other) _____ Don't know _____ Refused
Q12	Including you, how many smokers are there in your household now? _____ # of smokers in your household _____ Don't Know _____ Refused
Q13	Of the five closest friends or acquaintances that you spend time with on a regular basis, how many of them are smokers? _____ #(Record # between 0 and 5) _____ Don't know _____ Refused
Q14	On a scale from 1 to 5 with 1 being 'not at all' and 5 being 'extremely', how well supported were you by your partner, friends, and/or colleagues? <div style="display: flex; justify-content: space-around; width: 100%;"> 1 2 3 4 5 </div> <div style="display: flex; justify-content: space-around; width: 100%; margin-top: 5px;"> Not at all Slightly Moderately Very Extremely </div>
Q15	On a scale from 1 to 5 with 1 being 'not at all' and 5 being 'extremely', to what extent did you feel you had someone to turn to? <div style="display: flex; justify-content: space-around; width: 100%;"> 1 2 3 4 5 </div> <div style="display: flex; justify-content: space-around; width: 100%; margin-top: 5px;"> Not at all Extremely </div>
Q16	On a scale from 1 to 5 with 1 being 'not at all' and 5 being 'extremely', to what extent did you feel that someone was relying on you to stop smoking this time? <div style="display: flex; justify-content: space-around; width: 100%; margin-top: 10px;"> 1 2 3 4 5 </div>

	Not at all	Extremely
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Self-Efficacy

Q17	On a scale from 1 to 5 with 1 being ‘not at all’ and 5 being ‘extremely’, how confident were you in your ability to quit smoking?	
	1 2 3 4 5	
	Not at all	Extremely

Self-Efficacy/Temptation
Listed below are situations that lead some people to smoke. We would like to know **HOW TEMPTED** you are now to smoke in each situation. Please answer the following questions using the following five point scale. 1 = Not at all tempted
2 = Not very tempted
3 = Moderately tempted
4 = Very tempted
5 = Extremely tempted

Q18a	When out with friends.	1	2	3	4	5
Q18b	When I first get up in the morning	1	2	3	4	5
Q18c	When I am very anxious and stressed	1	2	3	4	5
Q18d	Over coffee while talking and relaxing	1	2	3	4	5
Q18e	When I feel I need a lift (e.g. energy boost)	1	2	3	4	5
Q18f	When I am very angry about something or someone	1	2	3	4	5
Q18g	With my spouse or close friend who is smoking	1	2	3	4	5
Q18h	When I realize I haven't smoked for a while.	1	2	3	4	5
Q18i	When things are not going my way and I am frustrated	1	2	3	4	5

Q18j	When I am talking on the phone	1	2	3	4	5
Social norms, Attitudes and Beliefs about Smoking						
Q19	What is your overall opinion of smoking? Is it... ? <input type="checkbox"/> Very positive <input type="checkbox"/> Positive <input type="checkbox"/> Neither positive nor negative <input type="checkbox"/> Negative <input type="checkbox"/> Very negative					
Please indicate whether you agree or disagree with the following statements. There is no right or wrong answer - we are most interested in your thoughts.						
Q20	I worry that smoking will damage my health in the future <input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree					
Q21	My friends disapprove of smoking. <input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree					
Q22	Society disapproves of smoking. <input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree					
Q23	Cigarette smoke is dangerous to non-smokers. <input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree					
Q24	Smoking helps people stay slim. <input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree					
Q25	Smoking helps people feel more comfortable at parties and in other social situations <input type="checkbox"/> Strongly agree					

	<input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree
Q26	Smoking helps reduce stress <input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree
Q27	Smoking can help people when they are bored. <input type="checkbox"/> Strongly agree _____ <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree
Q28	My family disapproves of smoking. <input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree

Stress

The questions in this scale ask you about your feelings and thoughts during the last month. In each case, please indicate, by circling your response, how often you felt or thought a certain way.

