# YOUNG ADULT SMOKING CESSATION AND MOBILE HEALTH: A QUALITATIVE INVESTIGATION OF THE CRUSH THE CRAVE APP

by

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**Abstract**

Smoking remains a major public health issue, particularly among young adults because smoking rates are highest in this demographic. With young adults' low uptake of the various smoking cessation interventions available, innovative ways to support young adult smoking cessation are needed, and there is much enthusiasm about the use of mobile phones, especially apps, to reach this population. How these tools influence smoking cessation, however, remains largely unknown. Therefore, the purpose of this qualitative case study was to understand the design and use of the mobile app, Crush the Crave (CTC), for helping young adults quit smoking. Data included document analysis, fieldwork, and semi-structured interviews with 15 key informants (those involved in the development of CTC) and 31 young adult CTC users. Guided by sociomateriality theory and an affordances approach, as well as a gender-based analysis, data were inductively analyzed to derive thematic findings in relation to the influence of CTC on young adult's quit smoking efforts. Findings were grouped per the overall strengths and limitations of the app, and the affordances of the app. Affordances were grouped according to each design component of the app: credibility, task support, social support, and dialogue support. Data from key informants revealed the expectations of CTC for helping young adults quit smoking, which were juxtaposed to young adults' actual experiences with the app. While key informants' expectations often aligned with young adults' experiences, there were also some noteworthy differences and additional experiences that the key informants did not anticipate. The credibility, task support, and dialogue support functions lent to largely positive experiences and practices, including trust in the app, encouragement and motivation for quitting, and enhanced awareness of smoking behaviour. The social support component lent to negative user experiences (vulnerability) and practices (low engagement) that rendered this aspect as the

weakest component in supporting efforts to quit. There were also some notable gender differences and similarities in relation to the preferences and experiences of young women and men. This study highlights both productive and unproductive approaches to the development of smoking cessation apps, and offers new directions for future improvements and app development.

## Preface

This dissertation is the original work of the author, Laura Struik. The research study was conducted under the supervision of committee members: Dr. Joan L. Bottorff (supervisor, Chair in Health Promotion and Cancer Prevention, Director of the Institute for Healthy Living and Chronic Disease Prevention, Professor at the School of Nursing, University of British Columbia's Okanagan Campus), Dr. N. Bruce Baskerville (Senior Scientist at the Propel Centre for Population Health Impact, Research Associate Professor in the Faculty of Applied Health Sciences, University of Waterloo), Dr. Susan Crichton (Director of the Innovative Learning Centre, Director of the Faculty of Education, Associate Professor in the Faculty of Education, UBC's Okanagan Campus), and Dr. John Oliffe (Professor at the School of Nursing, UBC). Ethics approval for this study was obtained from the University of British Columbia (Okanagan campus) Behavioural Research Ethics Board prior to commencement of data collection (Certificate No. H15-00466)

## Table of contents

**List of tables**

**List of figures**

**List of definitions**

**eHealth –** The term "eHealth" refers to health services and information delivered or enhanced through the Internet and related technologies" (Eysenbach, 2001).

**mHealth** - The term "mHealth" refers to the use of mobile phone technologies for the delivery of health interventions and is situated in the broader term, "eHealth".

**App** - In keeping with Lewis and colleagues (2014), I will be using the term "app" instead of "application". "App" refers to a third-party software application that performs a particular task around a particular topic, such as aiding smoking cessation.

**List of abbreviations**

**CTC** – Crush the Crave

**LTPB** – Leave the Pack Behind

**USCPG** – U.S. Clinical Practice Guidelines

**RCT** – Randomized Control Trial

**KI** – Key Informant

**P** – Participant

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I close with praises and thanks to God, who has given me this gift to positively contribute to the health and lives of others. "As each has received a gift, use it to serve one another, as good stewards of God's varied grace." 1 Peter 4:10.

## Dedication

Dedicated

to my daughter, Elizabeth.

You inspire me to strive for excellence in everything I am and everything I do.

# CHAPTER 1 – INTRODUCTION

In this study, a sociomateriality lens was employed to explore the interaction between young adult smokers and the smoking cessation smartphone app, Crush the Crave (CTC), a theory that upholds both the app and the end-user as equal contributors to outcomes from using the app. The purpose of this case study was to describe how a quit smoking app influences young adult smoking cessation, how young adults interact with this intervention, and how this interaction shapes young adults' smoking cessation experiences and practices. The overall goal was to improve understanding of key mechanisms that lend to positive and negative outcomes, and ultimately to provide guidance for improving existing smoking cessation apps, as well as the development, implementation, and evaluation of new apps for smoking cessation.

This Chapter begins with an overview of the background and context that frames the study and a description of the smoking cessation smartphone app, CTC, which was examined in this study. This is followed by a problem statement, study purpose, specific research questions, and a description of the theoretical lens drawn upon for this study, that of sociomateriality.

## Background and context

Young adult smoking remains a critical public health issue across North America because smoking rates in this age demographic are highest (Reid, Hammond, Rynard, & Burkhalter, 2015; U.S. Department of Health and Human Services, 2014). For example, 17.9% and 18.5% of Canadian young adults aged 20-24 and 25-34 respectively smoke, which is almost 5% above the national average of 14.6% (Reid et al., 2015). In addition, there is recent evidence indicating that young adults are taking up smoking at increasing rates (Bernat, Klein, & Forster, 2012; Jha et al., 2013; O'Loughlin, Dugas, O'Loughlin, Karp, & Sylvestre, 2014), which has been attributed to co-use with marijuana (Ramo et al., 2013), and new marketing tactics by the tobacco industry

(Fairchild et al., 2014; Kostygina et al., 2014; Villanti et al., 2013). Despite these alarming trends, most young adult smokers express a desire to quit. For example, Canadian young adults aged 20-24 and 25-34 reported that they were seriously considering quitting in the next 6 months at 61.7% and 71.5% respectively (Reid et al., 2014). Given evidence that quitting before the age of 40 reduces the risk of a tobacco-related death by as much as 90% (Jha et al., 2013), as well as that quit attempts decrease with age as patterns of tobacco use become engrained (Reid et al., 2014), helping young adults quit smoking is a priority.

Finding effective solutions to help young adults quit smoking remains a challenge. Despite the existence of a myriad of evidence-based smoking cessation options (Raw, McNeill, & West, 1999b), research suggests that younger adult smokers are particularly unlikely to seek treatment, as compared to older smokers (Bader, Travis, & Skinner, 2007; Curry, Sporer, Pugach, Campbell, & Emery, 2007; Hughes, Cohen, & Callas, 2009). However, according to a recent meta-analysis conducted to examine if this lack of utilization was because smoking-cessation interventions found effective for the general adult population were simply not effective for young adults, it was found that when young adults do use these interventions they are effective (Suls et al., 2012). These findings suggest that currently established interventions may not appeal to young adults or that current recruitment strategies might not be successful in promoting the interventions to them. This underutilization of smoking cessation interventions by young adults, combined with a lack of age-appropriate cessation interventions (Suls et al., 2012) and comprehensive marketing to younger populations by the tobacco industry (Centers for Disease Control and Prevention, 2012) are major reasons for the lack of decline in young adult smoking rates. New strategies for reaching young adult smokers are needed. One recent direction is the emergence of mobile technologies as promising platforms to enhance tobacco control

efforts directed towards this population in an effective and efficient manner (Whittaker, Merry, Dorey, & Maddison, 2012).

Mobile technologies have become ever more pervasive in young adults' everyday lives. According to recent statistics, young adults aged 18 to 29 lead the way in the use of mobile phones (93%) (Lenhart, 2013) and smartphones (79%) (Smith, 2013). The use of smartphone applications (apps) has become particularly popular among young adults. Not only are young adults most likely to download apps, but they are also the most intense users of apps (Purcell, 2011). It is not surprising, then, that young adults are the most frequent users of health-related apps (Fox & Duggan, 2013). In light of this evidence, there has been increasing interest in harnessing smartphone apps as a means of delivering health behaviour interventions to this age demographic.

The use of smartphone apps for smoking cessation offers many unique benefits compared to traditional approaches, most notably because individuals can access these interventions anytime and in everyday settings (Cole-Lewis & Kershaw, 2010) whereby assistance is immediately available when needed (e.g., help in dealing with cravings). The complex functionalities supported by smartphone apps increases the intensity of health behaviour interventions, and it has been suggested that increased intensity and tailoring of interventions enhances commitment to cessation goals, resulting in higher quit rates (Curry, McBride, Grothaus, Louie, & Wagner, 1995; Miguez, Vazquez, & Becona, 2002; Ossip-Klein, Carosella, & Krusch, 1997). Encouragingly, recent evidence suggests that app-based smoking cessation interventions are more appealing than any other mobile-based smoking cessation intervention (Bricker et al., 2014), especially among young adults (Bader et al., 2007; BinDhim, McGeechan,

& Trevena, 2014; Minian, Schwartz, Di Sante, & Philipneri, 2010; Naughton, Jamison, & Sutton, 2013; Ybarra, Holtrop, Prescott, & Strong, 2014).

Despite enthusiasm in delivering smoking cessation interventions to young adults through smartphone apps and the existence of dozens of smoking cessation smartphone apps, research evidence on these interventions remains scarce. There is a particular lack of research on how these interventions are designed to influence tobacco use, as well as how they have been taken up by young adults (Dennison, Morrison, Conway, & Yardley, 2013). While initial qualitative research indicates that smartphone apps are acceptable and feasible platforms for delivering health behaviour interventions (e.g., Bock, Heron, Jennings, Magee, & Morrow, 2013; Burner, Menchine, Kubicek, Robles, & Arora, 2014; Burns et al., 2011; Muessig et al., 2013; Vandelanotte et al., 2013), there remains a lack of research with the aim of developing an in-depth understanding of the interaction between smoking cessation smartphone apps and the target users (Dennison et al., 2013), as well as whether or not the apps are used in ways that are consistent with the underlying principles of development (Leonardi & Barley, 2008). It has been highlighted by eHealth researchers that there is a particular lack of focus in the intervention literature on smartphone interventions for young adults despite the fact that this is a priority population for a broad range of health behaviour issues, including tobacco use (Buhi et al., 2012; Hebden, Cook, van der Ploeg, & Allman-Farinelli, 2012). Furthermore, despite established evidence that gender-sensitive approaches are needed for smoking cessation interventions, and that eHealth cessation interventions that include a gender-sensitive approach have been found to positively influence receptivity to and use of the interventions (e.g., Bottorff et al., 2016; Haines-Saah et al., 2015; Schwartz et al., 2014), no efforts to investigate the influence of gender-related factors and/or ways to incorporate a gender-sensitive approach into mobile-based smoking

cessation interventions specifically have been found. Indeed, to fully capitalize on the power of smartphone apps for smoking cessation, and health promotion more broadly, there is a need for better understanding of the ways that these interventions promote and support young adult health behaviours (Buhi et al., 2012).

## Problem statement

Despite that young adults are the largest users of quit smoking apps, there is a dearth of research investigating the role of these interventions in young adults' smoking cessation efforts. There is a particular lack of in-depth research investigating the design and use of smoking cessation interventions delivered via smartphone apps with consideration for the various contextual factors that may influence engagement with these interventions, including gender. This knowledge gap leads to questions about what aspects of mobile-based smoking cessation interventions work well and where improvements can be made to strengthen these interventions. In addition, existing qualitative research studies that have been conducted have only investigated one element of smoking cessation practices in the area of mHealth (often the perceptions of the target users) to the exclusion of other key elements, such as the app functions and the underlying principles of development. In order to capitalize on this innovative approach for reducing smoking rates among young adults, understanding how these interventions promote and support young adult women's and men's smoking cessation efforts is essential.

## Statement of purpose and research questions

The purpose of this case study was to contribute to the literature in relation to understanding how a smoking cessation smartphone app was designed to influence young adult smoking cessation, how young adults interact with this intervention, and how this interaction shapes young adults' smoking cessation experiences and practices, with consideration for the

influence of gender. The following is the overarching research question that guided the conduction of this study: How do young adults who smoke interact with the smoking cessation smartphone app, CTC, to constitute smoking cessation experiences and practices? To address this overarching question, three research questions were employed:

1. How was CTC designed to influence young adults' smoking cessation?
2. How do young adults engage with CTC for smoking cessation and how does gender influence this engagement?
3. How are young adults' smoking cessation experiences and practices influenced through CTC and how does gender influence these experiences and practices?

## Theoretical framework: Sociomateriality

The theoretical framework used to guide the study is that of sociomateriality. This framework was developed in response to observations that qualitative research on the use of digital technologies tended to focus on user perceptions while the technological aspects of these innovations remained unexamined (Leonardi &Barley, 2010; Orlikowski & Scott, 2008). Sociomateriality offers a way to overcome established opposition between social determinism and material determinism, considering both technological tools (material agency) and individuals (social agency) as two components of a same underlying phenomenon (Leonardi, 2009). Sociomateriality originates from Callon's (1986) and Latour's (1995) sociological works on Actor Network Theory (ANT), from Giddens' Structuration Theory (1984), as well as the structurationist approaches that have followed Giddens' work. Although still in nascent stages of development (Scott & Orlikowski, 2013), sociomateriality offers researchers a novel perspective to understanding digital technologies, people using technologies, and the interaction between technologies and their environment (Ulmer & Pallud, 2014). In relation to the present study,

sociomateriality theory provided a useful perspective for studying how young adults use CTC and how the use of this app affects young adults and their smoking cessation efforts.

From a sociomaterial perspective, an app is more than a technological tool, it is a social substance, an active participant in the creation of new practices (Lupton, 2014). The app itself is a sociocultural artefact and the product of decision makers (developers, software designers, researchers, clinicians, and others). In the case of smoking cessation apps, assumptions about young adult smoking cessation practices become inscribed and reified in the app. When put into a social context, the app will shape the actions and perceptions of those who engage with it. Using a sociomateriality framework, therefore, will help illuminate how young adults' activity and meaning making in relation to engaging with CTC for smoking cessation imbricates with the materiality of the app and together, creates new practices for smoking cessation. Attention to the sociomaterial will help reveal the dynamics that are actually constituting the ways in which the app is taken up, used, and experienced. The term "sociomateriality", therefore, essentially reminds us that: 1) all materiality is social and was created through social processes, and it is interpreted and used in social contexts, and 2) that all social action is possible because of some materiality (Leonardi, 2012).

In the context of smoking cessation practices, there is much to be gained from employing sociomateriality theory, which involves a commitment to examining the material, such as apps and their related functionalities, and the ways they interact and mesh with human elements. The smartphone, the app, the app functionalities, and the human body are interwoven with states of mind, young adult smokers, and the developers and organizations that contributed to the development of the app. How smoking cessation practices are influenced through these new media calls for attendance to these multiple ensembles. Rather than viewing young adults'

smoking cessation practices and experiences as individual constructions, or as "caused" by technological tools, they are viewed as a result of the interaction between these tools and people in practice (Hutchby, 2001). In trying to understand how and why new apps present as promising media for smoking cessation and what types of new practices come about as a result, as well as to improve the design and development of future apps, the materiality of these technological artifacts must be brought forward.

Sociomateriality is underpinned by two main research streams: agential realism (Orlikowski & Scott, 2008; Orlikowski, 2007; Scott & Orlikowski, 2013) and critical realism (Leonardi, 2008; Leonardi & Barley, 2010; Leonardi, 2011; Leonardi & Rodriguez-Lluesma, 2012; Leonardi, 2013). Operating from a critical realist foundation, the material and the social are external relations, and it is when material/technological artifacts are put into relationship with the social through human action that they become "sociomaterial" (Leonardi, 2013). Thus, while materiality[1] might be a property of an app, sociomateriality represents the enactment of a particular set of activities that meld materiality with "social"[2] phenomena (Leonardi, 2012).

Because the material and the social are external relations from a critical realist perspective, the interactions between the material and the social are context dependent. Although the materiality of a technological artifact, such as an app, transcends variations in space and time, the uses and actions can be different depending on the context in which it is being used (Leonardi, 2013). In short, what the technological tool *is* does not change across space and time,

[1] "Materiality" here refers to "the arrangement of an artifacts' physical and/or digital materials in particular forms that endure across differences in space and time" (Leonardi, 2013, p. 74), meaning that the constituent features of a technological artifact are (in theory) available to all users in the same way.

[2] "Social" refers to abstract concepts, such as norms, communication patterns, meanings, desires, fears, and cultural discourses (Leonardi, 2013).

but what it *does* can and often does change because the context of its use changes. What a technological tool does, or the functions of the tool, is also called its material agency. The material agency of technological tools is only provoked through a user (who has social agency) commanding it to do so. This material agency, therefore, not only depends on the apps' materiality but also on the perceptions of whether the materiality affords a user the ability to achieve his or her goals or places a constraint on them (Leonardi, 2013). A person's goals and the ability of the technological tool to help them achieve those goals is dependent on context.

A sociomaterial perspective underpinned by critical realism will be adopted in this study to understand the relation between the CTC app and young adult smokers. A critical realist sociomaterial ontology is curious about what shifts/new practices are affected as young adults and CTC become imbricated, and how time and context plays a role in sustaining and changing these practices. The critical realist underpinnings of Leonardi's sociomateriality (2013) is also commensurable with the focus on understanding design and development processes of CTC in addition to the ways in which young adults engage with the app, rather than arbitrarily focusing on one or the other. Furthermore, the operationalization of Leonardi's sociomateriality enables the generation of insights about how to improve the design and implementation processes of CTC, and smoking cessation apps more broadly (Leonardi & Rodriguez-Lluesma, 2012).