Q29a	In the last month, how often have you felt that you were unable to control the important things in your life? Never Almost Never Sometimes Fairly Often Very Often 0 1 2 3 4
Q29b	In the last month, how often have you felt confident about your ability to handle your personal problems? Never Almost Never Sometimes Fairly Often Very Often 0 1 2 3 4
Q29c	In the last month, how often have you felt that things were going your way? Never Almost Never Sometimes Fairly Often Very Often 0 1 2 3 4
Q29d	In the last month, how often have you felt difficulties were piling up so high that you could not overcome them? Never Almost Never Sometimes Fairly Often Very Often 0 1 2 3 4

Nicotine Withdrawal

Q30	Please rate yourself for <u>the last 7 days</u>, for the following:
-----	----------------------------------------------------------------------------

	None	Slight	Mild	Moderate	Severe
a. Angry, irritable, frustrated	0	1	2	3	4
b. Anxious, nervous	0	1	2	3	4
c. Depressed mood, sad	0	1	2	3	4
d. Desire or craving to smoke	0	1	2	3	4
e. Difficulty concentrating	0	1	2	3	4
f. Increased appetite, hungry, weight gain	0	1	2	3	4
g. Insomnia, sleep problems, awakening at night	0	1	2	3	4
h. Restless	0	1	2	3	4
i. Impatient	0	1	2	3	4
j. Constipation	0	1	2	3	4
k. Dizziness	0	1	2	3	4
l. Coughing	0	1	2	3	4
m. Dreaming or nightmares	0	1	2	3	4
n. Nausea	0	1	2	3	4
o. Sore throat	0	1	2	3	4

Quit Resources

Q31. Since you enrolled in the study 6 months ago, which of the following did you use or are you currently using to help you quit smoking? (Choose all that apply):

Resource or Product	Used in the Past 6 months	Currently Using
p. Telephone quitline/support	<input type="checkbox"/>	<input type="checkbox"/>
b. Nicotine replacement therapy products (e.g. gum, patch, inhaler)	<input type="checkbox"/>	<input type="checkbox"/>
c. Prescription cessation medications (e.g. Wellbutrin or Champix)	<input type="checkbox"/>	<input type="checkbox"/>
d. Health professional advice (e.g. doctor, pharmacist)	<input type="checkbox"/>	<input type="checkbox"/>
e. Group cessation programs	<input type="checkbox"/>	<input type="checkbox"/>
f. Self-help materials	<input type="checkbox"/>	<input type="checkbox"/>
g. Quit smoking contests	<input type="checkbox"/>	<input type="checkbox"/>
h. Quit smoking websites Please Specify _____	<input type="checkbox"/>	<input type="checkbox"/>
i. Quit smoking smartphone apps Please specify _____	<input type="checkbox"/>	<input type="checkbox"/>
j. Social media sites (Facebook/Twitter/Instagram)	<input type="checkbox"/>	<input type="checkbox"/>

Please specify _____		
k. Hypnotherapy	<input type="checkbox"/>	<input type="checkbox"/>
l. Herbal therapy	<input type="checkbox"/>	<input type="checkbox"/>
m. Laser therapy	<input type="checkbox"/>	<input type="checkbox"/>
n. Other (Please specify) _____	<input type="checkbox"/>	<input type="checkbox"/>

_____None of the above

If used these items in the last 6 months, items selected above in Q31 will appear as options for Q32]

Use and Cost of Quit Resources or Products		
Q32. Please tell us the name of each quit resource or product, <i>how much of the product you used</i>, the <i>number of times</i> you had a program visit, and about <i>how much you spent (and were not reimbursed)</i> on each resource or product you used, IN THE LAST 6 MONTHS.		
Resource or Product	How much <i>did you use</i> OR how many times <i>did you visit</i>, IN THE LAST 6 MONTHS	\$ Amount spent, IN THE LAST 6 MONTHS (If applicable)
a. Telephone quitline/support Please specify program name(s) _____	Text field	Text field
b. Nicotine replacement therapy products (e.g. gum, patch, inhaler) Please specify product name(s) _____	Text field	Text field
c. Prescription cessation medications (e.g. Wellbutrin or Champix) Please specify product name(s) _____	Text field	Text field
d. Health professional advice (e.g. doctor, pharmacist) Please specify type of professional(s) _____	Text field	Text field

e. Group cessation programs Please specify program name(s)_____	Text field	Text field
f. Self-help materials Please specify material name(s)_____	Text field	Text field
i. Quit smoking smartphone apps Please specify [auto fill from Q30]	Text field	Text field
lk. Hypnotherapy Please specify program name(s)_____	Text field	Text field
l. Herbal therapy Please specify program name(s)_____	Text field	Text field
m .Laser therapy Please specify program name(s)_____	Text field	Text field
n. Other (Please specify) [auto fill from Q30]	Text field	Text field
E-cigarette Questions		
Q33	Have you <u>ever tried or used</u> an electronic cigarette (e-cigarette, vaporizer)? <input type="checkbox"/> Yes [Go to Q34] <input type="checkbox"/> No [Go to Q46] <input type="checkbox"/> Don't know <input type="checkbox"/> Refused	
Q34	What flavours of electronic cigarette (e-cigarette, vaporizer) have you <u>ever tried or used</u>? (Select all that apply) <input type="checkbox"/> Tobacco <input type="checkbox"/> Menthol <input type="checkbox"/> Coffee <input type="checkbox"/> Spice (e.g., cinnamon) <input type="checkbox"/> Candy (e.g., chocolate) <input type="checkbox"/> Fruit (e.g., strawberry) <input type="checkbox"/> Alcohol (e.g., piña colada) Other (please specify): _____	

	<input type="checkbox"/> Don't know <input type="checkbox"/> Refused
Q35	<p>Have you ever tried or used an electronic cigarette (e-cigarette, vaporizer) that contained nicotine?</p> <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know <input type="checkbox"/> Refused
Q36	<p>Do you have a <u>usual brand</u> of electronic cigarette (e-cigarette, vaporizer) that you use?</p> <input type="checkbox"/> Yes (Go to Q37) <input type="checkbox"/> No (Go to Q38) <input type="checkbox"/> Don't know <input type="checkbox"/> Prefer not to answer
Q37	<p>What is your <u>usual brand</u> of electronic cigarette (e-cigarette, vaporizer)? (Select all that apply)</p> <input type="checkbox"/> VaPUR <input type="checkbox"/> Jasper & Jasper <input type="checkbox"/> Blu <input type="checkbox"/> Dune <input type="checkbox"/> Smoke NV <input type="checkbox"/> NJOY <input type="checkbox"/> Vapor King Other (please specify): _____ [open-ended text] <input type="checkbox"/> Don't know <input type="checkbox"/> Refused
Q38	<p>In your lifetime, which product did you <u>try first</u>, a “regular” tobacco cigarette or an electronic cigarette (e-cigarette, vaporizer)?</p> <input type="checkbox"/> “Regular” tobacco cigarette <input type="checkbox"/> E-cigarette <input type="checkbox"/> Don't know <input type="checkbox"/> Refused
Q39	<p>In the last 30 days, how often did you electronic cigarettes (e-cigarettes, vaporizer)?</p> <input type="checkbox"/> Every day (Go to Q40 “day”) <input type="checkbox"/> At least once a week (Go to Q40 “weekly”) <input type="checkbox"/> At least once in the last 30 days (Go to Q40 “monthly”) <input type="checkbox"/> Not at all (Go to Q42)

	<input type="checkbox"/> Don't know <input type="checkbox"/> Prefer not to answer
Q40	<p>You mentioned that you currently use electronic cigarettes (e-cigarettes, vaporizer) [daily/weekly/monthly]. On average, how many e-cigarettes / e-cigarette cartridges do you use each day? <input type="checkbox"/> Number you use each day <input type="checkbox"/> Don't know <input type="checkbox"/> Refused</p> <p>You mentioned that you currently use electronic cigarettes (e-cigarettes, vaporizer) [daily/weekly/monthly]. On average, how many e-cigarettes / e-cigarette cartridges do you use each week? <input type="checkbox"/> Number you use each week <input type="checkbox"/> Don't know <input type="checkbox"/> Refused</p> <p>You mentioned that you currently use electronic cigarette (e-cigarette, vaporizer) [daily/weekly/monthly]. On average, how many e-cigarettes / e-cigarette cartridges do you use each month? <input type="checkbox"/> Number you use each month (Go to Q42) <input type="checkbox"/> Don't know (Go to Q42) <input type="checkbox"/> Refused (Go to Q42)</p>
Q41	<p>How soon after waking do you <u>usually</u> have your first electronic cigarette (e-cigarette, vaporizer)? <input type="checkbox"/> Within the first 5 minutes <input type="checkbox"/> 6-30 minutes <input type="checkbox"/> 31-60 minutes <input type="checkbox"/> More than 60 minutes <input type="checkbox"/> Don't know <input type="checkbox"/> Refused</p>
Q42	<p>Please tell us <u>why you first tried</u> an electronic cigarette (e-cigarette, vaporizer). I tried an e-cigarette because... (Select all that apply) <input type="checkbox"/> Someone offered me one <input type="checkbox"/> I thought it would be fun <input type="checkbox"/> I thought it might taste good <input type="checkbox"/> I was curious what it would be like <input type="checkbox"/> I thought it could help me quit smoking <input type="checkbox"/> I thought it might be less harmful to me than a cigarette <input type="checkbox"/> I wanted to use it in a place where I couldn't smoke</p> <p>Other (please specify): _____ [open-ended text]</p>