One way to empirically investigate sociomateriality is through Leonardi's affordances lens (Leonardi, 2012). The term affordance refers to the actionable properties between an artifact and an actor (Zhang, 2008). According to Hutchby (2001), affordances are not exclusively properties of people or of artifacts — they are constituted in relationships between people and the materiality of the things with which they come in contact. Hutchby uses the term "materiality" as opposed to matter because he believes that affordances are constituted through

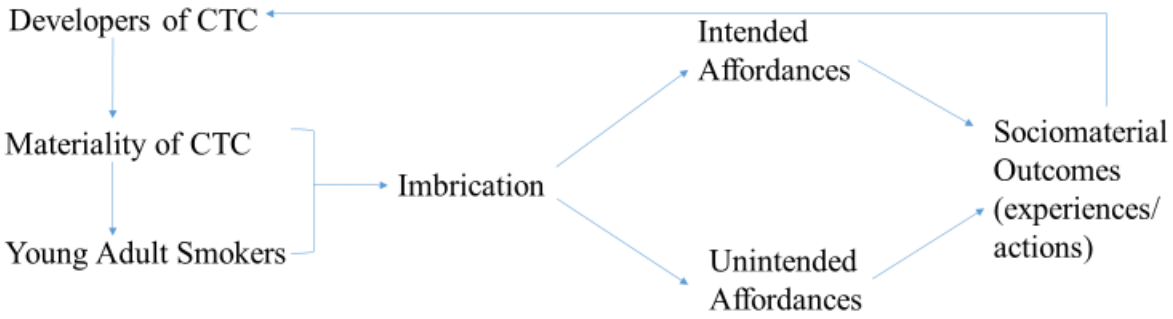
both physical and digital artifacts. In this formulation, materiality exists independent of people, but affordances do not. Because people come to materiality with diverse goals, they perceive a technological tool as affording distinct possibilities for action. For Hutchby, the affordances of an artifact can change across different contexts even though its materiality does not. Similarly, people may perceive that an artifact offers no affordances for action, perceiving instead that it constrains their ability to carry out their goals. It has been argued that, because people come to materiality with diverse goals, they perceive a technological tool as affording distinct possibilities or limitations for action (Treem & Leonardi, 2012). Hence, studying affordances - through untangling the complex interactions between multiple social actors and material artifacts—is one potential approach to empirically exploring sociomateriality (Leonardi and Barley, 2008).

In this study, the aim was to empirically untangle the complex interactions between developers, users, and the materiality of a smoking cessation app—CTC— through an affordances approach. As previously articulated, affordances are what happen when a sociomaterial relationship occurs. Because it is important to consider the developers' intentions with an app, as well as young adults' experiences with an app, two types of affordances were examined: intended affordances and unintended affordances. Intended affordances are affordances that were purposely designed by the developers, regardless of whether or not users recognize and experience these affordances. Unintended affordances are those that are recognized by the end-users but were not intended by the developers. Both intended and unintended affordances may be identified by end-users.

An affordance approach in this study promoted a focus on the underlying mechanisms that lend to particular experiences and practices among young adults smokers as a result of

engaging with CTC. More broadly, the notion of affordances offered a deeper look into how apps can be improved upon for smoking cessation because the focus is on the affordances/constraints they offer users. Figure 1 is a conceptual diagram of how an affordances approach lends to a deeper understanding of how sociomaterial outcomes (young adults' experiences and practices around smoking cessation) in relation to CTC come about. The figure shows how developers of CTC influence the materiality of the app (the features and functions within), and when the app is put into relationship (imbricates) with a person or population group (in this case, young adults), particular affordances result, which could be intended by the developers (intended affordances) and/or be in addition to and not expected by the developers (unintended affordances). These affordances lend to particular experiences and practices, which could be positive or negative.

*Figure 1. Sociomaterial outcomes in relation to CTC*




**Presentation of the dissertation**

This dissertation is presented in a series of Chapters. The second Chapter provides a review of relevant literature in highlighting the knowledge gap addressed by the current study. Study methodology is presented in the third Chapter, and findings Chapters are presented in Chapters 4, 5, and 6. Chapter 4 addresses the first research question (developers' expectations for

use), focusing on findings from interviews with key informants. Chapters 5 and 6 address the second and third research questions (young adult engagement and experiences with CTC) respectively, presenting findings from interviews with young adults. In Chapter 7, findings of key informants and young adults are compared and contrasted and discussed in the context of relevant research. In Chapter 8, significant theoretical and conceptual findings are discussed in light of existing research, which is followed by a discussion of implications, limitations, and recommendations.

# CHAPTER 2 – LITERATURE REVIEW

The purpose of this case study was to improve our understandings of how young adult smokers and the Crush the Crave (CTC) app interact to constitute smoking cessation experiences and practices. In this Chapter, a review of relevant literature is presented in order to locate the current study and point to the knowledge gap it addresses. A brief outline of current tobacco use behaviours among young adults and the implications for future morbidity and mortality rates is provided. In addition, the benefits of early quitting is described. Young adults' use of smoking cessation interventions is also detailed and contrasted with the use of the interventions by the general adult population. The promise of smartphone apps for reaching young adults with smoking cessation interventions is then described, which includes a description of young adults' use of mobile phone technologies (in which smartphone apps is included), the current reach of smoking cessation smartphone apps, and the appeal of these interventions among young adults. A brief description of the types of smoking cessation apps now available is also provided, with a focus on apps designed for young adults. Finally, research on the use of mobile phone technologies for smoking cessation, with a focus on smartphone apps, is then reviewed and described.

## Tobacco use and young adults

### *Smoking prevalence among young adults*

Young adulthood is a critical period of development when tobacco use behaviours become established, and the tobacco industry is taking advantage of the transition from adolescence into adulthood to promote smoking uptake and cigarette consumption in this age demographic (Fairchild et al., 2014; Hafez & Ling, 2005; Kostygina et al., 2014; Ling & Glantz, 2002; Sepe, Ling, & Glantz, 2002; Sepe & Glantz, 2002). Currently, young adults represent the

largest population of smokers across North America (Reid et al., 2015; U.S. Department of Health and Human Services, 2014). In Canada, 17.9% and 18.5% of young adults aged 20-24 and 25-34 respectively smoke, which is almost 5% above the national average of 14.6% (Reid et al., 2015). Although the overall smoking rate in Canada has decreased fairly steadily, this decline appears to have slowed in recent years, particularly among young adults (Reid et al., 2015). In a 2012 report by the Surgeon General, it has been estimated that for every tobacco-related death two new young people under the age of 26 become regular smokers (Centers for Disease Control and Prevention, 2012). In addition, it has been reported that young adults between the ages of 20 and 24 have the highest rates of exposure to second-hand smoke (84.2%). It has been suggested that reasons for these alarming trends includes high co-use with other drugs, particularly marijuana (Ramo et al., 2013), and new marketing tactics by the tobacco industry, such as recent advertising for flavored tobacco products (Kostygina et al., 2014; Villanti et al., 2013) and promotion of electronic cigarettes, which could prove to be a gateway to tobacco use (Fairchild et al., 2014).

***Smoking initiation among young adults***

The trend toward increased smoking initiation among young adults is also of concern. While smoking initiation usually occurs in adolescence, current research suggests that smoking initiation has increased among young adults in recent years (Bernat et al., 2012; Freedman, Nelson, & Feldman, 2012; Jha et al., 2013; O'Loughlin et al., 2014; Substance Abuse and Mental Health Services Administration, 2013). According to the 2012 National Survey on Drug Use and Health (NSDUH), for example, the number of individuals who began smoking at age 18 or older increased from 623,000 in 2002 to 1.1 million in 2012 (Substance Abuse and Mental Health Services Administration, 2013). Not surprisingly, the average age of smoking initiation has also

increased – it was reported that, among recent initiates aged 12-49, the average age of first cigarette use was 17.8 years, which was higher than the corresponding average age in 2011 (17.2 years) (Substance Abuse and Mental Health Services Administration, 2013). In addition, it was reported in research studies that a surprisingly large proportion of young adults initiated smoking after high-school in recent years (Bernat et al., 2012; Jha et al., 2013; O'Loughlin et al., 2014). For example, in a prospective cohort investigation of 1,293 students recruited in 1999-2000 from all grade 7 classes in a convenience sample of 10 high schools in Montreal, Canada, it was found that 14% of the 971 smoking initiators, initiated smoking after high school (O'Loughlin et al.). Similarly, in a longitudinal study of a population-cohort in the United States (n=2,034), it was found that 25% of participants initiated smoking between the ages of 18 and 21.

***Smoking cessation among young adults***

Despite that smoking prevalence increases from adolescence into adulthood, most young adult smokers want to quit. For example, Canadian young adults aged 20-24 and 25-34 reported that they were seriously considering quitting in the next 6 months at 61.8% and 58.5% respectively (Reid et al., 2015). Within each age group (20-24 and 25-34), around half of those seriously considering quitting in the next 6 months were also considering quitting in the next 30 days (Reid et al., 2015). Even though quit attempts decrease with age as patterns of tobacco use becomes habituated and symptoms of nicotine addiction become more pronounced, a substantial number of young adults aged 20-24 (61.3%) and 25-34 (52.2%) had made a quit attempt in 2013 (Reid et al., 2015). Despite that most young adults indicate wanting to quit and have attempted to quit, quitting percentages were lower and more variable among younger smokers, particularly those under the age of 25 (Reid et al., 2014). Only 8.8% among those aged 20-24 and 11.3% among those aged 25-44 were successful in quitting (Reid et al., 2015). This is largely owed to

the addictive nature of nicotine, particularly for young smokers. According to the Centers for Disease Control and Prevention (2012), the younger an individual is when they start using tobacco, the more likely they are to become addicted to nicotine and the more heavily addicted they will become. As a result, cessation is problematic and challenging for young users, making early quitting very difficult (Mayhew, Flay, & Mott, 2000; Riggs, Chou, Li, & Pentz, 2007).

***Implications of young adult tobacco use***

High smoking prevalence rates and low cessation success rates among young adults has significant implications for future morbidity and mortality rates related to smoking. On the basis of current smoking rates among young adults, it has been estimated that the global average for annual tobacco-attributable deaths will rise from about five million in 2010 to more than 10 million in a few decades as the young smokers of today reach middle and old age (Jha, 2009; Peto, Lopez, Boreham, & Thun, 2012). Large studies in the United Kingdom, the United States, Japan, and India have examined the eventual effects on mortality in populations of men and of women in which many began to smoke in early adult life and did not quit (Doll, Peto, Boreham, & Sutherland, 2004; Jha et al., 2008; Jha et al., 2013; Pirie et al., 2013; Sakata et al., 2012; Thun et al., 2013). These studies all showed that mortality among cigarette smokers was two to three times higher for those in middle age (about 30-69 years of age) compared to the mortality of non-smokers in the same age group, leading to a reduction in life span by an average of about 10 years. In light of current trends indicating that smoking prevalence is highest among young adult smokers compared to older adult smokers combined with evidence that the risks in middle age are much greater for smokers who started in early adulthood than for those who started later, this means that the future mortality rates among smokers will be that much more pronounced compared to non-smokers than they have been in the past (Jha & Peto, 2014). A lack of focus in

intervening to address the issue of young adult smoking will lend to a rise in adult smokers in the next decade, as well as increased pressure on the health care system due to increases in tobacco-related health complications, such as cancer and cardiovascular disease.

***Benefits of early quitting***

Numerous studies have demonstrated that quitting smoking improves health and the quality of life, especially when an individual quits at an early age. For example, in an analysis of data from a cohort of 216,917 adults aged 25 or older in the U.S. National Health Interview Survey (NHIS) between 1997 and 2004, it was reported that those who quit between the ages of 25 and 34, survival curves were nearly identical to those for participants who had never smoked, meaning that those who quit smoking gained about 10 years of life, as compared with those who continued to smoke (Jha et al., 2013). Those who quit between the ages of 35 and 44, 45 and 54, and 55 and 64 gained nine, six, and four years respectively. In relation to hazard ratios for lung cancer, it was reported that those who permanently quit smoking between the ages of 25 and 34 had the lowest relative risk at 1.2 compared to a relative risk of 2.6 for those aged 35-44, 4.0 for those aged 45-54, 5.6 for those aged 55-64, and a staggering 16.4 among those who continued to smoke (Jha et al., 2013). In addition to significantly reducing the risk for tobacco-related illness and death, smokers who quit improve the health of those around them by reducing their exposure to secondhand smoke, and pregnant women who stop smoking can increase their chances of giving birth to healthy babies, as well as improve their own health (Centers for Disease Control and Prevention, 2012). Despite comprehensive evidence that the younger a smoker quits smoking, the greater the health benefits, most smokers don't successfully quit smoking until after the age of 45 (Jha et al., 2013; Reid et al., 2014), when the adverse health impacts of smoking are

not completely reversible. This evidence underscores the urgent need to reach young adults with effective smoking cessation interventions.

## Smoking cessation interventions and young adults

Finding effective solutions to help young adults quit smoking remains a challenge. Despite the existence of a myriad of evidence-based smoking cessation options (Raw, McNeill, & West, 1999a), research suggests that younger adult smokers are particularly unlikely to seek treatment as compared to older smokers (Bader et al., 2007; Curry et al., 2007; Hughes et al., 2009; Solberg, Boyle, McCarty, Asche, & Thoele, 2007). For example, according to a survey investigating the use of cessation treatments, young adults (ages 18-24) were half as likely to have used pharmacological (e.g., nicotine replacement therapy) or psychological (e.g., advice from a health professional) treatments to aid cessation as older adults (Hughes et al., 2009). Similarly, Solberg and colleagues (2007) found that 73% of young adults (aged 18–24 years) who attempted to quit smoking in the previous year did not use any assistance, even when they had access to cessation resources.

A meta-analysis was conducted to examine if this lack of utilization was because smoking cessation interventions found effective for the general adult population were simply not effective for young adults (Suls et al., 2012). In this study, the authors identified 14 randomized controlled clinical trials for review, in which treatments consisted of pharmacotherapies and/or cognitive-behavioural therapy, counseling, and social support. The authors found that, when aggregating all study outcomes indicated for the subsamples of those aged 18-24, interventions (versus controls) were associated with higher odds of smoking cessation. In addition, it was found that the results for subsamples of those aged 18-24 followed those of the parent studies: in the nine cases where there was an overall treatment effect for all ages in the parent study, there

was similarly an effect for the young adult group, but no treatment effect for the subsample of young adults in the five parent studies where no treatment effect was found. The authors concluded that interventions that are typically effective for the general adult population work as well for young adults, but that young adults underutilize evidence-based treatments. These findings suggest that currently established interventions may not appeal to young adults or that current recruitment strategies might not be successful in promoting the interventions to them. In light of research evidence indicating that when young adults do use smoking cessation resources they are significantly more likely to quit smoking (Diemert, Bondy, Brown, & Manske, 2013), there is an urgent need to invigorate smoking cessation interventions directed towards young adults (U.S. Department of Health and Human Services, 2014). One recent direction is the emergence of mobile phone technologies (mHealth) as promising platforms to enhance smoking cessation interventions directed towards this population in an effective and efficient manner (Dennison et al., 2013; Ybarra, Holtrop, Bagci Bosi, & Emri, 2012).

## Young adults and mobile phone technologies

Mobile phone technologies have become ever more pervasive in young adults' everyday lives. Young adults are early adopters of these technologies and, according to recent statistics, they continue to lead the way in owning new mobile phone technologies that come to market. It has been reported that 93% of young adults (aged 18-29) own a mobile phone (Lenhart, 2013), and 79% of 18-24 year olds and 81% of 25-34 year olds own a smartphone (Smith, 2013), making young adults the largest demographic to own mobile phones in general and smartphones specifically. Young adults also represent the largest population to use their mobile phones for a variety of activities. For example, according to a 2012 Pew Internet and American Life Project survey, texting is almost universal among mobile phone owners aged 18 to 29 with 97% of using

their mobile phones to send texts (Pew Research Center, 2012). On average, young adults in the United States (18-29 years old) send 88 SMS text messages a day, which is more than triple the volume sent by those ages 30 to 49 (Smith, 2011). Mobile phone owners aged 18-29 are also the most likely of any demographic group to use their phone to go online: 85% of them do so (Duggan & Smith, 2013). Furthermore, young adults lead the way in social networking via mobile phones, with 67% of those aged 18-29 reporting that they engage in social networking on their mobile phones (Pew Internet Research Project, 2014).

The use of smartphone apps has become particularly popular among young adults. Not only are young adults the most likely age demographic to download apps, but they are also the most intense users of apps (time spent and engagement) (Purcell, 2011). It is not surprising, then, that young adults are the most frequent users of health-related apps. It has been reported that 42% of those who seek health information through apps are young adults (Fox & Duggan, 2013). While app use between men and women is relatively similar, women are moderately more likely to download a health-related app (Bonnington, 2013). In addition, it has been recently found that, while men use more apps compared to women (27.2 vs. 26.3 apps, respectively), women spend more time on apps than men (38 hours and two minutes/month vs. 36 hours and 51 minutes/month, respectively) (Nielsen, 2015). It is also noteworthy that, in the general population, while app use remains the same, user engagement has increased; for example, compared to 23 hours and 2 minutes in 2012, users in 2014 increased the time they spent engaging on apps by 63% to 37 hours and 28 min (Nielsen, 2015).