	<input type="checkbox"/> Don't know <input type="checkbox"/> Refused
Q43	<p>Please tell us why you <u>currently use</u> electronic cigarette (e-cigarette, vaporizer). I use e-cigarettes because... (Select all that apply)</p> <input type="checkbox"/> They are affordable <input type="checkbox"/> They are fun to use <input type="checkbox"/> They taste good <input type="checkbox"/> Using e-cigarettes might help me to quit smoking <input type="checkbox"/> They might be less harmful to me than cigarettes <input type="checkbox"/> They might be less harmful to people around me than cigarettes <input type="checkbox"/> I can use e-cigarettes in places where smoking isn't allowed <input type="checkbox"/> I don't currently use electronic cigarettes
	<input type="checkbox"/> Other (please specify): <input type="checkbox"/> [open-ended text]
	<input type="checkbox"/> Don't know <input type="checkbox"/> Refused
Q44	<p>Of your 5 closest friends, how many <u>have tried</u> electronic cigarettes (e-cigarettes, vaporizer)?</p> <input type="checkbox"/> 0 <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> Don't know <input type="checkbox"/> Refused
Q45	<p>Of your 5 closest friends, how many <u>currently use</u> electronic cigarettes (e-cigarettes, vaporizer)?</p> <input type="checkbox"/> 0 <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> Don't know <input type="checkbox"/> Refused

[CTC and Quit Guide Groups]

Intervention Use					
Q46	<p>Did you download the [Crush the Crave APP/download or look at the On the Road to Quitting guide]? ___ Yes (Go to Q15) ___ No (Go to Q14)</p>				
Q47	<p>Please tell us why you did not download the [CTC APP/download or look at the On the Road to Quitting Guide].</p> <p>[Open text field] Go to “You have now completed all the questions”</p>				
Q48	<p>Over the last 6 months, how frequently have you [used CTC/looked at or read the On the Road to Quitting Guide]? ___ Never ___ 1-3 times per month ___ Once a week ___ 2-3 times a week ___ Daily</p>				
Q49	<p>Overall, on a scale from 1 to 5, how satisfied would you say you are with the [CTC APP/On the Road to Quitting Guide]?</p>				
	Not at all satisfied 1	2	3	4	Very satisfied 5
Q50	<p>Would you use the [CTC APP/Quit guide] again if you needed help quitting smoking? ___ Yes ___ No</p> <p>If not, please tell us why? _____</p>				

[CTC Group only]

Q51	<p>21. Which features of the app, if any, did you use (check all that apply)?</p> <p>___ Cigarette tracker ___ Craving tracker ___ Distractions page (Games, Music, Videos) ___ Awards page ___ My Progress Page</p>
-----	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

	<input type="checkbox"/> Health Calculators Page <input type="checkbox"/> My Map feature <input type="checkbox"/> Leader Board feature Quit Help Pages: <input type="checkbox"/> My Quit Plan page <input type="checkbox"/> Information Pages (e.g. weight gain, alcohol & tobacco, exercise, etc.) <input type="checkbox"/> Online resources (LTPB, Quit4Life, CCS, Smokers' Helpline) <input type="checkbox"/> Call Quitline <input type="checkbox"/> The Crave Community (facebook, twitter) <input type="checkbox"/> Other: Please list: _____ <input type="checkbox"/> None of the above
[Only items selected in Q36 will appear as options for Q37]	
Q52	Which features, if any, did you find most helpful in your quitting process (Check all that apply)? <input type="checkbox"/> Cigarette tracker <input type="checkbox"/> Craving tracker <input type="checkbox"/> Distractions page (Games, Music, Videos) <input type="checkbox"/> Awards page <input type="checkbox"/> My Progress Page <input type="checkbox"/> Health Calculators Page <input type="checkbox"/> My map feature <input type="checkbox"/> Leader board feature Quit Help Pages: <input type="checkbox"/> My Quit Plan page <input type="checkbox"/> Information Pages (e.g. weight gain, alcohol & tobacco, exercise, etc.) <input type="checkbox"/> Online resources (LTPB, Quit4Life, CCS, Smokers' Helpline) <input type="checkbox"/> Call Quitline <input type="checkbox"/> The Crave Community (facebook, twitter) <input type="checkbox"/> Other: Please list: _____ <input type="checkbox"/> None of the above

[CTC and Quit Guide Groups]

Q53	22. On a scale from 1 to 10, how helpful was the [CTC App/On the Road to Quitting Guide] to quit smoking?								
Not helpful 1	2	3	4	5	6	7	8	9	Very helpful 10

Q54	Please indicate whether you agree or disagree with the following statements regarding [Crush the Crave APP/On the Road to Quitting guide].
a.	I use [Crush the Crave/the Quit Guide] frequently <input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree
b.	I thought [Crush the Crave/the Quit Guide] was easy to use <input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree
c.	I found the [various functions of Crush the Crave well laid out / Quit Guide to be well laid out.] <input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree
d.	I felt very confident using [Crush the Crave/Quit Guide] <input type="checkbox"/> Strongly agree <input type="checkbox"/> Agree <input type="checkbox"/> Neither agree nor disagree <input type="checkbox"/> Disagree <input type="checkbox"/> Strongly disagree
Q55	What aspects of the [Crush the Crave smartphone app/Quit Guide] were most appealing? (e.g. design, format, instructions, navigation, terminology, etc.) [Open text field]
Q56	Which resources in the [CTC smartphone app/Quit Guide] were most difficult to use? [Open text field]
Q57	How could the resources in the [CTC smartphone app/Quit Guide] be improved? [Open text field]

[CTC Group only]

Q58	So that we can link your <i>CTC APP</i> use information to your survey responses, could you please provide us with your <i>CTC username</i>? Please remember that all information you provide is private and confidential and will only be seen by project research staff. [Open text field] ___ Don't know ___ Refused
[CTC and Quit Guide Group]	
Q59	Is there anything else you would like to tell us about the Quit Smoking Program you were doing? [Open text field]

You have now completed all the questions. Thank you very much for your time and help, and for participating in our research study! We will send you an honorarium **for \$15** in appreciation for your completion of the 6 month follow-up survey. In addition, you will get another entry in the draw to win an iPad Air 2 64GB. The draw willtake place at the end of the study in 2015.

Please verify your contact information:

[Participant Name]

[Participant Address]

Please remember, only our research team will see your answers and email and contact information are used only to send you the honorarium and enter you name into the draw.

If you are interested in the study findings, you can contact the Project Manager at the Propel Centre for Population Health Impact at the University of Waterloo by phone at 519-888-4567, extension 35819, or email at lholtby@uwaterloo.ca We will be happy to share a copy of the final report with you once it becomes available.

[If CTC APP Group and “Yes” to download]

Telephone Interview:

As part of the research study, we are also asking a sample of study participants if they would be interested in participating in a 60minute telephone interview to provide some more details about their experience using the quit smoking program. Those study participants who take part in the interviews will receive up to a\$50 honorarium to thank them for their time.

Would you be interested in participating in 30 minute telephone interview to discuss your experience using the quit smoking program?

_____ **YES**

Great, we will follow up with you shortly to schedule a time to talk with you. Please indicate below the telephone number where we can reach you.

PHONE: _____

Okay, thank you so much for your time. We will be in touch with you shortly.

_____ **NO**

Okay, thank you so much for your time. This concludes the survey.

Appendix B - Descriptive Statistics

Appendix B1 - Distribution of missing values across baseline and follow-up variables

Baseline variables	n ^a (%)	Follow-up variables	n ^a (%)
Sex	6 (0.7)	Quit (30-day)	14 (1.6)
Marital status	3 (0.4)	Quit (7-day)	16 (1.9)
Education	4 (0.5)	E-cigarette use	11 (1.3)
Income	83 (9.7)	Ever EC with nicotine use	27 (3.2)
Occupation	24 (2.8)	Quit attempt	12 (1.4)
Ethnicity	23 (2.7)	Intervention use	18 (2.1)
Social norms	13 (1.5)	Self-efficacy	11 (1.3)
TTFC	3 (0.3)	Social norms	20 (2.4)
CPD	6 (0.7)		
Self-efficacy	12 (1.4)		
Age/region/quit supports	n.a.		

a- Total number of missing values including 'don't know' or 'refused' responses, n.a.- not applicable

Appendix B2 - Mean CPD (cigarettes per day) at baseline and 6-month follow-up survey based on smoker's category

Smoker's category	Baseline		Follow-up		p-value ^a	C.I.
	n, Mean CPD	SD	n, Mean CPD	SD		
Cigarette smokers	619, 13.2	8.1	619, 8.1	8.9	<0.01	4.2--6.1
Persistent EC users	57, 12.7	6.4	57, 8.4	13.6	0.03	0.4--8.2
Transient EC users	214, 14.3	8.9	214, 7.8	8.9	<0.01	4.8--8.2
Non-users	341, 12.9	7.6	341, 8.1	8.1	<0.01	3.6--5.9

a=p-values calculated from paired t-tests.

n= Total number of smokers at baseline or 6-month follow-up survey who did not quit at 6-month follow-up survey.