As smartphone data and pricing plans become cheaper, it is expected that an even larger segment of the population will utilize smartphone functions, thereby expanding the potential utility and reach of apps (Abroms, Padmanbhan, Thaweethai, & Phillips, 2011). In fact, there is

evidence that the digital disparity concerning mobile technologies among population groups is declining, with African Americans and English-speaking Latinos being as likely as whites in the US to own any sort of mobile phone (Zickuhr & Smith, 2012). Smartphones, therefore, hold significant potential in reaching diverse populations to reduce health disparities (Hampton, 2012; Munoz, 2010), as well as rural communities to provide health interventions (Kratzke, Wilson, & Vilchis, 2013). In light of this, there has been increasing interest in smartphones as a means for delivering smoking cessation interventions to young adults, essentially enabling health care professionals and researchers to bring interventions to young adult smokers where they "are" (Dennison et al., 2013; Essany, 2013; Ybarra et al., 2014).

## Smartphone apps and smoking cessation

Smartphone apps hold particular promise for reducing smoking rates because they support a multitude of complex functionalities that are not available via text or video messaging interventions. Smartphone apps can host all kinds of multimedia, including static and interactive rich-text, pictures, audio and video, as well as the retrieval of additional content when there is an Internet connection, without any user effort (BinDhim et al., 2014). Through a variety of interactive self-monitoring activities available through apps (e.g., question and answer forms, text writing, audio or video recordings), users are able to add data about their health, which is then graphed and displayed so that users can understand their progress (e.g., number of days smokefree) (BinDhim et al., 2014). Moreover, the social nature of smartphones provides individuals with many opportunities to tap into various support networks (Dennison et al., 2013), both intervention-related (e.g., quit buddies, intervention-related social media pages, leaderboards), as well as in relation to their personal social networks (e.g., personal contacts). Even further, the increasing use of internal sensors in smartphones to infer context, such as

geographical location, movement, emotion, and social engagement, has enabled tracking of health behaviours and the delivery of interventions that are tailored to specific contexts (e.g., sending reminders and motivational messages in contexts that trigger smoking) (Dennison et al., 2013). These features enabled by smartphones are a clear advancement over websites and text messaging programs because of their high potential to boost user engagement (Bricker et al., 2014), which has been consistently documented as a strong predictor of smoking cessation (Civljak, Stead, Hartmann-Boyce, Sheikh, & Car, 2013; Webb, Webb, Schroeder, & North, 2013; Webb, 2009; Whittaker et al., 2012).

Compared to other mobile-based smoking cessation interventions (e.g., text messaging interventions), smartphone app-based smoking cessation interventions have been met with enthusiasm by health care consumers. In March 2014, Bricker and colleagues (2014) searched the xyo.net app search engine and found a total of 546 English language smoking cessation apps in the Apple Store and Google Play that were downloaded to smartphones approximately 3.2 million times in the United States and 20 million times worldwide. In comparison, between 2012 and 2013, the U.S. tobacco quitline received approximately one million enrollments and U.S. text messaging programs received approximately 140,000 subscriptions (Bricker et al., 2014). While this literature does not shed light on the success of these interventions, it does speak to the popularity of these types of tools, and potential reach if proven to be successful.

**Smartphone apps for smoking cessation among young adults**

There is evidence that smartphone apps for smoking cessation are appealing to young adults. For example, researchers measured and compared the uptake of an evidence-based smoking cessation app (Quit Advisor) in three countries (United States, United Kingdom, and Australia) over one year (BinDhim et al., 2014). The researchers found that the smartphone app

primarily reached younger smokers (mean age = 32) that were not seeking professional help (e.g., quitline) but were ready to quit in the next 30 days. In addition, more than half of the respondents had downloaded smoking cessation apps in the past and, of that group, 75% had made quit attempts (lasted at least 24 hours) by using an app. These findings are consistent with the interview findings of a study conducted by the Ontario Tobacco Research Unit in 2010, which was part of a study to assess the impact of the smoking cessation system on young male smokers (Minian et al., 2010), where results indicated that many participants had heard of using smartphone technology to help them quit and said that they would be interested in using these programs.

Recent research has also indicated that young adults prefer more intense smoking cessation interventions than what is currently offered via text messaging-based smoking cessation interventions (Bader et al., 2007; Naughton et al., 2013; Ybarra et al., 2014). For example, in a research study by Bader and colleagues (2007), young adult smokers identified the need for mobile-based interventions that offer assistance in quitting with additional functionality, such as linking to existing social networks for support in quitting. This is similar to the findings of Ybarra and colleagues (2014), who found that young adult participants wanted more social connectivity than what was offered in the text messaging-based smoking cessation program, Stop My Smoking (SMS) USA. Given evidence that tapping into social networks for social support is an active ingredient of evidence-based smoking cessation treatment (Fiore, 2008), and that social networks have been found to be beneficial for smoking cessation among young adults (Chen, White, & Pandina, 2001; Curry et al., 2007; Minian, Schwartz, DiSante, & Philipneri, 2010), the use of smartphones present as a natural fit for smoking cessation interventions targeting young adults.

**Evaluative evidence in relation to mobile-based smoking cessation interventions**

There is a growing body of evaluative evidence demonstrating that mobile phone-based technologies can support smoking cessation. Several systematic reviews have been conducted evaluating mHealth smoking cessation interventions (Ghorai et al., 2014; Gulliver et al., 2015; Wittaker et al., 2009, 2012, and 2016). These systematic reviews will be described in the following section.

Ghorai and colleagues (2014) conducted a systematic review with the aim to provide a thorough representation of mobile-based interventions in smoking cessation contexts and to identify the strengths and limitations of these interventions. The authors included all randomized or quasi-randomized trials in which a mobile phone was the primary mode of communication in the intervention. The authors limited studies by peer review status and English language. Studies also had to include behaviour change as one of the major outcomes. The authors searched for studies in Wiley online library, PsychINFO, PubMed, MEDLINE, CINAHL, Web of Science, Eric, Proquest Science Journals, EMBASE, Informit e-library, Scopus, Cochrane Database of Systematic Reviews, Cocharne Library, Cochrane Central Register for Controlled Trials, Cochrane Methodology Register, Cochrane DSR ACP Journal Club, and DARE (between 1980 and 2013) using combinations of the search phrases “smoking cessation” and/or “mobile”. Data were extracted on study characteristics and intervention (type, design, outcome). Fifteen studies were included (pooled sample of 13,094 participants), 11 were randomized controlled trials (Brendryen & Kraft, 2008; Brendryen et al., 2008; Bramley et al., 2005; Free et al., 2011; Naughton et al., 2012; Peterson et al., 2009; Rodgers et al., 2005; Strecher, Shiffman, & West, 2012; Vidrine et al., 2006; Whittaker et al., 2011; Ybarra et al., 2013) and four were pre-post design studies (Abroms et al., 2012; Obermayer et al., 2004; Riley, Obermayer, & Jean-Mary,

2008; Strecher et al., 2005). Studies included three types of interventions: text messaging, text messaging and the Internet, and mobile tele-counseling. The intervention period ranged from four weeks to one year. Of the 15 studies, nine used self-report measures and the remaining studies used bio-chemical validation. Only three of the interventions were based on theories, which included social cognitive theory, the transtheorietcal model, and the behavioural self-regulation theory. Most of the studies demonstrated positive short-term effects. The authors concluded that, although text messaging interventions showed positive effects, they were not likely the most effective means to deliver smoking cessation interventions, and identified an urgent need for research investigating smartphone apps for smoking cessation. In addition, the authors pointed to the need for research detailing the design processes of mHealth interventions because this is an important factor that determines the success of these interventions.

Gulliver and colleagues (2015) conducted a systematic review and meta-analysis of technology-based (e.g., computer/internet, telephone, text-messaging) interventions for tobacco and other drug use among young adults. The authors included all randomized trials in which a technology-based intervention was evaluated in a tertiary setting (university/college). The authors searched for studies in PsychINFO, PubMed, and Cocharne Library databases in 2013 using combinations of phrases that fit within three broad concepts: intervention aim (tobacco/drug use), population (college or university students), and modality (technology). The authors limited studies by English language. Twelve studies were included (sample sizes ranged from 65 to 517). Data were extracted according to study characteristics, study origin, participants and target group, intervention characteristics, outcome measures, study quality and intervention efficacy. Most of the studies targeted tobacco use (n=9), with eight targeting smoking and one targeting spit tobacco. Two targeted marijuana and the last one was a multi-targeted study

examining stress, marijuana, alcohol, and tobacco use. All of the studies were conducted in high-income countries. The 12 studies included interventions that ranged from stand-alone computer programs (n=5), the internet (n=4), telephone (n=2), and text messaging (n=2). The intervention duration ranged from 15 minutes to 30 weeks. Most of the studies included interventions that were self-administered (n=7). A meta-analysis was conducted on the six tobacco use studies that used an abstinence outcome measure (four measured 7-day abstinence, one measured 30-day abstinence, and one measured 7-day point-prevalence abstinence) and included a control group. The tobacco interventions were delivered via computer, internet/email, or telephone. The meta-analysis demonstrated that those who used the intervention were 1.5 times more likely to be abstinent compared to the controls. The authors concluded that technology-based interventions hold great potential to substantially contribute to lower morbidity and mortality rates related to young adult tobacco use.

Probably the most comprehensive systematic reviews of evidence in relation to mobile phones for smoking cessation has been conducted by Whittaker and colleagues (2009, 2012, & 2016). The first systematic review conducted by Whittaker and colleagues (2009) aimed to determine whether mobile phone-based interventions are effective at helping smokers quit, which showed short-term benefits, but not long-term benefits of mobile-based smoking cessation interventions. A second update by the authors, which included five studies, showed overall long-term benefits of these interventions but with high statistical heterogeneity in the pooled results (Whittaker et al., 2012). Using the same methods, Whittaker and colleagues (2016) recently updated this review, which includes the five trials in the 2012 review. In this update, the authors included randomized and quasi-randomized trials of any type of mobile phone-based intervention for smoking cessation. Participants included smokers of any age who are motivated

to quit. The primary outcome of interest was smoking abstinence at six months after the start of the intervention. The authors searched the Cochrane Tobacco Addiction Group Specialized Register, the UK Clinical Research Network Portfolio for current projects, the Clinical Trials Register for ongoing or recently completed studies, the Cochrane Central Register of Controlled Trials, MEDLINE, and EMBASE in 2015, with the criteria that the title, abstract, or keywords included any word that encompassed variations of the phrase "mobile phone". No restrictions were placed on language or date of publication. Data were extracted based on study participant characteristics, type of intervention, data to assess the risk of bias in the included studies, and measures of treatment effect (e.g., smoking cessation). The authors also included a meta-analysis using the Mantel-Haenszel fixed-effect method to pool risk ratios. Seven new trials were included in the review (Abroms 2014; Bock 2013; Ferguson 2015; Gritz 2013; Haug 2013; Naughton 2014; Shelley 2015), along with the previous five trials that were reviewed in 2012 (Borland, 2012; Free et al., 2009; Free et al., 2011; Rodgers et al., 2005; Whittaker et al., 2011). The trials included a pooled sample of 11,885 participants. Most of the studies employed text messaging as the primary component of the intervention, with seven purely text messaging-based (Abroms 2014; Borland 2013; Ferguson 2015; Free 2009; Free 2011; Rodgers 2005; Whittaker 2011). Several combined text messaging with in-person visits or assessments (Bock 2013; Gritz 2013, Haug 2013; Naughton 2014; Shelley 2015). Whittaker and colleagues (2011) used text messages with links to online videos (Whittaker et al., 2011). Shelley (2015) provided mobile phones to participants as part of their three-arm study (pharmacology only, pharmacology plus text messaging, and pharmacology, text messaging, and phone counselling). Gritz (2013) did not include any text-messaging component, but provided participants with mobile phones for counselling. All studies were conducted in high-income countries. The studies included diverse

groups – young people (Haug 2009; Whittaker et al., 2011), HIV-positive, multi-ethnic, low-income population (Gritz et al., 2013; Shelley et al., 2015), and recruitment methods – online (Bock et al., 2013; Borland et al, 2013; Abroms et al., 2014) and in-person (Haug et al., 2013; Naughton et al., 2014; Shelley et al., 2015). The authors found that, with the exception of one study (Rodgers et al., 2005), the included studies had low risk of bias. Other than three studies (Borland et al., 2012; Naughton et al., 2014; Whittaker et al., 2011) most of the studies produced significant results. Based on the pooled results of all 12 studies, smokers who received the mobile intervention were 1.7 times more likely to stay smokefree at 6 months compared to those who did not receive the intervention (9.3% quit with the intervention compared to 5.6% quit with no intervention). Despite the relatively positive results of the 2012 and 2016 reviews, it must be noted that the results were heavily weighted by the findings of Free and colleagues (2011), due to the large sample size. If one were to take away this study's results from the reviews, there would be little evidence to support the enthusiasm of using mobile-based smoking cessation interventions, particularly text-messaging smoking cessation interventions. The authors concluded that more evaluative research of mobile-based interventions is needed in different contexts, as well as different intervention types. The authors also particularly noted the absence of research on smoking cessation apps and highlighted the need to for such research.

**Evaluative evidence in relation to smoking cessation apps**

At the time of the aforementioned reviews, there was no published research on smartphone apps for smoking cessation, but the authors indicated that this should be a priority for future mHealth research. Since these reviews, some evaluative evidence has emerged. In order to locate the current state of knowledge on smartphone apps for smoking cessation, a

systematic search was conducted. The methods, results, and implications of this review are presented in the following sections.

### *Methods*

For the review, the following databases were searched: PsychINFO, EMBASE, Medline OVID, and CINAHL. Search terms included combinations of the key phrases "smoking cessation" and "mobile phones" using a variety of related terms (Appendix A). Limitations included published in English, peer-reviewed, and abstracts available (when possible). All studies published up until December 2016 were included in the search, revealing 2,122 articles. After removing duplicates, the search generated 1,091, to which the inclusion and exclusion criteria were applied (Appendix B). In total, 12 articles were included in the review.

### *Results*

The 12 studies included in the review consisted of eight qualitative studies (Abroms et al., 2011, 2013; Choi et al., 2014; Hoeppner et al., 2015; Ploderer et al., 2014; Struik & Baskerville, 2014; Ubhi et al., 2016a, 2016b) (see Table 1), and four quantitative studies (Bricker et al., 2014; Buller et al., 2014; Heffner et al., 2015; Ubhi et al., 2015) (see Table 2). In six of the eight qualitative studies, researchers analyzed the content of smoking cessation apps (Abroms et al., 2011, 2013; Choi et al., 2014; Hoeppner et al., 2015; Ubhi et al., 2016a, 2016b). In the remaining two, researchers of one study analyzed the content of the Facebook page associated with a quit smoking app (Struik & Baskerville, 2014), and researchers of the other study employed a "research through design" approach to evaluate the use of a cessation app from the perspectives of the end users (Ploderer et al., 2014), the only evaluative study found that harnessed end user input. The four quantitative studies included three small randomized

controlled pilot trials (Bricker et al., 2014; Buller et al., 2014; Heffner et al., 2015), and one observational study (Ubhi et al., 2015),

*Table 1. Qualitative studies*

| **Authors & Publication Date** | **Location/ Context** | **Purpose** | **Sample** | **Study Design** | **Data Collection** | **Data Analysis** | **Main Study Findings** |
|---|---|---|---|---|---|---|---|
| Abroms et al. (2011) | United States | To examine the content of existing iPhone apps for smoking cessation, paying particular attention to the<br><br>degree to which these apps adhere to established best practices in smoking cessation, their popularity among iPhone users, and the relationship between these variables. | The 47 most popular smoking cessation apps for iPhone. | Content analysis | Apps were collected by entering the search term *stop smoking* into iTunes. | Each app was coded for its approach (calculator, calendar, hypnosis, rationing, or other), level of adherence to the U.S. Health Service's 2008 Clinical Practice Guidelines, and frequency of downloads. Inter-rater reliability was established. | Smoking cessation apps were found to have low levels of adherence to key guidelines (averaged 7.8 points out of a possible 60 points). Few, if any, apps recommended or linked the user to proven treatments such as pharmacotherapy, counseling, and/or a quitline. The most popular apps (primarily calculator and hypnosis apps) were less likely to |

| **Authors & Publication Date** | **Location/ Context** | **Purpose** | **Sample** | **Study Design** | **Data Collection** | **Data Analysis** | **Main Study Findings** |
|---|---|---|---|---|---|---|---|
| | | | | | | | score higher on the adherence index. |
| Abroms et al. (2013) | United States | To examine the content of existing iPhone apps for smoking cessation, paying particular attention to he<br><br>degree to which these apps adhere to established best practices in smoking cessation, their popularity among iPhone users, and the relationship between these variables. | The 98 most popular smoking cessation apps for iPhone (n=47) and Android (n=51) | Content analysis | Apps were collected by entering the search terms *stop smoking, quit smoking,* and *smoking cessation* into iTunes and Google Play. | Each app was coded for its approach (calculator, calendar, hypnosis, rationing, tracker, informational, game, lung health tester, or other), level of adherence to the U.S. Health Service's 2008 Clinical Practice Guidelines, and frequency of downloads. Inter-rater | Smoking cessation apps were found to have low levels of adherence to key guidelines (averaged 12.9 points on the index out of a possible 42 points). Few apps recommended or linked the user to proven treatments such as pharmacotherapy, counseling, and/or a quitline. While the most popular apps were less likely to score higher on the adherence index, apps with higher |

| Authors & Publication Date | Location/ Context | Purpose | Sample | Study Design | Data Collection | Data Analysis | Main Study Findings |
|---|---|---|---|---|---|---|---|
| | | | | | | reliability was established. | adherence index scores were more likely to receive positive user rates. Options to access social support networks improved since the previous content analysis. |
| Choi, Noh, & Park (2014) | South Korea | To analyze and evaluate the contents of smoking cessation apps available in South Korea employing the self-determination theory (SDT) as a theoretical framework for analysis. | 175 smoking cessation apps | Content analysis | Using the keywords *smoking* and *smoking cessation* in Korean or English into iTunes, 309 eligible apps were found, out of which 175 were randomly | A coding scheme was developed based on the basic needs of SDT (autonomy, relatedness, and competence), and the gain/loss theory. General characteristics of the apps | It was found that, while most apps had at least one feature that tapped into one of the three basic needs of SDT, very few tapped into all three. Extrinsic goals (e.g., money), were more dominantly present in the apps compared tin intrinsic goals (e.g. |

| Authors & Publication Date | Location/ Context | Purpose | Sample | Study Design | Data Collection | Data Analysis | Main Study Findings |
|---|---|---|---|---|---|---|---|
| | | | | | selected for analysis. | were also collected (market type, price type, developer type, and contents type). Inter-rater reliability was established. | personal improvement). Gain framing appeared more frequently than loss framing. |
| Hoeppner et al. (2015) | United States | To assess the presence of tailoring features in smoking cessation apps and if tailoring is related to smoking cessation app popularity (downloads) and user-rated quality (# of stars). | 225 Android smoking cessation apps. | Content analysis | Apps were searched using the search term, *smoking cessation.* | Each app was coded for the existence of tailoring features using the 5As (ask, advise, assess, assist, and arrange follow-up), number of downloads, and user ratings. | It was found that apps primarily used simplistic tools, such as calculators and trackers) and rarely used tailoring. Those that did use tailoring were positively associated with downloads and user ratings. Apps with more complex |

| Authors & Publication Date | Location/ Context | Purpose | Sample | Study Design | Data Collection | Data Analysis | Main Study Findings |
|---|---|---|---|---|---|---|---|
| | | | | | | | functions and tools (proactive alerts, responsiveness to quit status, or two-way interactions) addressed more of the 5As. |
| Ubhi et al. (2016a) | United Kingdom | To assess if smoking cessation apps available in the Apple App Store in 2012 could be reliably assessed for presence of behaviour change techniques (BCT) that have been found to be effective in face-to-face support for smoking cessation, as well as the use of engagement and | 184 free and paid smoking cessation apps in the Apple App Store. | Content analysis | Apps were searched by using the keywords, *smoking cessation, stop smoking, no smoking, quitting, and quit.* | A coding framework was developed based on the five BCTs (supporting identity change, rewarding abstinence, advising on change routines, advising on coping, and advising on medication | It was found that the content of smoking cessation apps could be reliably assessed for the presence of BCTs, engagement, and ease-of-use features. In relation to BCTs, it was found that the apps primarily focused on supporting identity change and rewarding abstinence, but |

| Authors & Publication Date | Location/ Context | Purpose | Sample | Study Design | Data Collection | Data Analysis | Main Study Findings |
|---|---|---|---|---|---|---|---|
| | | ease-of-use features in the apps, and to what extent. | | | | use), and 11 items related to engagement, and nine items related to ease-of-use. Inter-rater reliability was established using prevalence and bias adjusted kappas (PABAK) for the BCTs, and averages were used for the engagement and ease-of-use features. | very few referenced pharmacotherapy options. It was also found that the apps, on average, contained many engagement and ease-of-use features (averaged 69% and 83% respectively). |
| Ubhi et al. (2016b) | United Kingdom | To assess the extent to which smoking cessation apps available in the Apple App | 137 free smoking cessation apps in the | Content analysis | Apps were searched by using the keywords, *smoking* | The coding framework employed in the previous study (Ubhi et | BCTs supporting identity change, rewarding abstinence and advising on |

| Authors & Publication Date | Location/ Context | Purpose | Sample | Study Design | Data Collection | Data Analysis | Main Study Findings |
|---|---|---|---|---|---|---|---|
| | | Store between 2012 and 2014 contained behaviour change techniques (BCT) that have been found to be effective in face-to-face support for smoking cessation, as well as the use of engagement and ease-of-use features in the apps. The authors wanted to determine if the content of the apps had changed since their previous study. | Apple App Store. | | *cessation, stop smoking, no smoking, quitting, and quit.* | al., 2016a) was employed. Inter-rater reliability was established. | changing routines were less prevalent in the 137 (110 of which were new) free apps in 2014 as compared with the 83 free apps available in 2012 (14.6% vs. 42.2%, 18.2% vs. 48.2%, and 17.5% vs. 24.1%, respectively). Advice on coping with cravings and advice on the use of stop-smoking medication were more prevalent in 2014 as compared with 2012 (27.7% vs. 20.5% and 14.6% vs 3.6%, respectively). Only three apps |

| Authors & Publication Date | Location/ Context | Purpose | Sample | Study Design | Data Collection | Data Analysis | Main Study Findings |
|---|---|---|---|---|---|---|---|
| | | | | | | | contained all five BCTs. The use of recognised engagement features was less common in 2014 than in 2012 (45.3% vs. 69.6%) while ease-of-use features remained very high (94.5% vs. 82.6%). |
| Struik & Baskerville (2014) | Canada | To characterize content of the Facebook page of the smoking cessation app, CrushtheCrave®. | 399 Facebook posts | Framework analysis | Posts were collected in reverse chronological order so that the most recent activity on the CTC Facebook page was represented (spanning | Using the framework approach, a thematic framework was developed, and the posts were coded accordingly. Inter-rater | The original posts primarily aimed to support smoking cessation and, at a lesser extent, to market the app. Most of the reply posts were in response to the supporting smoking cessation posts. The most |

| Authors & Publication Date | Location/ Context | Purpose | Sample | Study Design | Data Collection | Data Analysis | Main Study Findings |
|---|---|---|---|---|---|---|---|
| | | | | | October 2012 to June 2013). Sampling was driven by saturation of themes. Of the 399 posts, 121 were original posts and 278 reply posts. | reliability was established. | common user responses were engagement with the images associated with the original posts and sharing smoking-related experiences, with the latter more frequently found under the supporting smoking cessation posts. Women were more likely to post on the page. Men were more likely to post sarcastic remarks on the page. |
| Ploderer, Smith, Pearce, & | Australia | To identify the various coping strategies enabled | 14 participants between the | Using a research through | Interviews, log data, and diary data were | Following qualitative data analysis | It was found that six quitting strategies were |

| Authors & Publication Date | Location/ Context | Purpose | Sample | Study Design | Data Collection | Data Analysis | Main Study Findings |
|---|---|---|---|---|---|---|---|
| Borland (2014) | | by the smoking cessation app, DistractMe, and to provide insights and recommendations for similar intervention. | ages of 20 and 53 (11 female, 3 male). Nicotine dependence ranged from low to high. | design approach, this study conducted a qualitative analysis of real-life quit attempts using the app. | collected during the 6-week trial period of the app. | procedures outlined by Miles and Huberman (1994), a thematic framework was developed, and the posts were coded accordingly. Inter-rater reliability was established. | supported through the app: diversion, avoidance, preparation, fortification, and confrontation. Participants employed strategies to prevent cravings more often than immediate coping strategies. Although participants shared more distractions than tips, they engaged with tips more than distractions to aid in their cessation attempts. Participants indicated that social exchanges |

| Authors & Publication Date | Location/ Context | Purpose | Sample | Study Design | Data Collection | Data Analysis | Main Study Findings |
|---|---|---|---|---|---|---|---|
| | | | | | | | between quitters supported by the app was an important feature that helped them in their quitting journey. |

*Table 2. Quantitative studies*

| Authors & Publication Date | Location | Study Design | Participants/ Sample Size | Outcome Measure(s) | Intervention Design and Theory Used (if any) | Duration of Intervention | Length of Follow-up | Main Study findings |
|---|---|---|---|---|---|---|---|---|
| Bricker et al. (2014) | United States | Double-blind RCT pilot trial comparing the | 196 adults (aged 18 or older) who are current smokers and | App utilization, ACT theory-based | The SmartQuit app was adapted from web and | 2 months | 2 month follow-up via online survey. | SmartQuit participants opened their app an average of 37.2 times, |

| Authors & Publication Date | Location | Study Design | Participants/ Sample Size | Outcome Measure(s) | Intervention Design and Theory Used (if any) | Duration of Intervention | Length of Follow-up | Main Study findings |
|---|---|---|---|---|---|---|---|---|
| | | acceptance and commitment therapy (ACT)-based smoking cessation app, SmartQuit, with the National Cancer Institute's QuitGuide app. | are motivated to quit smoking. | acceptance process, and 30-day point prevalence cessation outcome at two-month follow up. | telephone-based ACT interventions (Bricker, Wyszynski, Comstock, & Heffner, 2013; Bricker, Mann, Marek, Liu, & Peterson, 2010) and included features that helped users stay motivated by focusing on ACT values-based motivations (e.g., other smokers' | | | as compared to 15.2 times for QuitGuide participants ($p < 0001$). The overallquit rates were 13% in SmartQuit vs. 8% in QuitGuide (OR = 2.7; 95% CI = 0.8–10.3). Consistent with ACT's theory of change, among those scoring low (below the median) on acceptance of cravings at baseline (n = 88), the quit rates were 15% |

| Authors & Publication Date | Location | Study Design | Participants/ Sample Size | Outcome Measure(s) | Intervention Design and Theory Used (if any) | Duration of Intervention | Length of Follow-up | Main Study findings |
|---|---|---|---|---|---|---|---|---|
| | | | | | testimonials), develop a personalized quit plan (e.g., identifying social support), develop ACT-based acceptance skills (e.g., coping with cravings), develop ACT-based self-compassion skills (e.g., prevent negative self-judgements), and tracking progress (e.g., | | | in SmartQuit vs. 8% in QuitGuide (OR = 2.9; 95% CI = 0.6–20.7), rendering SmartQuit as 60% more effective than the QuitGuide app. |

| Authors & Publication Date | Location | Study Design | Participants/ Sample Size | Outcome Measure(s) | Intervention Design and Theory Used (if any) | Duration of Intervention | Length of Follow-up | Main Study findings |
|---|---|---|---|---|---|---|---|---|
| | | | | | number of times they resisted smoking). | | | |
| Buller et al. (2013) | United States | Randomized pretest-posttest two-group design comparing a smartphone app (REQ-Mobile) with a text messaging intervention (onQ) for smoking cessation. | 102 young adults (aged 18-30) who are current smokers and motivated to quit. | Self reported usability of REQ-Mobile and quitting behavior (quit attempts, point-prevalence, 30-day point-prevalence, and continued abstinence) | The delivery of onQ text messages was managed by the Quit Coach expert system (Balmford, Borland, & Benda, 2008; Balmford, Borland, Li, & Ferretter, 2009; Borland, Balmford, & Hunt, 2004). Messages were | 12 weeks | 6 and 12 week follow-up via online questionnaire. | In the REQ-Mobile group, 61% (n=31) opened the inbox, received 128.5 short messages, and opened just over 76 short messages. In comparison, 59% of smokers who used the onQ service received an average of 107.8 text messages. |

| Authors & Publication Date | Location | Study Design | Participants/ Sample Size | Outcome Measure(s) | Intervention Design and Theory Used (if any) | Duration of Intervention | Length of Follow-up | Main Study findings |
|---|---|---|---|---|---|---|---|---|
| | | | | were assessed in posttests | grounded in social cognitive theory (Bandura, 1986), and a modified versiojn of the transtheoretical model (Prochaska, Redding, & Evers, 2005), and messages suggested tasks to plan, set, and maintain a quit date, cope with cravings and relapse, and consolidate a | | | Smokers who used REQ-Mobile and were followed up at 6 weeks and evaluated its usability favorably: around 70% considered it simple, reliable, useful, easy, designed for them, satisfying, easy to learn, and user friendly. Participants were less positive on REQ-Mobile being straightforward (56%), |

| Authors & Publication Date | Location | Study Design | Participants/ Sample Size | Outcome Measure(s) | Intervention Design and Theory Used (if any) | Duration of Intervention | Length of Follow-up | Main Study findings |
|---|---|---|---|---|---|---|---|---|
| | | | | | non-smoking lifestyle. The REQ-Mobile was a companion app to onQ and provided participants with additional features to perform the tasks advised through the onQ messages (e.g., create lists on reasons for quitting, listen to testimonials from former smokers, and | | | consistent (63%), and well integrated (56%). The authors found that the smartphone intervention, REQ-Mobile, was feasible for delivering cessation support but appeared to not move smokers to quit as quickly as text messaging. More frequent use of REQ-Mobile, however, was positively associated with |

| Authors & Publication Date | Location | Study Design | Participants/ Sample Size | Outcome Measure(s) | Intervention Design and Theory Used (if any) | Duration of Intervention | Length of Follow-up | Main Study findings |
|---|---|---|---|---|---|---|---|---|
| | | | | | read documents to support their quitting. Once participants quit for more than one week, they were shifted to the onQ intervention because maintenance counselling was not programmed into the app. | | | greater 30-day point-prevalence abstinence at 12 weeks (p=0.02) compared to the frequent receipt of text messages from onQ (p=0.14). |
| Heffner et al. (2015) | United States | Feature-level analysis of data from the pilot | 76 adults (18 or older) who currently smoked and | App utilization and self-reported 30-day point | See Bricker et al (2014) above. | 8 weeks | 60-day follow-up survey. | The most used features (quit plan, tracking and sharing) were mostly |

| Authors & Publication Date | Location | Study Design | Participants/ Sample Size | Outcome Measure(s) | Intervention Design and Theory Used (if any) | Duration of Intervention | Length of Follow-up | Main Study findings |
|---|---|---|---|---|---|---|---|---|
| | | trial comparing SmartQuit with the National Cancer Institute's QuitGuide app (Bricker et al., 2014) to determine the most used features and usage association with quitting. | wanted to quit. | prevalence abstinence. | | | | CBT, only two were ACT. Of the 10 most used features, only two were associated with quitting (viewing the quit plan (p=0.03) and tracking practice of letting urges pass (p=0.03). Tracking ACT skill practice was used by fewer participants (n=43) but was associated with quitting (p=0.01). |

| Authors & Publication Date | Location | Study Design | Participants/ Sample Size | Outcome Measure(s) | Intervention Design and Theory Used (if any) | Duration of Intervention | Length of Follow-up | Main Study findings |
|---|---|---|---|---|---|---|---|---|
| Ubhi et al. (2015) | United Kingdom | Observational study involving automated data collection from SmokeFree28 (SF28) users between August 2012 and August 2013. | 1170 adults aged 16 or older, smoked at the time of study registration, set a quit date, and used the app once on or after their quit date. | Primary outcome measure was the proportion of users who continued to use the app for at least 28 days, and recorded abstinence for the full period with no more than two lapses. Other measures included demographic | SF28 focuses on behavioural change techniques (BCT) that would be expected from theory and evidence to aid smoking cessation. PRIME theory (Plans, Response, Impulses, Motives, and Evaluations) underpinned the app, which aims to explain and predict the | 28 days | 28 days | Self-reported cessation rate for 28 days or longer was 18.9% (95% CI 16.7-21.1). This finding was higher in users who were older, in non-manual occupation, and in those using pharmacotherapy. |

| Authors & Publication Date | Location | Study Design | Participants/ Sample Size | Outcome Measure(s) | Intervention Design and Theory Used (if any) | Duration of Intervention | Length of Follow-up | Main Study findings |
|---|---|---|---|---|---|---|---|---|
| | | | | characteristics, nicotine dependence, money spent on cigarettes, and pharmacotherapy used. | impact of an intervention on a behaviour. The app contains a target of being smokefree for 28 days, which is documented to increase the chances of maintaining smokefree status by more than five-fold. | | | |

### *Content of smoking cessation apps*

Studies focusing on the content of smoking cessation apps examined the extent to which apps were evidence-based in that they followed established practice guidelines, included effective behaviour change strategies, and features and functions to enhance engagement and ease-of-use (Abroms et al., 2011, 2013; Choi et al., 2014; Hoeppner et al., 2015; Ubhi et al., 2016a, 2016b). In one study (Struik & Baskerville, 2014), researchers aimed to characterize the content of a Facebook page that was used in conjunction with a smoking cessation app to provide social support. The major findings of each of these studies is described below.

In two content analyses (Abroms et al., 2011, 2013), researchers investigated how closely the most popular smoking cessation apps followed the U.S. Clinical Practice Guidelines (USCPG). These guidelines serve as the current standard in smoking cessation interventions, which includes tracking smoking status and offering quit planning, advice on pharmacotherapy, tools to enhance motivation, and social support for quitting (Fiore, 2008). In their most recent analysis, Abroms and colleagues (2013) found that the average guidelines adherence index score for all apps in the sample was 12.9 out of a possible 42 points. The authors also found that only 28.1% of the apps strongly adhered to a single guideline. Only a handful of apps recommended an approved smoking cessation medication and none of the apps referred users to a quitline or arranged for follow-up. Furthermore, the analysis revealed that the most common smoking cessation apps, calculator apps (38.8%) and hypnosis apps (17.3%), were less likely to score higher on the adherence index. Interestingly, apps with higher adherence index scores were more likely to receive positive user rates for both the iPhone apps and the Android app, indicating that apps that follow the USCPG are more appealing than those that do not follow the guidelines. These findings align with the authors' previous content analysis conducted in 2009, in which

they analyzed 47 iPhone apps (Abroms, et al., 2011). One improvement found since their previous content analysis was the option to harness social support via means other than email, such as community bulletin boards or social media links (e.g., Facebook). The authors concluded that apps rarely adhere to established guidelines for smoking cessation and recommended that future apps be developed based on evidence-based practices.