CPD= Cigarettes per day smoked, C.I.= Confidence Interval, SD= Standard deviation

Appendix B3 - Frequency analysis for 30-day and 7-day smoking abstinence

Response	30-day quit	7-day quit
Quit	218 (26%)	309 (37%)
Did not quit	619 (74%)	526 (63%)

Note: The missing values associated with 30-day quit (1.6%) and 7-day quit (1.9%), mentioned in Appendix B1 have been excluded.

Appendix C - Situational Analysis

Appendix C1 - Proportion of e-cigarette and non-users showing high temptations (self-efficacy) for smoking in different situations.

Situation (Highly tempted ^a)	Persistent users n, %	Transient users n, %	Non-users n, %	χ^2 , p-value ^b
When out with friends.	38, 57%	161, 57%	300, 61.5%	5.76 2.20
When I first get up in the morning.	40, 60%	147, 52%	224, 46%	10.34 0.04
When I am very anxious and stressed.	59, 87%	241, 85%	414, 85%	5.42 0.23
Over coffee while talking and relaxing	34, 51%	136, 48%	244, 50%	3.90 0.41
When I feel I need a lift. (e.g. energy boost)	21, 31%	56, 20%	122, 25%	10.90 0.03
When I am very angry about something or someone.	57, 85%	224, 79%	400, 82%	4.90 0.30
With my spouse or close friend who is smoking.	46, 68%	176, 62%	317, 65%	3.30 0.50
When I realize I haven't smoked for a while.	36, 53%	105, 37%	185, 38%	8.60 0.07
When things are not going my way and I am frustrated.	52, 77%	195, 69%	351, 72%	6.0 0.20
When I am talking on the phone.	13, 19%	37, 13%	68, 14%	5.20 0.26
Overall high self-efficacy	28, 42.4%	111, 39.4%	194, 40.4%	1.40 0.85

^aOnly participants who stated 'Highly tempted' to the statements have been mentioned in the table.

^bComparison made for baseline_self-efficacy using χ^2 tests, between participants who were persistent, transient and non-users and who were highly tempted, moderately tempted and not tempted in various situations, at 6-month follow-up survey. p-value (level of significance=0.05).

Appendix C2 - Proportion of e-cigarette and non-users showing agreement to various social norms situations.

Situation (Agreed ^a)	Persistent users n, %	Transient users n, %	Non-users n, %	χ^2 , p-value ^b
I worry that smoking will damage my health in the future.	63, 93%	259, 91%	443, 91%	0.43 0.98
My friends disapprove of smoking.	24, 35%	74, 26%	135, 28%	2.4 0.66
Society disapproves of smoking.	38, 56%	173, 61%	320, 66%	11.4 0.023
Cigarette smoking is dangerous to non smokers.	57, 84%	243, 86.5%	410, 84%	2.20 0.71
Smoking helps people stay slim	16, 24%	52, 18%	102, 21%	1.92 0.75
Smoking helps people feel more comfortable at parties and in other social situations.	33, 49%	160, 57%	290, 59%	3.7 0.45
Smoking helps reduce stress.	47, 70%	209, 74%	331, 68%	4.1 0.40
Smoking can help people when they are bored.	43, 63%	172, 61%	296, 61%	2.2 0.71
My family disapproves of smoking.	36, 53%	168, 60%	307, 63%	4.5 0.34
Overall negative opinion	43, 64%	207, 73%	336, 69%	3.24 0.52

^aOnly participants who stated 'Agreed' to the statements have been mentioned in the table.