Choi and colleagues (2014) conducted a content analysis to evaluate the extent to which smoking cessation smartphone apps incorporate content that aligns with the self-determination theory, which simulates autonomous motivation, arguing that simply aligning with the USCPG is not enough. Of the 175 selected apps, it was found that, while most apps (94%, 165/175) had at least one feature that tapped into one of the three basic needs identified in self-determination theory, only 18 of the 175 (10.3%) addressed all three. In addition, the authors found that the apps tended to present extrinsic goal content (e.g., money) over intrinsic ones (e.g., health), the latter of which is less likely to stimulate autonomous motivation. The authors did find, however, that most of the goal content adopted gain framing, which has been positively associated with quitting smoking (Cornacchione & Smith, 2012; Gallagher & Updegraff, 2012). Choi and colleagues (2014) concluded that smartphone apps for smoking cessation not only rarely adhere to the USCPG, but that they also rarely incorporate content that aligns with the self-determination theory (SDT), which simulates autonomous motivation.

Hoeppner and colleagues (2015) conducted a content analysis to assess the presence of tailoring features in smoking cessation apps available in the Google Play Store and the subsequent relationship to app popularity and user-rated quality. Tailoring features were informed by the 5A's Framework, which includes ask (e.g., talking about tobacco use), advise (e.g., support a quit attempt), assess (e.g., determine willingness to quit), assist (e.g., provide a

menu of tools and strategies for quitting), and arrange (e.g., follow-up). Of the 225 included apps, it was found that, despite the "smart" capabilities now afforded via smartphone apps, the selected apps primarily used simplistic tools (e.g., tracking, calculating, counting). They also found that the apps rarely delivered smoking cessation support using the 5As (number of 5As addressed averaged 2.1) and only used tailoring for an average of 0.7 of the 5As. Those that did use tailoring features were positively associated with downloads and user ratings. Apps that employed more complex functions, such as proactive alerts, responsiveness to quit status, or two-way interactions, addressed more of the 5As, used more tailoring to address the 5As, and/or used more ways of tailoring 5As content compared to those that included more simplistic tools. The authors concluded that smoking cessation apps fall short of providing tailored feedback despite end-user preferences for these features, as evidenced by downloads and user-ratings.

Two content analyses were conducted to assess the extent to which smoking cessation apps available in the Apple App Store contained behaviour change techniques (supporting identity change, rewarding abstinence, advising on change routines, advising on coping, and advising on medication use,) as well as the use of engagement and ease-of-use features. The first content analysis (Ubhi et al., 2016a) included 184 free and paid apps available in 2012, while the second content analysis (Ubhi et al., 2016b) included 137 free apps available between 2012 and 2014. The latter analyses was conducted to assess change in the content of the more recent apps. In their first analysis, the authors found that the apps primarily focused on two (supporting identity change and rewarding abstinence) of the five behaviour change techniques. They also found that very few apps made reference to pharmacotherapy options for quitting smoking. In relation to engagement and ease-of-use features, on average, the apps contained a high proportion of them (69% and 83% respectively). In their most recent analysis (Ubhi et al.,

2016b), the authors found that the behaviour change techniques were even more scarce compared to the results of their previous study. Compared to the 83 free apps available in 2012, the behaviour change techniques, supporting identity change, rewarding abstinence and advising on changing routines were less prevalent in the 137 free apps in 2014 (14.6% vs. 42.2%, 18.2% vs. 48.2%, and 17.5% vs. 24.1%, respectively). On a positive note, advice on coping with cravings and advice on the use of stop-smoking medication were more prevalent in 2014 as compared with 2012 (27.7% vs. 20.5% and 14.6% vs 3.6%, respectively). Only three apps contained all five behaviour change techniques. The use of recognised engagement features (e.g., personalization, visual cues/dashboards, instant feedback/gratification/gamification) was less common in 2014 than in 2012 (45.3% vs. 69.6%) while ease-of-use features (e.g., layout, easy to read, font size, aesthetics) remained very high (94.5% vs. 82.6%). The authors concluded that there was little improvement of iPhone-based apps for smoking cessation between 2012 and 2014 in relation to incorporating evidence-based behaviour change techniques that are known to improve the success of quit attempts.

Finally, in the study by Struik and Baskerville (2014), the researchers aimed to characterize the content of the Facebook page that was used to provide social support in conjunction with the smoking cessation app for young adults, CTC. Posts posted between October 2012 and June 2013 were coded. Out of the 399 posts coded, 121 were original posts and 278 were reply posts. The original posts, almost entirely generated by a moderator, served two main purposes: to support smoking cessation (71%) and to market the app (29%). Most of the reply posts were in response to the supporting smoking cessation posts (77%). The most common user response was engagement with the images associated with the original posts and sharing smoking-related experiences, with the latter more frequently found under the supporting

smoking posts (38% versus 17%). The authors concluded that Facebook can be harnessed to strengthen social support features as part of a smoking cessation app, even though most apps do not tap into social networks, such as Facebook (Abroms et al., 2011, 2013).

In summary, this group of studies characterized the content of smoking cessation apps, and one study characterized the content of a Facebook page as part of a smoking cessation app. Overall, it appears that most smoking cessation apps lack application of USCPG, incorporation of strategies for behaviour change, and the inclusion of features and functions to enhance user engagement and/or ease-of-use. In only one study, researchers characterized the content of a Facebook page for enhancing social support associated with a smoking cessation app targeting young adults. It was found that, although user-engagement was low, the content of the Facebook posts was largely supportive.

***Effects of smoking cessation apps***

Researchers evaluating the effects of smoking cessation apps have used a variety of quantitative approaches (Bricker et al., 2014; Buller et al., 2014; Heffner et al., 2015; Ubhi et al., 2015). Two studies were small pilot trials (Bricker et al., 2014; Buller et al., 2014), one utilized log data to determine effect (Ubhi et al., 2015), and the last one utilized log data to determine a relationship between feature use and effect (Heffner et al., 2015). In only one study, researchers employed a qualitative approach to capture end-users' experiences with a smoking cessation app (Ploderer et al., 2014). The authors of this study also utilized log data to complement the qualitative findings. The main findings of these studies discussed in the following section.

Bricker and colleagues (2014) recruited a national sample of 196 adults (ages 18 or older; mean age = 41 in both intervention and control groups) into the double-blind randomized controlled pilot trial that compared a smartphone delivered acceptance and commitment therapy

(ACT) app for smoking cessation (SmartQuit) with the National Cancer Institute's QuitGuide app. The SmartQuit app was adapted from web and telephone-based ACT interventions (Bricker, Wyszynski, Comstock, & Heffner, 2013; Bricker, Mann, Marek, Liu, & Peterson, 2010) and included features that helped users stay motivated by focusing on ACT values-based motivations (e.g., other smokers' testimonials), develop a personalized quit plan (e.g., identifying social support), develop ACT-based acceptance skills (e.g., coping with cravings), develop ACT-based self-compassion skills (e.g., prevent negative self-judgements), and tracking progress (e.g., number of times they resisted smoking). The QuitGuide app had content based on Smokefree.gov and contained the following features: thinking about quitting (e.g., identifying reasons to quit), preparing to quit (e.g., identify social support), quitting (e.g., skills to avoid cravings), and staying quit (fighting cravings). Participants (n=196) recruited smoked at least five cigarettes daily for at least the past 12 month and were motivated to quit in the next 30 days. Participants, randomized to study groups, were sent weekly emails reminders to use the interventions for the eight-week duration of the study. At two-months post randomization, the overall retention rate for both intervention and control conditions was 84%. The authors found that, on average, SmartQuit participants reported opening the app 37.2 times compared to 15.2 times among the QuitGuide participants. In addition, SmartQuit participants reported higher overall satisfaction with the app compared to QuitGuide participants: 85% reported that the app was organized (vs. 67%), 53% reported it was useful for quitting (vs. 38%), and 59% were satisfied overall (vs. 45%). In addition, quit rates were higher among SmartQuit participants (13%; 95% CI=6-22%) compared to QuitGuide participants (8%; 95% CI=3-16%) (OR=2.7; 95% CI=0.8-10.3). Consistent with ACT's theory of change, among those scoring low on acceptance of cravings at baseline (n=88), the quit rates were 15% in SmartQuit versus 8% in

QuitGuide (OR=2.9; 95% CI=0.6-20.7). Moreover, from baseline to two-month follow-up, there was an increased in acceptance of cravings in the SmartQuit arm ($p<0.04$) but not in the QuitGuide arm, and higher acceptance of cravings was strongly associated with 30-day point prevalence abstinence at two-month follow-up (OR=6.1; 95% CI=3.0-15.2). Given the small sample size, 95% confidence intervals for the quit rate intervals were quite wide. However, the authors concluded that, if proven definitive, the overall effect size would have high public health significance. The results of this study support the conclusions of Choi and colleagues (2014), who suggested that apps should be based on behaviour change theories in addition to the USCPG, and that this would likely result in higher quit rates.

Buller and colleagues (2014) compared a smartphone app (REQ-Mobile) with a text messaging intervention (onQ) for smoking cessation in a small sample (n=102) of young adult smokers aged 18 to 30 through a randomized pretest-posttest two-group design. The delivery of onQ text messages was managed by the Quit Coach expert system (Balmford, Borland, & Benda, 2008; Balmford, Borland, Li, & Ferretter, 2009; Borland, Balmford, & Hunt, 2004). Messages were grounded in social cognitive theory (Bandura, 1986), and a modified version of the transtheoretical model (precontemplation, contemplation, preparation, action, maintenance of smoking cessation) (Prochaska, Redding, & Evers, 2005), and messages suggested tasks to plan, set, and maintain a quit date, cope with cravings and relapse, and consolidate a non-smoking lifestyle. The REQ-Mobile was a companion app to onQ and provided participants with addition features to perform the tasks advised through the onQ messages (e.g., create lists on reasons for quitting, listen to testimonials from former smokers, and read documents to support their quitting). Once participants quit for more than one week, they were shifted to the onQ intervention because maintenance counselling was not programmed into the app. Participants

were invited by email to complete follow-up questionnaires online at six and 12 weeks. Similar to the sample in the study by Bricker and colleagues (2014), participants were current smokers and were interested in quitting. Participant retention was 65% at six-weeks posttest and 67% at 12-weeks posttest. In the REQ-Mobile group, 61% (n=31) opened the inbox, received 128.5 short messages, and opened just over 76 short messages. In comparison, 59% of smokers who used the onQ service received an average of 107.8 text messages. At six weeks follow up, smokers who used REQ-Mobile and evaluated its usability favorably: approximately 70% considered it simple, reliable, useful, easy, designed for them, satisfying, easy to learn, and user friendly. Participants were less positive on REQ-Mobile being straightforward (56%), consistent (63%), and well integrated (56%). The authors found that the smartphone intervention, REQ-Mobile, was feasible for delivering cessation support to young adults but appeared to not move smokers to quit as quickly as text messaging. More frequent use of REQ-Mobile, however, was positively associated with greater 30-day point-prevalence abstinence at 12 weeks ($p=0.02$) compared to the frequent receipt of text messages from onQ ($p=0.14$). The authors noted that the small sample size limited the statistical power of the results but concluded that a smoking cessation smartphone app could be successfully deployed and that most young adult smokers had considerable interest in the advice contained in the app.

Ubhi and colleagues (2015) conducted a preliminary evaluation of the smoking cessation app, SmokeFree28 (SF28), which aims to help smokers become smokefree for 28 days. SF28 was made for iPhones and available free of charge via iTunes. SF28 focuses on behavioural change techniques to aid smoking cessation. PRIME theory (Plans, Response, Impulses, Motives, and Evaluations) underpinned the app, which aims to explain and predict the impact of an intervention that addresses higher level cognitions (personal goals, identity and beliefs about

harms of a behaviour) on a behaviour and in this case, smoking (West, 2009). The app has a target of being smokefree for 28 days, which is documented to increase the chances of maintaining smokefree status by more than five-fold (West & Stapleton, 2008). The app also provides a list of evidence-based behaviour change techniques for smokers to help them quit, including advice on pharmacotherapy options, personal stories of smokers who quit for inspiration, a distraction game, and advice on avoiding smoking triggers. Using automated data collection, data from 1170 participants (aged 16 and up; 50% of which were aged 16-29) in the United Kingdom were collected for analysis, with the primary outcome measure being 28-day abstinence. The majority (84%) of participants set a quit date on the day of registration. In relation to app use, only 19% used the app for 28 days or more. Self-reported abstinence rate for 28 days or longer was 18.9% (95% CI 16.7-21.1). A strong positive association was found between the number of times the app was opened (user engagement) and 28-day abstinence (OR 1.17, 95% CI 1.15-1.19, P<.001). Recorded abstinence was higher among those who were older (30-49 years of age) (p=0.001), in non-manual occupations (p=0.032), who made a quit attempt over a year ago versus those who never made a quit attempt (p=0.002), and who used pharmacotherapy (p=0.001). The authors concluded that, while the findings are encouraging, similar to Buller et al. (2014), user-engagement needs to be enhanced in the app.

Heffner and colleagues (2015) conducted a secondary analysis on the pilot trial data by Bricker and colleagues (2014) (described above) to determine the 10 most-used app features and the prospective associations between feature usage and quitting. The analysis revealed that eight out of the 10 most popular features were based on traditional cognitive behaviour therapy, which were situated in the following categories: developing a quit plan, tracking, viewing progress, sharing, and journaling. The remaining two most popular features were ACT-specific features,

including the tracking practice of letting an urge pass and viewing and ACT exercise for staying motivated. Despite the popularity of these features, only two of the most popular features predicted smoking abstinence, which included viewing a quit plan (not ACT-specific) ($p=0.03$) and tracking practice of letting urges pass ($p=0.03$). Although not widely used by participants, tracking ACT skill practice was also predictive of quitting ($p=0.01$). The authors concluded that there was little association between app feature popularity and smoking abstinence.

Following a "research through design" approach, Ploderer and colleagues examined how the DistractMe smoking cessation app enabled coping strategies in 14 participants (11 female, 3 male) aged 20-53 (average age of 33) during the first few weeks of their quit attempts. The DistractMe app was developed to enable users to access and share distractions and tips to help them cope with their cravings. Based on interviews, diaries, and log data, six quitting strategies were supported through the app: diversion (diversion away from cigarettes and towards content in the app), avoidance (avoiding situations that lead to smoking), and displacement (doing something else to prevent cravings), preparation (e.g., reflecting, gathering information), fortification (strengthening motivation), and confrontation (concentrating on cravings and actively resist). Participants employed strategies to prevent cravings more often than immediate coping strategies. Although participants shared more distractions than tips through the app, they engaged with tips more than distractions to aid in their cessation attempts. Finally, participants indicated that social exchanges between quitters supported by the app was an important feature that helped them in their quitting journey. At the time of the second interview (6-12 weeks into the study), seven participants reported non-smoking status, two reported that they significantly reduced smoking, and five reported their smoking status as the same as at baseline. The authors concluded that apps for cessation that include distractions and tips can be taken up and used by

smokers who are trying to quit. They recommended that a study of a larger community of users is needed to explore the benefits of self-expression and interactivity with peers, improve the diversity and depth of content available on the app, and to work towards a self-sustainable community.

In summary, the above review presents preliminary evidence to support the use of apps for supporting smoking cessation. Researchers of the quantitative studies and the one qualitative study concluded that the overall positive results render apps as promising new media to reach smokers. A summary of key findings in relation to the included studies and the implications for future research in relation to smoking cessation apps are discussed in the following section.

***Summary of included studies***

While there are dozens of smoking cessation smartphone apps now available in smartphone stores (Abroms et al., 2013), only a small minority of apps for smoking cessation are evidence-based (Abroms et al., 2011, 2013; Choi et al., 2014; Ubhi et al., 2016a, 2016b), and only a handful have been rigorously evaluated. There is still a limited understanding about the most important elements for inclusion in a smoking cessation app, how to effectively integrate evidence related to cessation and behaviour change into cessation apps, and how technologies available through apps can be harnessed to increase smoking cessation rates. Furthermore, it appears that smoking cessation apps are rarely customized to users' needs, nor are the complex functions made available through smartphone technologies utilized to enhance tailoring (Hoeppner et al., 2015). The literature shows an ongoing neglect of incorporating evidence-based strategies to support smokers in their quit attempts.

All evaluations of smoking cessation apps included apps that incorporated behaviour change theory as the intervention. Except for Buller and colleagues (2014), researchers found

that the intervention apps based on such theory were positively associated with mobilizing smoking cessation. Bricker and colleagues (2014) were the only researchers to conduct a pilot trial of a behaviour change theory-informed app compared to an app that included strategies based on best practice guidelines but did not include strategies based on behaviour change theory. The researchers found that the theory-informed app mobilized smoking cessation significantly more than the control app. The findings of this study offer empirical evidence to support Choi and colleagues (2014), who asserted that apps must go beyond the USCPG and include behaviour change theory that can be maximized through the "smart" aspects of apps to enhance quit rates.

The reviewed literature also revealed a dearth of research evaluating apps for smoking cessation. Only 12 studies were found through the above literature search. Relative to the large number of smoking cessation apps that have become available over the last several years, this number is very small. Also, more than half of the studies found were content analyses of app content or related social media. In this regard, the lack of research evaluating the effect of these interventions is striking. It must be noted, however, that seventeen clinical trials of smoking cessation apps are currently underway according to a recent search (clinicaltrials.gov), which is encouraging.

It is also noteworthy that qualitative research lags significantly behind compared to quantitative research approaches. Although evidence from clinical trials are an essential part of determining the success of mHealth interventions, the effectiveness of these interventions cannot be solely based on clinical trials alone. Researchers have cautioned that the effectiveness of such complex interventions requires much more than experimental evaluations located in the positivist

or postpositivist paradigms[3] (Greenhalgh & Russell, 2010; van Gemert-Pijnen et al., 2011), whereby which it is believed that knowledge is objectively acquired through careful observation and measurement (Guba & Lincoln, 1994). Greenhalgh and Russell (2010) assert that "eHealth ''interventions'' may lie in the technical and scientific world, but eHealth dreams, visions, policies, and programs have personal, social, political, and ideological components, and therefore typically prove fuzzy, slippery, and unstable when we seek to define and control them" (p. 1). The very definition of eHealth demonstrates that eHealth, is much more than a simple combination of medicine and technology—the "e" in eHealth is not just a prefix for "electronic" health; rather, it is a more broadly encompassing prefix that includes efficiency, enhancing quality of care, evidence-based, empowerment, encouragement of patient-provider partnerships, education, enabling information exchange, extending healthcare beyond its traditional walls, ethics, and equity (Eysenbach, 2001). In short, eHealth is an integration of technology, medicine, individuals, and context. Indeed, the complex, dynamic, and the contextually-dependent nature of mHealth interventions calls for more contextual research approaches (Greenhalgh & Russell, 2010; van Gemert-Pijnen et al., 2011), and qualitative research is particularly suited to situating the success of these interventions, or the lack thereof, in context (Greenhalgh & Russell, 2010).

While initial qualitative research indicates that mobile-based smoking cessation interventions are acceptable and feasible platforms for delivering health behaviour interventions in general (Jamison, Sutton, & Gilbert, 2012; Minian et al., 2010; Naughton et al., 2013), there remains a lack of research with the aim to develop a deep understanding of end-user experiences

[3] Underpinning all research projects are paradigms or knowledge claims (Guba & Lincoln, 1994). There are five main paradigms described by Guba and Lincoln (1994): positivism, postpositivism, critical theory, constructivism, and participatory. Qualitative research is most often conducted from within the constructivist, critical theory, and participatory paradigms and quantitative research within the positivist and postpositivist paradigms (Guba & Lincoln, 2005).

and practices related to engaging with these interventions (Dennison et al., 2013). Only one qualitative study was found that met the inclusion criteria and contributed to evaluations of a smartphone app for smoking cessation from the end user's perspective (Ploderer et al., 2014). The findings of this study pointed towards several important implications for future app development and implementation, drawing attention to the importance of contextualizing app use. For example, it was found that sharing distractions through the app reinforced users' non-smoking status, aligned with the privacy preferences of the group, and served as a gateway to sharing content among users rather than just consuming content. It was also found that conveying personal stories through tips was a powerful tool for reinforcing users' smokefree status. Indeed, research investigating the ways in which users engage with these interventions is critical because it provides information about what aspects of mobile-based smoking cessation interventions work well to sustain and support engagement with the intervention and where improvements can be made to strengthen these interventions.

Also noteworthy, is the lack of research on the use of smoking cessation apps among young adults. Only two studies entailed an examination of the effect of a smoking cessation app on young adult smoking cessation (Buller et al., 2014; Ubhi et al., 2015). Buller and colleagues found that quit rates among the intervention app users were lower than that of the control group, who used a text-messaging intervention. Ubhi and colleagues found that quit rates were lower among young adults (16-29) compared to their older counterparts who used the SmokeFree28 app. That these interventions are having a differential effect on young adult behaviour change compared to their older counterparts highlights the need to focus research efforts on this population in relation to mHealth interventions. In particular, qualitative research is needed to highlight the needs, preferences, and experiences of young adults who use apps for supporting

smoking cessation. Even though young adults represent the largest users of smartphone technologies, the potential value in using smartphone apps for health behaviour change interventions directed towards this population will not be fully realized until more in-depth evaluative efforts are made. Indeed, to fully capitalize on the power of smartphone apps for smoking cessation, and health promotion more broadly, there is a need for better understanding of the ways that these interventions promote and support young adult health behaviours as they engage with these interventions (Buhi et al., 2012).

Research detailing the underlying principles of development and design processes of mHealth smoking cessation interventions, such as apps, is also limited (Bender et al., 2013; Dennison et al., 2013; Ghorai et al., 2014; Tomlinson, Rotheram-Borus, Swartz, & Tsai, 2013). None of the reviewed studies provided an in-depth description of the developmental processes that undergird smoking cessation apps. Tomlinson and colleagues have described the current influx of mHealth interventions as a wave of black boxes because there is a lack of research detailing the developmental processes of and subsequent expectations for these interventions. The paucity of research on the development of these initiatives reflects a primary concern for health outcomes in the mHealth intervention literature despite that the processes of development are critical to establishment of optimal and scalable interventions (Tomlinson et al., 2013). For example, while Ploderer and colleagues (2014) did not make explicit the underlying development principles of the DistractMe app, they did describe which user experiences aligned with the design intentions of the app. As a result, the authors were able to draw conclusions about which aspects of the app worked well and how development practices can be improved in order to optimize its effect. According to Leonardi and Barley (2008), failure to bridge development and use makes it difficult to answer questions, such as, “do developers intend their

technologies to shape certain practices in particular ways and, if so, how do designers embody their intentions in the designs?" "Do the designs have the effects the designers intended"? By understanding the underlying principles of development of mHealth interventions, the ways in which user experiences align with these objectives can be determined, exposing both productive and unproductive developmental practices that underpin smoking cessation apps.

## Gender and tobacco use

Gender has become an increasingly important concept in conducting health research (Greaves, 2011). As Greaves argues, every person is gendered in some way, and therefore, the integration of a gender in health research will contribute to the production of more accurate, effective and relevant research findings and subsequently inform the development of optimal strategies for preventing illness and improving health. While it is recognized that sex and gender are intertwined, there is a clear distinction between the two. Sex refers to the physiological and biological aspects of being male or female and gender refers to the non-biological (e.g., cultural and social) characteristics of being a woman or a man (World Health Organization, 2016). Gender is understood to be socially constructed through "an ongoing process of learned sets of behaviours, expectations, perceptions, and subjectivities that define what it means to be a woman and what it means to be a man" (Lemish, 2008, p. 59). According to social theories of masculinity and femininity, gender ideals and discourses of gender are reproduced or contested in the ways in which individuals engage in health practices (Lyons, 2009). For example, overuse of tobacco and other substances, and a disregard for self-care among young men has been interpreted as their alignment with Western masculine ideals, such as personal strength and invulnerability to illness and disease (Bottorff et al., 2012). On the other hand, women often

align with idealized forms of femininity through their practices of self-care, seeking professional health care and caring for others (Bottorff et al., 2012).

Gender influences on reducing and stopping smoking have been described in the literature. In relation to smoking cessation, it has been found that, compared to men, women are less successful on their initial quit attempts, experience negative affect while quitting, and are less successful with nicotine replacement therapy (NRT) (Perkins, Donny, & Caggiula, 1999; Wetter et al., 1999; Cepeda-Benito, Rynosos, & Erath, 2004; Hogle & Curtin, 2006). In relation to motivation to quit smoking, McKee and colleagues (2005) found that women scored higher than men on all quitting-motive scales, which includes health, well-being, financial, physical appeal, and social approval motives. In the same study, women also scored higher than men on scales related to the perceived risks of quitting, such as weight gain and negative affect. In relation to smoking relapse, women have been found to relapse in situations involving negative emotions (e.g., stress), whereas men tend to relapse in positive situations (e.g., social events) (Ortner et al., 2002). Furthermore, men are more likely to reduce their smoking because of pressure from social networks (e.g., spouse, family, friends) compared to women (Westmaas, Wild, & Ferrence, 2002).

In light of these gender-related influences on tobacco use, gender-sensitive approaches in eHealth smoking cessation interventions, have begun to emerge (e.g., QuitNow Men). Research evaluating eHealth cessation interventions that include a gender-sensitive approach have been found to positively influence receptivity to and use of the interventions, as well as mobilize smoking cessation (e.g., Bottorff et al., 2016; Haines-Saah et al., 2015; Schwartz et al., 2014). Yet, no efforts to investigate the influence of gender and/or ways to incorporate a gender-sensitive approach into mobile-based smoking cessation interventions specifically have been

found. Indeed, the ways in which young men and women use and benefit or not from smoking cessation interventions as they engage in quitting smoking may differ. Therefore, attention should be paid to potential gender-related influences in the ways in which young men and women take up and use eHealth smoking cessation interventions, such as CTC.

## Summary

Through the above review of the literature, the importance of smoking cessation among young adults, the failure to reach young adult smokers with traditional cessation interventions, and the promise of smartphone apps for reaching young adults with smoking cessation interventions is highlighted. There are several evidence-informed apps now available that hold potential to positively influence young adult smoking behaviours based on emerging evidence supporting the efficacy of mHealth smoking cessation interventions, and smartphone apps for smoking cessation specifically. To date, however, there appears to be no literature that includes an in-depth description of the interaction between young adult smokers and smoking cessation apps, and how this interaction influences young adults' smoking cessation efforts. The literature also appears to lack research that contains detailed accounts of the underlying principles of development of these interventions and how they align with users' experiences. Furthermore, despite burgeoning evidence of the influence of gender on tobacco use, research in eHealth lacks attention to gender as an influencing factor on the uptake and impact of these interventions. This study addresses these gaps.

# CHAPTER 3 – RESEARCH METHODS

This Chapter includes a description of the research methods that were employed in this study and discussion of the rationale for the research design. Within this Chapter, I also describe the selected mobile app, data collection procedures, the research sample, approaches to data analysis, rigour, and ethics procedures.

## Rationale for a qualitative research approach

Following Leonardi's (2013) sociomaterial perspective, the use of smoking cessation apps is interwoven with the cultural contexts and practices in which an app and the users are situated. The interactions that occur between end-users and eHealth behaviour interventions are thus connected to a wider ecology. Investigating these interactions, therefore, calls for a qualitative research approach to expose the various and interwoven factors that lend to particular experiences and practices in relation to behaviour change (in this case, smoking cessation). Qualitative research entails an emphasis "on the qualities of entities and on processes and meanings that are not experimentally examined or measured (if measured at all) in terms of quantity, amount, intensity, or frequency" (Denzin & Lincoln, 2005, p. 2). Employing a qualitative research approach aids in interpreting the complex dimensions of human experience, allowing a researcher to translate the situated meanings behind people's words and actions (Corbin & Strauss, 2008). Through this study, it is hoped that a multifaceted understanding of how users and the Crush the Crave (CTC) app interact in constituting smoking cessation experiences and practices will be gained. The guiding questions for this study are as follows:

1. How was CTC designed to influence young adults' smoking cessation?
2. How do young adults engage with CTC for smoking cessation?

3. How are young adults' smoking cessation experiences and practices influenced through CTC?

## Rationale for case study research methods

The above research questions necessitated a research approach that is capable of attuning to the interrelated elements and interactions that lend to experiences and practices because of engaging with CTC. Sociomateriality illuminates the interdependent nature of the elements and interactions and so isolating factors for investigation is considered unreliable because sociomaterial relations are context-specific and bound up with the rest of the system. As the term "sociomaterial" suggests, both the "socio" and the "material" must be foregrounded and case study methods provided this research study with the necessary flexibility to do so.

Case study methods enables going beyond mere description and into a more detailed understanding of the underlying processes of a case—CTC in this case. Rather than being a methodological choice, a case study is a paradigmatically flexible approach (Luck, Jackson, & Usher, 2006) that signifies an intensive focus on a particular case(s) (Rosenberg & Yates, 2007; Sandelowski, 2011). This intensive focus on a case has been recognized as the biggest strength that a case study brings to a research study (Merriam, 1998). Employing a case study approach to the present study was fitting because of its particularistic nature, that is, the focus of this study was on a particular intervention (CTC) (Stake, 1995). In addition, case studies can be conducted within a short time period to explore a narrower field of interest and are therefore, ideally suited to examine the interactions between a population group and a particular intervention (Parthasarathy, 2014). Furthermore, case studies are most suitable for exploring new processes, of which there is little understanding (Baxter & Jack, 2008), such as the ways in which innovative health behaviour interventions that make use of digital media for behaviour change

are taken up and used, and how these interactions shape experiences and practices related to the health behaviour of interest. Case studies also enable researchers to pay close attention to the influence of social, political and other contexts that influence the nature of the case (Stake, 1995). This intensively contextualized approach enabled tackling surrounding social structures and cultural contexts, such as gender, that shape young adults' interactions with CTC.

Case studies are especially useful for program evaluation because this approach enables a holistic investigation of the program, the context of the program, and the experiences of those who are living the program (Balbach, 1999; Stake, 1995). Compared to traditional evaluation designs, a researcher who employs a case study evaluation broadens the scope by which to assess the effect of the program (Balbach, 1999). This is because case studies enable the researcher to include a variety of elements operating together to make that case the case it is deemed to be (Sandelowski, 2011). For this study, a case study approach enabled the investigation of various elements that make CTC function in a particular way, including developers' goals and subsequent expectations for use, the features and functions that lie within the app, and young adults' experiences and perspectives of engaging with CTC for smoking cessation. In short, the case is a configuration of aspects of both sociomaterial practices in relation to the CTC intervention and the CTC intervention itself.

It must be noted that Stake (1995) identifies three different types of case studies: intrinsic, instrumental, and collective. Fairly recently, however, Sandelowski (2011) argues that all case studies are instrumental because all cases are seen in the context of an array of other cases. In keeping with this rationale, this study is considered an instrumental case study.

## Rationale for critical realist paradigm

As stated earlier, a case study has been defined as "a transparadigmatic and transdisciplinary heuristic that involves the careful delineation of the phenomena for which evidence is being collected (event, concept, program, process, etc.)" (VanWynsberghe & Khan, 2007, p. 80). As such, it is important to be explicit about the paradigmatic assumptions that underpin case study research. This research study was underpinned by a critical realist paradigm.

Critical realism is a paradigm that offers an alternative to positivism and constructivism. Influenced by the works of Bhaskar, critical realism is a logic of inquiry that denies that we can have any certain knowledge of the world, and accepts that there is a possibility of alternative valid accounts of any phenomenon (Maxwell, 2012). Critical realists, therefore, retain an ontological realism (there is a real world that exists independently of our perceptions, theories, and constructions) while accepting a form of epistemological constructivisim or interpretivism (our understanding of this world is inevitably a construction from our own perspectives and standpoint) (Maxwell). Critical realism essentially relegitimates ontological questions about the phenomena we study (concepts refer to real phenomena, rather than being abstractions from sense data or purely our own constructions) and enables the investigation of objects/entities, which can be human, social or material, complex or simple, structured or unstructured. The primary aim of this study was to understand how the CTC app, together with young adults, influences smoking cessation practices (good and bad) and the ontological grounding of critical realism enables consideration for the materiality of the app as part of, and shaping, young adults' smoking cessation practices.

Critical realism is underpinned by the notion that reality is divided into three layers – the actual (events and actions that are more likely to be observed), the real (underlying powers,

tendencies, and structures within objects, which could be human, social, or physical, that generate events in the actual domain), and empirical (fallible human perceptions and experiences) (Clark, Lissel, & Davis, 2008). This stratified reality illuminates the complexity of reality and that there are underlying mechanisms (the real domain), which may or may not be observable, that have a very real impact on events and outcomes (Maxwell, 2012). The essence of this stratification is that it theorizes reality to be an open system, whereby numerous factors are present and interact in highly complex and variable ways over time and context to produce social phenomena (Clark et al.). Basing research on critical realism means that the complex causes of how and why changes in health or social factors occur need to be understood and it is only by considering all three realities (which are encompassed in the real domain) that an accurate understanding of these phenomena can be gained (Maxwell). Knowledge gained from critical realist research, therefore, has more practical utility in that it can shed light on how dimensions of context and individual characteristics interact to influence health, which is important to designing and improving health interventions, and ultimately health (Clark et al.).

Behavioural interventions, such as CTC, are important strategies to influence patterns of behaviour—in this case, smoking behaviours among young adults. These interventions are highly complex and multifaceted interventions and yet, are primarily evaluated on the basis of using the same closed-systems views of causation and methods (e.g., randomized controlled trials) (Greenhalgh & Russell, 2010; van Gemert-Pijnen et al., 2011). The findings of such studies do not account for the role of contextual factors in shaping outcomes or explain why variability in outcomes occur (Clark et al., 2008). Critical realist research directs researchers to understand "what works for whom, when and why" (Pawson & Tilley, 1997) and explore the complex ways in which interventions interact with people and settings to result in different

outcomes. According to Clark and colleagues, critical realism is especially appropriate when the outcome(s) of interest are behavioural, such as smoking cessation, because this approach grounds interventions like CTC in open-systems. Pawson and Tilley conceive behaviours in such systems as complex outcomes, produced from the ways in which programs come together with people to generate new choices and capacities. In other words, interventions enable and constrain – rather than determine – an individual's behaviour, and individuals have the ability to influence and transform these interventions. The power of the program, therefore, is not inherent in the program, people, or places, but in the ways the program works (mechanism) for people in different contexts (Clark et al.). This assumption aligns with Leonardi's (2013) sociomaterliaty theory in which both the individual and technological tools come together and interact to enable/constrain behaviours and practices, as in smoking cessation. This approach facilitates rich learning on how an intervention, such as CTC, works (or fails to) that can be used to improve effectiveness.