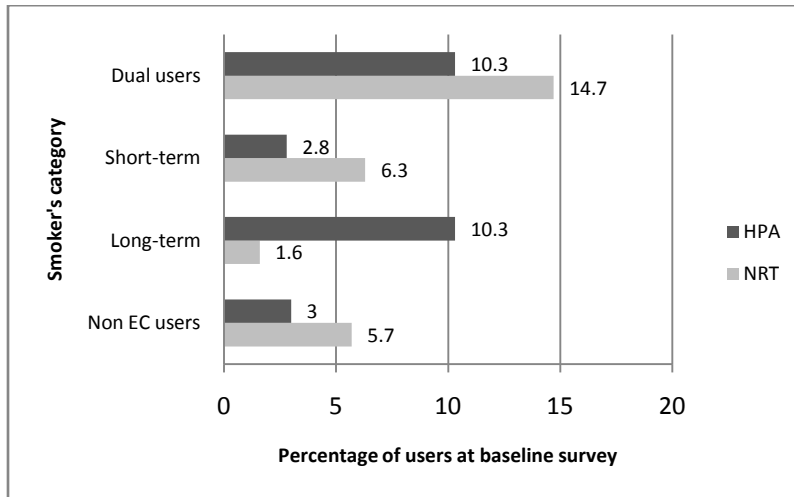
^bComparison made using χ^2 tests, between participants who were persistent, transient and non-users and who agreed, disagreed or stated neither for various situations, at 6-month follow-up survey. p-value (level of significance=0.05).

Appendix C3 - Perceptions of use among persistent and transient e-cigarette users.

Reasons for using ECs	Persistent E-cigarette users n=68 (n, %)	Transient E-cigarette users n=218 (n, %)	χ^2 , p-value ^a
Affordable	23 (34%)	59 (27%)	3.7, 0.052
Fun	9 (13%)	23 (10.5%)	1.2, 0.26
Tasty	26 (38%)	6 (30.3%)	4, 0.045
Quit aid	48 (71%)	144 (66%)	5.7, 0.016
Less harm to me	42 (62%)	106 (49%)	10.7, 0.001
Less harm to people	36 (53%)	83 (38%)	1.4, 0.23
In restrictions	17 (25%)	47 (22%)	1.5, 0.21

^aComparison made using χ^2 tests, between participants who were persistent and transient users at 6-month follow-up survey. p-value (level of significance=0.05).

Appendix D - Most prevalent cessation supports among smoker's categories



HPA= Health Care Professional's Advice

NRT= Nicotine Replacement Therapy

Appendix E - Logistic Regression Analysis

Appendix E1 - Multivariable logistic regression for the association between frequency of e-cigarette use and 30-day smoking abstinence.

Frequency of EC use	Abstinent n ^a (%)	Bivariable ^b	Multivariable ^c
		OR (CI) p-value	OR (CI) p-value
Last 30-days ^d	16 (13.2)	1.00	1.00
Once a week EC users	17 (25.3)	2.19 (1.02--4.69) 0.044	1.77 (0.77--4.06) 0.18
Daily EC users	24 (24.5)	2.18 (1.08--4.39) 0.03	2.16 (1.03--4.53) 0.043
Non-users	159 (28.7)	2.64 (1.50--4.61) 0.0007	2.56 (1.43--4.59) 0.0015

CI = Confidence Interval; OR = Odds Ratio, p-value at 0.05 level of significance.

^aNumber and percent of participants who were abstinent at 30 days at 6-month follow-up in each category.

^bBivariable analysis: series of models that assessed association of all socio-demographics, psychological and usage characteristics individually with 30-day smoking abstinence.

^cConfounders included in Multivariable analysis: ethnicity, baseline variables (quit aid_current use, self-efficacy, social norms, nicotine dependence) and 6-month variables (quit attempt, intervention use).

^dReference group.

Appendix E2 - Multivariable logistic regression for the association between e-cigarette user category, other predictors and 7-day smoking abstinence.