Critical realism has some major epistemological implications given the three ontological layers of critical realism. Indeed, in order to uncover underlying mechanisms that lead to particular behaviours, a critical realist does not rely on observation alone. Critical realism is based on an epistemological interpretivism, that is, knowledge production is a social practice (Easton, 2010). Critical realists acknowledge that social phenomena are intrinsically meaningful and hence, meaning not only describes them, but also constitutes them (Easton). To understand meaning, therefore, a hermeneutical element is essential—that is, interpretation of verbal and/or text data in relation to the phenomena of interest. Interviews with young adults, therefore, served as an appropriate primary method of data collection for understanding how CTC influences smoking cessation. During these interviews, particular attention was given to understanding

participants' perspectives on how they used CTC and why they used or avoided using certain aspects of the app as they engaged with quitting smoking. In addition, interviews with key informants were used to explore the underlying goals and expectations in relation to the app in order to obtain a fuller understanding of what aspects of the app worked well, as well as which aspects did not and why, ultimately informing improved development and implementation practices for mobile-based smoking cessation interventions.

## Data collection procedures

Data collection was designed to capture the design intentions behind CTC and end-users' experiences and practices from engaging with the app. The research sample was drawn from researchers, project managers, government employees, and a media developer, and from Canadian young adult smokers participating in an existing RCT evaluating young adults' use of CTC. Data collection commenced after young adults had been using the app for at least six months. Data collection at this time enabled me to retrospectively investigate how CTC influenced young adults' smoking cessation efforts over time, anticipating that participants would recall specific events and circumstances as they shared their perspectives.

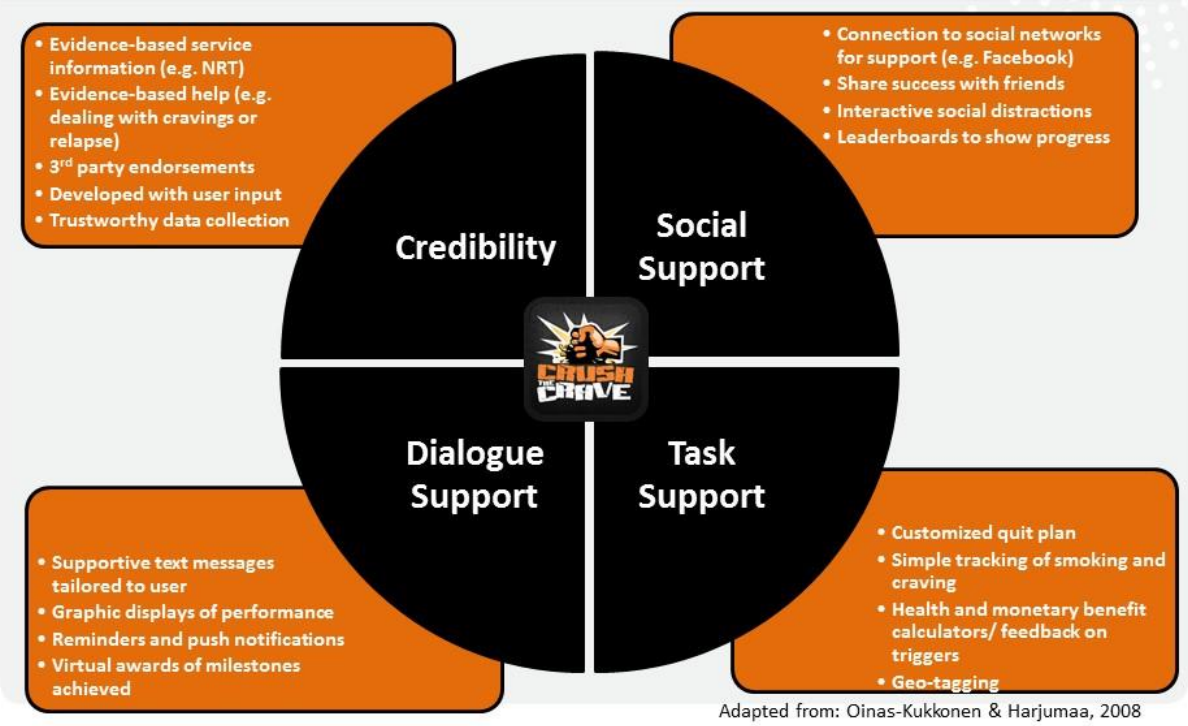
### *Case selection*

CTC was developed in early 2012 by a team of population health researchers, social media experts and computer programmers as an evidence-informed quit smoking smartphone app for young adults ages 19 to 29. As an evidence-informed smoking cessation app, CTC was designed to help close the gap between existing smartphone apps (Abroms et al., 2011) and evidence on what works in getting smokers to quit (Fiore, 2008). In developing CTC, a panel of experts in social media and tobacco cessation, a comparative analysis of the top five downloaded cessation apps, and two rounds of focus groups with young adult smokers were used to create the

content and test the usability, design, and functionality of CTC. In addition, the developers and designers of the app incorporated principles of persuasive technology for behaviour change (Fogg & Hreha, 2010) along with evidence on what works in helping smokers quit according to the USCPG (e.g., setting a quit date, identifying triggers, finding strategies for dealing with cravings, receiving positive reinforcement) (Fiore, 2008).

CTC is available for Android and iOS devices in both English and French. The primary goals of this intervention are to help young adults quit smoking and remain smokefree, CTC offers such features as a customized quit plan, the tracking of cravings and smoking habits, notifications of money saved and health improvements achieved, direct dial-up to telephone-based support, virtual awards that credit performance towards reaching milestones, evidence-informed credible information (e.g., nicotine replacement therapy), and the ability to connect with a community of people for social support via social media, such as Facebook. Once an individual downloads the CTC app, they are prompted to set a quit date. The features of the app then support individuals in their cessation journey, whether they decide to quit cold turkey or to follow a customized quit plan. They can also tap into various social media that have been integrated into CTC for interaction and support, including Twitter, Facebook, YouTube links, LinkedIn, Tumblr, Reddit, Google+, and Pinterest. Figure 2 provides an overview of the key design components of CTC as conceptualized by the developers. Figure 3 presents screenshots of the various pages within the app.

*Figure 2. Evidence-informed design components of CTC*




Adapted from: Oinas-Kukkonen & Harjumaa, 2008

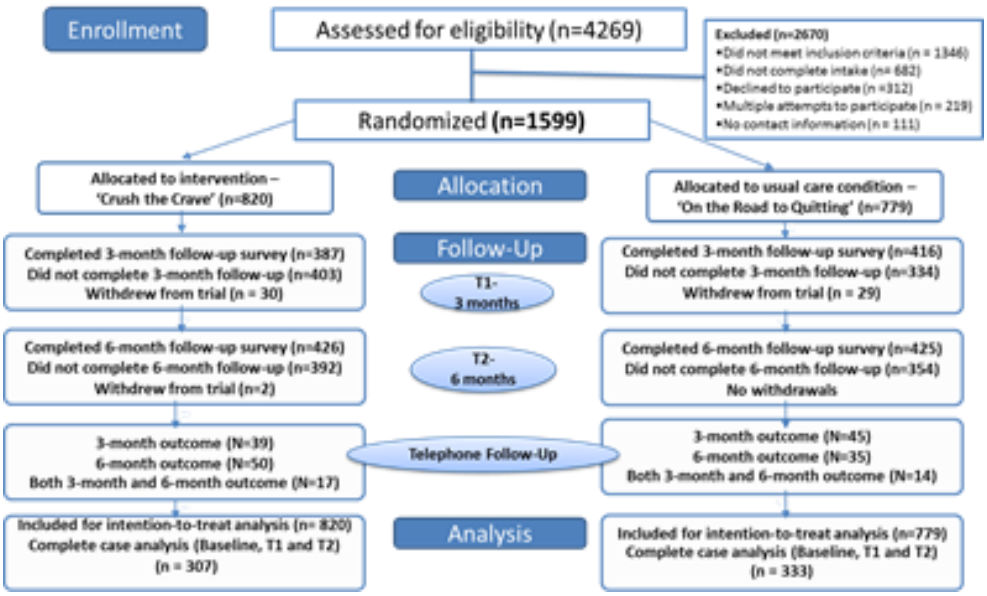
*Figure 3. Screenshots of the CTC app pages*


CTC was intentionally selected as the case for this research project. In light of evidence that existing smoking cessation smartphone apps are not developed by health professionals or researchers, do not draw on behaviour change theories or techniques, and do not have content aligned to clinical guidelines and other evidence-based practices (Abroms et al., 2011), CTC is a relatively novel intervention in the area of smoking cessation. I reasoned that investigating an app that holds significant promise to positively influence smoking behaviours among young adults because it includes evidence-based strategies is a fruitful starting point for moving mobile-

based cessation interventions forward. Investigating interventions that hold the most promise and carry the least possibility for negative effects is the most effective way to move mHealth forward in a productive, relevant, and effective way, and ultimately lead interventions to scale-up quickly.

At the time of this study, the CTC app was being evaluated in a randomized control trial (RCT). Figure 4 is the CONSORT flow diagram for this study. A sample of 1,599 Canadian young adult smokers who were motivated to quit were randomized to the CTC intervention group or the control group, which was allocated the 'On the Road to Quitting' self-help guide by Health Canada. In the RCT, baseline, 3-month, and 6-month follow-up surveys were collected to assess the effect of CTC on smoking cessation compared to the quit guide. The present study served as a companion study to this RCT. Young adult participants for the present study were drawn from the individuals in the intervention group that completed all three surveys (n=307).

*Figure 4. CTC RCT CONSORT flow diagram.*




Three data collection methods were used for this dissertation study: fieldwork, document collection, and interviews. Due to the nature of wireless technologies, ubiquity of smartphone

use, mobility issues, and size of the devices (Orlikowski & Scott, 2008), the ability to directly observe the interaction between users and the app was limited. The use of multiple data sources and comprehensive interview guides in the present study, however, addressed this potential concern, and this is supported in the sociomaterial literature (e.g., Ulmer & Pallud, 2014). I conducted all data collection myself. The data collection methods are discussed in turn below.

### *Fieldwork*

Fieldwork included mapping the characteristics of the CTC app and associated social media platforms linked to the app. App and related social media data, including texts, pictures, and videos were collected via screenshots and hyperlinks to assist me in recalling and describing CTC. I then developed a detailed narrative description of the various aspects of CTC (see Appendix C).

### *Document collection*

Documents related to the design and development of CTC were collected for analysis. This included panel meeting minutes, storyboards, presentations, publications, reports, memos, and intellectual property reports. These documents helped contextualize key informants' goals for CTC and subsequent expectations for use. The contents of the documents were analyzed considering the intended end-users (young adult women and men who smoke) and how contextual and social structures influenced design features, tone, language, and delivery mechanisms. Assistance in locating these documents was negotiated with the developers of CTC, and primarily included formal reports and research team meeting outcomes.

### *Interviews*

Semi-structure interviews were held with key informants and young adults. Semi-structured interviews are less directive and more open-ended (Stake, 1995), which ensured that

the experiences and perceptions of those participating in the study were captured. For example, additional probative questions were asked to help garner what participants thought as important and helped to reveal contextual factors outside of the app that influenced their interactions with the app. Interviews were guided by sociomateriality theory, with key informant interviews focused on capturing the intended affordances and young adults' interviews focused on capturing the experienced affordances of CTC, which could have been intended (by key informants) or unintended. ***Key informant interviews*** began with questions about their professional roles and experiences in relation to the development of CTC, which was followed by questions about their perceptions of the overall strengths and weaknesses of the app and expectations for how the app would influence young adults' smoking cessation efforts, the latter capturing the intended affordances of the app. Except for one Skype interview, key informant interviews were conducted via telephone. Key informant interviews ranged from 40 to 80 minutes. Key informants who agreed to participate in the study received a $5 Starbucks or Tim Hortons gift card to thank them for contributing to the study. ***Young adult interviews*** began with questions about their personal experiences with tobacco use, which was followed by questions about their overall use and perspectives on the app, and the influence that CTC had on their quit smoking efforts, the latter capturing both intended and unintended affordances of the app. Due to geographical distance, all interviews were held via telephone. All interviews were conducted via telephone. Young adult interviews ranged from 30-80 minutes. All study participants received an honorarium ($50/interview) to acknowledge time spent on the study.

Appendix D and Appendix E are the key informant and young adult interview guides respectively. To obtain demographic, smoking behaviour, and app use data from young adults, participant responses to questions asked in the intake and 6-month CTC RCT survey study

questionnaires were collected. Field notes were completed during the interviews to record topics that I wanted to revisit during the interviews, as well as to document findings that surprised me or stood out. All interviews were conducted by me. This allowed me the opportunity to increase the depth of the data by extending questioning on matters raised by others as additional participants were interviewed and permitted me to check analytical approaches and emerging themes identified in the analyses.

## Research sample

### *Recruitment procedures and consent*

Key informants were those regarded as directly involved in the development and implementation of CTC. Key informants were put in touch with the principal investigator via an introductory email sent by the senior scientist of CTC. Key informants were provided information about the study and then invited by email (See Appendix F for key informant email invitation). Key informants were invited to contact the principal investigator via email or telephone, at which time, they were screened for eligibility, invited to participate and provided with the consent form (see Appendix G). Key informants participating in interviews provided advance written consent.

Young adults were recruited from the sample of young adults participating in the RCT to evaluate CTC. All young adults who selected "yes" to being contacted for additional research in the RCT survey were included in the list of potential contacts. These young adults were sent an email with information about the study and were then invited to participate in the study (see Appendix H for the young adult email invitation). Interested individuals were invited to contact the principal investigator via email or telephone, at which time, they were screened for eligibility and invited to participate if found to be eligible. For individuals who expressed interest but did

not confirm availability, the following recruitment protocol was employed: one follow-up email, then phone call, and then text message, and then a final email, in that order. Young adults who participated in the interviews provided written consent in advance of the interviews (see Appendix I).

***Sample***

Using a purposive sampling strategy, key informants were derived from those who were directly involved in the decision making in relation to the development, design, and implementation of CTC. All participants were able to provide informed consent and spoke English. Individuals not directly involved in the development, design, and implementation of CTC were excluded.

Also using purposive sampling, the young adult sample was derived from young women and men who were participating in the RCT study for CTC willing to provide descriptions of their experiences and use of CTC for smoking cessation and how it has influenced their tobacco use behaviours. Only those who had downloaded and used/were using the app were included given the focus on young adult's experiences in engaging with the app. In addition, eligible young adults were either current smokers or non-smokers at the time of interview. All participants had completed the six-month follow-up survey for the RCT study. All participants provided informed consent and spoke English.

The sample sizes for this study began with the suggestions by Guest and colleagues (2006) that "a sample of six interviews may be sufficient to enable development of meaningful themes and useful interpretations" (p. 78). This number of participants served as a useful starting point for data collection, with the ultimate driver of sampling being the saturation of themes, which is in keeping with sampling guidelines for qualitative research (Mason, 2010). To prevent

premature closure of the study, I followed the advice of Dey (1999) who suggested that saturation should be more concerned with reaching the point where "the new" does not add to the overall framework of the study (p. 136). To assess saturation, data were analyzed contemporaneously with their collection, with sampling continuing until data were repeated and representative coverage of emergent themes were saturated (Sandelowski, 1995).

***Description of key informant sample.*** Individual interviews were conducted with 15 key informants. The sample of key informants included individuals in various job roles, with most of them holding an academic position. Except for three individuals who were involved in the evaluation component of CTC, most of the key informants were involved in CTC during development of the app. The design of the app was primarily led by male academics. Table 3 provides a brief description of the key informant sample (disaggregated by sex) in relation to their job role, time of involvement in CTC, and which aspect of CTC they were involved in.

*Table 3. Key Informant sample*

| | **Job Role** | **Time of involvement in CTC** | **Intervention Involvement** |
|---|---|---|---|
| **Men (n=8)** | Academic | During development | App design |
| | Academic | During development | App design |
| | Academic | During and after development | App design and evaluation |
| | Clinician Scientist | During development | App design |
| | Data systems specialist | During development | App branding |
| | Media developer | During and after development | App design and marketing |
| | Academic | During and after development | App design and evaluation |
| | Senior Scientist | During and after development | App design and evaluation |
| **Women (n=7)** | 1st Project manager | During development | Study management |
| | 2nd Project manager | After development | Study management |
| | Academic | After development | Evaluation |

| | Job Role | Time of involvement in CTC | Intervention Involvement |
|---|---|---|---|
| | Academic | During development | Literature Review |
| | Academic | After development | Evaluation |
| | LTPB (Partner organization) | During development | App design and marketing |
| | Research Coordinator | During and after development | Management of social media |

***Description of young adult sample***. Interviews were conducted with 31 young adults. Tables 4, 5, and 6 provide demographic, smoking behaviour, and user experiences with CTC respectively, collected from the RCT surveys. To assess demographic representativeness of the current study's sample, Table 4 compares demographic data of the present study sample with the demographics of the entire intervention group in the RCT, which were collected at baseline. The present study sample had slightly higher education levels and income than the overall RCT intervention group. Demographics that are notably similar between the two samples included being predominantly White, followed by Aboriginal. Also, almost half of participants resided in Ontario with almost no representation of young adults who live in the two Territories or Nunavut.