Variable	Abstinent n ^a (%)	Bivariable			Multivariable		
		OR crude	95% C.I.	p-value	OR adjusted all ^c	95% C.I.	p-value
(a) Smoker's category							
(i) E-cigarette users							
Persistent ^d	21 (30.9)	1.00	--	--	1.00	--	--
Transient	97 (34.2)	1.14	0.64--2.03	0.65	1.26	0.67--2.37	0.47
Non-users	189 (38.7)	1.38	0.79--2.4	0.25	1.48	0.81--2.72	0.20
(b) Socio-demographics							
(i) Age [#]							
19-23 ^d	151 (38.0)	1.00	--	--	1.00	--	--
24-29	158 (34.8)	0.87	0.65--1.15	0.31			
(ii) Gender [#]							
Male ^d	161 (40.0)	1.00	--	--	1.00	--	--
Female	146 (36.8)	1.04	0.79--1.38	0.78			
(iii) Marital status [#]							
Single ^d	196 (37.0)	1.00	--	--	1.00	--	--
Married/others	112 (37.2)	1.01	0.76--1.36	0.93			
(iv) Education [#]							
No university/college degree ^d	127 (36.5)	1.00	--	--	1.00	--	--
University degree	179 (35.9)	0.95	0.72--1.27	0.75			
(v) Income [#]							
less than \$15,000 ^d	56 (40.6)	1.00	--	--	1.00	--	--
\$15,000-\$44,999	116 (35.3)	0.80	0.53--1.20	0.28			
\$45,000-\$79,999	60 (37.0)	0.86	0.54--1.37	0.53			
\$80,000- \$120,000	47 (38.2)	0.91	0.55--1.50	0.70			
(vi) Occupation [#]							
Employed ^d	212 (38.0)	1.00	--	--	1.00	--	--
Unemployed	84 (33.1)	0.81	0.59--1.10	0.18			
(vii) Ethnicity [#]							
White ^d	205 (33.2)	1.00	--	--	1.00	--	--
Aboriginal	37 (41.1)	1.55	0.98--2.46	0.06	1.38	0.83--2.28	0.22
Others	55 (45.8)	1.66	1.12--2.47	0.02	1.61	1.05--2.47	0.028
(viii) Region [#]							
Ontario ^d	134 (37.3)	1.00	--	--	1.00	--	--
Others	175 (36.8)	0.98	0.74--1.30	0.87			
(c) Psychological predictors							
(i) Self-efficacy_base [*]							
Low ^d	43 (29.7)	1.00	--	--	1.00	--	--
High	145 (43.1)	1.79	1.18--2.73	0.006	1.92	1.22--3.04	0.005
(ii) Social norms_base							
Negative ^d	206 (35.2)	1.00	--	--	1.00	--	--
Positive	8 (38.1)	1.19	0.48--2.96	0.71	0.99	0.39--2.69	0.99
(iii) Level of dependence							
High ^d	71 (32.9)	1.00	--	--	1.00	--	--
Low	235 (37.5)	1.23	0.89--1.71	0.21	1.03	0.72--1.48	0.87
(iv) Quit attempt							
Yes ^d	276 (36.6)	1.00	--	--	1.00	--	--
No	25 (29.8)	0.75	0.46--1.24	0.26	0.69	0.39--1.23	0.21
(d) Quit aid and Intervention use							
(i) Quit aid user_intake							
Non-users ^d	243 (35.7)	1.00	--	--	1.00	--	--
Current users	66 (38.6)	1.86	0.61--1.23	0.41	1.19	0.81--1.74	0.38
(ii) App / Intervention user							
Yes ^d	256 (36.9)	1.00	--	--	1.00	--	--
No	49 (35.3)	0.91	1.62--1.34	0.64	0.76	0.50--1.16	1.20

CI = Confidence Interval; OR = Odds Ratio, p-value at 0.05 level of significance.

^aNumber and percent of participants who were abstinent at 7 days at 6-month follow-up in each category.

^bBivariable analysis: series of models that assessed association of e-cigarette user category, all socio-demographics, psychological and usage characteristics individually with 30-day smoking abstinence.

^cConfounders included in Multivariable analysis: ethnicity, baseline variables (quit aid_current use, self-efficacy, social norms, nicotine dependence) and 6-month variables (quit attempt, intervention user)

Following regression equation $Y = x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8 + \beta_0$ (constant), where $Y = 7$ -day smoking abstinence and $x_1 = EC$ use, $x_2 =$ ethnicity, $x_3 =$ self-efficacy, $x_4 =$ social norms, $x_5 =$ nicotine dependence, $x_6 =$ quit attempt, $x_7 =$ quit aid, $x_8 =$ intervention use;

$$\ln\{p/(1-p)\} = \ln\left\{\frac{e^{\beta_0 + \beta_1}}{1 - (e^{\beta_0 + \beta_1}) / (1 + e^{\beta_0 + \beta_1})}\right\} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \beta_8 x_8$$

Variables not included in the final Multivariable model.

* Variables remained significant after model adjustments.

^dReference group.

Appendix F - Project Timeline

The following Gantt chart presents the timeline of events that were conducted during the study.

2016	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Project development and approval						■	■					
Literature review								■	■			
Finalizing Methods and approval										■	■	■
2017	■	■	■	■	■	■	■	■	■	■	■	■
Proposal Defence	■											
Ethics clearance		■	■									
Data Analysis				■	■	■	■	■				
Thesis defence and Final Submission									■			