*Table 4. Demographic characteristics of current study sample compared to the intervention sample in the CTC trial at baseline*[*]

| Characteristics | Current Study Sample (n=31) | | RCT Sample (n=307) | |
|---|---|---|---|---|
| ***Age*** | Range=20-29; M=24.7; SD=2.72 | | Range=19-29; M=23.9; SD=3.07 | |
| ***Female*** | 13 | 42% | 149 | 49% |
| ***Education*** | | | | |
| <High school | 3 | 10% | 30 | 10% |
| High school | 4 | 13% | 85 | 28% |
| Some post-secondary | 9 | 29% | 76 | 25% |
| Trade | 1 | 3% | 16 | 5% |

| Characteristics | Current Study Sample (n=31) | | RCT Sample (n=307) | |
|---|---|---|---|---|
| College | 11 | 35% | 61 | 19% |
| University degree | 3 | 10% | 39 | 13% |
| ***Income*** | | | | |
| <$15,000 | 4 | 13% | 56 | 21% |
| $15,000-$29,000 | 4 | 13% | 67 | 25% |
| $30,000-$44,999 | 4 | 13% | 52 | 19% |
| $45,000-$59,999 | 5 | 16% | 31 | 12% |
| $60,000-$79,999 | 3 | 10% | 22 | 8% |
| $80,000-$99,999 | 1 | 3% | 16 | 6% |
| $100,000-$119,999 | 1 | 3% | 12 | 5% |
| $120,000 or more | 1 | 3% | 12 | 5% |
| ***Population Group*** | | | | |
| Aboriginal | 3 | 10% | 30 | 10% |
| Arab | 0 | 0% | 3 | 1% |
| White | 22 | 71% | 226 | 76% |
| Chinese | 0 | 0% | 8 | 3% |
| South Asian | 2 | 6% | 9 | 3% |
| Black | 0 | 0% | 2 | 1% |
| Fillipino | 0 | 0% | 4 | 1% |
| Latin American | 0 | 0% | 1 | 0% |
| Southeast Asian | 0 | 0% | 3 | 1% |
| Japanese | 0 | 0% | 0 | 0% |
| West Asian | 0 | 0% | 1 | 0% |
| Korean | 0 | 0% | 2 | 1% |
| Other | 4 | 13% | 10 | 3% |
| ***Home Province*** | | | | |
| BC | 2 | 6% | 43 | 14% |
| Alberta | 3 | 10% | 34 | 11% |
| Saskatchewan | 4 | 13% | 22 | 7% |
| Manitoba | 0 | 0% | 10 | 3% |
| Ontario | 15 | 48% | 138 | 45% |
| Quebec | 1 | 3% | 12 | 4% |
| New Brunswick | 2 | 6% | 9 | 3% |
| Nova Scotia | 3 | 10% | 21 | 7% |
| PEI | 0 | 0% | 7 | 2% |
| Newfoundland | 1 | 3% | 10 | 3% |
| Yukon | 0 | 0% | 0 | 0% |
| Northwest Territories | 0 | 0% | 1 | 0% |
| Nunavut | 0 | 0% | 0 | 0% |

*[*]Percentages may not add up to 100% due to rounding*.

The representativeness of the current study sample was also assessed with comparisons with the intervention group in the RCT in relation to smoking behaviour at six-months (See Table 5). Regarding smoking behaviour, most participants in both samples were still currently smoking. Fewer participants in the present study had intentions to quit smoking compared to the RCT intervention group at six months, and slightly fewer participants in the present study had been smokefree for 24 hours in the past six months compared to the overall RCT intervention group participants. Almost all of the present study's participants lived with someone who smoked. Nicotine replacement therapy, followed by self-help materials were the most popular quit aids in both samples. Use of quit aids decreased between RCT study intake and six months.

*Table 5. Smoking behaviour in current study sample compared to intervention sample in the CTC trial at 6 months**

| **Smoking Behaviour** | **Current Study Sample (n=31)** | | **RCT Sample (n=307)** | |
|---|---|---|---|---|
| ***Smoking status at 6-months*** | | | | |
| Non-smoking | 7 | 23% | 77 | 26% |
| Currently smoking | 24 | 77% | 22 | 75% |
| *Intend to quit in next 6 months* | 13 | 54% | 15 | 78% |
| *Intend to quit in next 30 days* | 12 | 50% | 10 | 51% |
| *Smokefree in past 6 months for 24hrs* | 19 | 79% | 27 | 90% |
| ***Times smoke free for 24 hrs in past 6mos*** | | | | |
| 1 | 8 | 26% | 48 | 17% |
| 2-3 | 5 | 16% | 85 | 31% |
| 4-5 | 10 | 32% | 61 | 22% |
| >5 | 7 | 23% | 82 | 30% |
| ***Partner who smokes (yes)*** | 12 | 39% | 11 | 39% |
| ***Number of smokers in household*** | | | | |
| 0 | 1 | 3% | 70 | 23% |
| 1 | 8 | 26% | 10 | 34% |
| 2 | 13 | 42% | 88 | 29% |
| 3 | 7 | 23% | 25 | 8% |
| 4 | 2 | 6% | 12 | 4% |
| >5 | 0 | 0% | 5 | 2% |

| Smoking Behaviour | Current Study Sample (n=31) | | RCT Sample (n=307) | |
|---|---|---|---|---|
| ***Use of quit aids (past 6 months)**** | | | | |
| Quitline | 2 | 6% | 31 | 10% |
| NRT | 11 | 35%% | 78 | 25% |
| Prescription | 1 | 3% | 21 | 7% |
| Health professional advice | 6 | 19% | 55 | 18% |
| Group cessation programs | 1 | 3% | 8 | 3% |
| Self-help materials | 6 | 19% | 70 | 23% |
| Quit smoking contests | 4 | 13% | 56 | 18% |
| Quit smoking websites | 1 | 3% | 13 | 4% |
| Social media sites | 2 | 6% | 75 | 24% |
| Hypnotherapy | 0 | 0% | 16 | 5% |
| Herbal therapy | 2 | 6% | 8 | 3% |
| Laser therapy | 0 | 0% | 12 | 4% |
| Other | 0 | 0% | 6 | 2% |
| ***Use of quit aids (currently)*** ** | | | | |
| Quitline | 0 | 0% | 3 | 1% |
| NRT | 3 | 10% | 34 | 11% |
| Prescription | 1 | 3% | 12 | 4% |
| Health professional advice | 1 | 3% | 28 | 9% |
| Group cessation programs | 0 | 0% | 5 | 2% |
| Self-help materials | 1 | 3% | 38 | 12% |
| Quit smoking contests | 2 | 6% | 26 | 9% |
| Quit smoking websites | 0 | 0% | 2 | 1% |
| Social media sites | 1 | 3% | 25 | 8% |
| Hypnotherapy | 0 | 0% | 8 | 3% |
| Herbal therapy | 1 | 3% | 4 | 1% |
| Laser therapy | 0 | 0% | 10 | 3% |
| Other | 1 | 3% | 3 | 1% |

**Percentages may not add up to 100% due to rounding.*

** Percentages may add up to more than 100% due to multiple responses.

The representativeness of the current study sample was also assessed with comparisons with the intervention group in the RCT in relation to user experiences with the app (See Table 6). Regarding user experiences with CTC, participants primarily used the app 1-3 times per month. Also, participants in the present study were overall, less satisfied with the app and would not use it again compared to data provided by the RCT intervention group. Participants primarily used the tracking features of the app, which paralleled their high ratings of these features. The Crave

community features (Facebook, Twitter) were the least used and least liked. More participants in the present study rated the app as not helpful compared to the RCT intervention sample.

*Table 6. User experiences with CTC at 6 months**

| CTC User Experience | Current Study Sample (n=31) | | RCT Sample (n=307) | |
|---|---|---|---|---|
| ***Frequency of use*** | | | | |
| Never | 2 | 6% | 46 | 18% |
| 1-3 times per month | 23 | 74% | 144 | 56% |
| Once a week | 2 | 6% | 32 | 13% |
| 2-3 times per week | 2 | 6% | 23 | 9% |
| Daily | 2 | 6% | 9 | 4% |
| ***Overall satisfaction*** | | | | |
| Not at all satisfied | 9 | 30% | 61 | 24% |
| Not very satisfied | 7 | 23% | 50 | 20% |
| Somewhat satisfied | 6 | 19% | 73 | 29% |
| Satisfied | 5 | 16% | 40 | 16% |
| Very satisfied | 3 | 10% | 28 | 11% |
| ***Would use CTC again*** | | | | |
| Yes, still using it | 7 | 23% | 49 | 20% |
| Yes, but not using it now | 11 | 35% | 120 | 48% |
| No | 13 | 42% | 81 | 32% |
| ***Features used**** | | | | |
| Cigarette tracker | 14 | 45% | 152 | 50% |
| Craving tracker | 11 | 35% | 127 | 41% |
| Distractions page | 3 | 10% | 56 | 18% |
| Awards page | 6 | 19% | 40 | 13% |
| My progress page | 12 | 39% | 91 | 30% |
| Health calculators page | 9 | 29% | 69 | 23% |
| My map feature | 0 | 0% | 6 | 2% |
| Leaderboard | 1 | 3% | 4 | 1% |
| My quit plan page | 5 | 16% | 49 | 16% |
| Information pages | 3 | 10% | 31 | 10% |
| Online resources | 0 | 0% | 10 | 3% |
| Quitline | 1 | 3% | 8 | 3% |
| Crave community (Facebook, Twitter) | 1 | 3% | 8 | 3% |
| None of the above | 6 | 19% | 63 | 21% |

| CTC User Experience | Current Study Sample (n=31) | RCT Sample (n=307) |
|---|---|---|

| | | | | |
|---|---|---|---|---|
| ***Most helpful features*** ** | | | | |
| Cigarette tracker | 10 | 32% | 103 | 34% |
| Craving tracker | 6 | 19% | 74 | 24% |
| Distractions page | 2 | 6% | 27 | 9% |
| Awards page | 2 | 6% | 19 | 6% |
| My progress page | 5 | 16% | 42 | 14% |
| Health calculators page | 4 | 13% | 35 | 11% |
| My map feature | 0 | 0% | 1 | 0% |
| Leaderboard | 0 | 0% | 1 | 0% |
| My quit plan page | 2 | 6% | 14 | 5% |
| Information pages | 0 | 0% | 4 | 1% |
| Online resources | 0 | 0% | 3 | 1% |
| Quitline | 1 | 3% | 6 | 2% |
| Crave community (Facebook, Twitter) | 0 | 0% | 3 | 1% |
| None of the above | 0 | 0% | 18 | 6% |
| | | | | |
| ***Overall helpfulness of CTC*** | | | | |
| Not at all helpful | 11 | 32% | 72 | 28% |
| Not very helpful | 7 | 23% | 60 | 24% |
| Somewhat helpful | 7 | 23% | 61 | 24% |
| Helpful | 4 | 13% | 48 | 19% |
| Very helpful | 2 | 6% | 14 | 5% |

**Percentages may not add up to 100% due to rounding.*
*** Percentages may add up to more than 100% due to multiple responses*.

Table 7 represents young adults' reasons for quitting smoking disaggregated by sex. While health was the most popular reason for quitting by both women and men, money was a close second for men. These top two reasons to quit smoking reflect other research findings. For example, Villanti and colleagues (2016) found that physical fitness and cost of tobacco were the top two reasons for quitting among young adults in the United States.

*Table 7. Reasons for quitting smoking in current study sample prior to using CTC*

| **Reasons for Quitting** | **Young women** | **Young men** |
|---|---|---|
| *Health* | 8 | 8 |
| *Saving money* | 2 | 7 |
| *Smoking policies* | 1 | 2 |
| *Non-smoking social norm* | 1 | 2 |
| *Non-smoking partner* | 1 | 2 |
| *Having children* | 2 | 1 |

## Data analysis

Data were analyzed contemporaneously with data collection. Interviews were audio-recorded and transcribed. Field notes were collected in notebooks. All documents collected were accessed electronically as PDF files or image files. Documents collected were uploaded into NVivo and my computer to aid in organization and retrieval of the data. Framework analysis, developed in the late 1980s by social policy researchers, was the analytical approach used in this study, which aims to draw descriptive and/or explanatory conclusions clustered around themes (Ritchie & Lewis, 2003). This approach is commonly used in case study research because it assists with managing and analyzing large data sets if time is limited (Crowe et al., 2011). Central to framework analysis is a series of interconnected stages (familiarization, identifying a thematic framework, indexing, charting, and mapping and interpretation) that enables the researcher to move back and forth between the data until a coherent account of the phenomenon is developed (Smith, 2011). This analytic approach espouses a commitment to transparency and intense analysis, which aligned with this research project's intensity, and commitment to context, a holistic approach, and reflexivity. This way, the context of young adults' experiences were retained, while exploring associations and explanations in the data and drawing on sociomateriality theory.

Familiarization consists of immersing oneself in the data. In this regard, I engaged in a detailed reading and re-reading of transcripts and related documents to become familiar with the overall perspectives on CTC, as well as the intended and experienced interactions between young adults and CTC influence smoking cessation (Sandelowski, 1995). This helped me become familiar with some of the essential features within the datasets.

Identifying a thematic framework consisted of identifying recurrent and important themes. To fulfill this stage of the analysis, the first four interviews with key informants, young women, and young men were closely reviewed as individual groups of data. This helped me acquire an appreciation for the essential features within the data prior to analysis (Sandelowski, 1995). Guided by an affordances approach, coding was then applied to help identify the affordances/constraints of CTC. In relation to the key informant interview data, coding consisted first of locating key informants' expectations for how CTC would be used and experienced by young adults, and then identifying the intended affordances to lend to these practices and experiences. Similarly, data from interviews with young women and men entailed the identification of their practices and experiences from using CTC for quitting smoking, and then the affordances (which included intended and/or unintended affordances) that lent to them. Data from interviews with young women were kept as a separate dataset from those with young men. This enabled me to compare and contrast young women's and men's experiences and capture notable gender-related findings in the datasets. This initial approach to the data enabled the generation of initial impressions about how CTC was expected to imbricate and how it actually imbricated with Canadian young adult smokers, and the practices and experiences that are a result of these sociomaterial relations. A preliminary coding framework was developed for each data set (key informants, young women, young men) from this process, which was then reviewed, and approved by my committee. This framework is presented in Appendix J. While the framework displays how the data was ultimately organized (the affordances preceding the sociomaterial outcomes), interviews and the initial stages of coding consisted of identifying the sociomaterial outcomes first, which were then subsequently explained by affordances. For example, during an interview, young adults described avoiding the CTC Facebook page. This

sociomaterial outcome was followed by an interview question (e.g., What is it about the Facebook page that you don't want to post?). This led to the affordance/constraint that lent to that sociomaterial outcome, and in the case of this example, constrained identity protection. The frameworks consisted of subcategories that were refined over time to capture emerging themes and subthemes.

Indexing consists of maintaining an audit trail of the coding process. This was accomplished by coding major themes and subsequent subthemes in relation to the analytical framework in NVivo. This enabled me to repeatedly review the coded data, note similarities and differences, and where possible, group similarities into more refined categories. As new data were collected, the process was repeated, and categories were revised or added to as required. Critical questions were employed throughout this process to aid in the refinement of the categories. For example, in relation to key informant interview data, questions posed included, "What experiences or practices were key informants expecting from engagement with this function?" and "What actionable construct (affordance) did key informants expect from this function when young adults engaged with it?" In relation to young adult interview data, questions posed included, "What is the actionable construct (affordance) that is lending to this experience or practice? What contextual factors are influencing this affordance/constraint? How is gender influencing experiences or practices as a result of this affordance?" Data related to each category were reviewed to identify gaps in the data or inconsistencies that needed further exploration in subsequent interviews. This iterative process was continuously applied to ensure that an in-depth account of sociomaterial relations in regard to CTC was provided.

Charting was accomplished by developing summaries of key informant and young adult interview data in tables and figures. Affordances, at first displayed in a hierarchical chart, were

presented according to the design component of the app (credibility, social support, task support, and dialogue support). The underlying mechanisms were then displayed in relationship to the intended outcomes (in the case of key informants), and experienced outcomes (in the case of young adults). This process retained original transcript data to preserve the context of each theme and subtheme. Appendix K is an example of how data was summarized using the analytical framework.

The final stage of analysis, mapping and interpretation of the data, involved comparing the interviewee responses within each assigned theme and sub-theme. At this time, finalized themes and subthemes were established. This final analytical framework was then transferred into a table, one for key informants and one for young adults. Representative quotes were selected from the original posts and responses to illustrate key themes and subthemes.

Throughout data analysis, I engaged in reflexive activities, such as journaling my reactions to the data and interrogating my interpretations, so that I was aware of how my own socio-historical and theoretical position as an individual and as a researcher influenced the analytic process. I acknowledge that my experiences and interest in eHealth interventions influenced what and how I interpreted that data and positioned the findings in terms of my commitment to improve and scale-up eHealth efforts. During the first few interviews, I recognized that I had an optimistic interpretation of the interview data (e.g., prioritizing the positive aspects of the app, focusing on the aspects of the app that worked well versus those that did not work well during conversations with young adults. Through self-reflexive questions, such as asking myself why particular interview data stood out, how I felt during interviews, and how that might influence my approach to the data, assisted me in addressing this bias during the interviews. This process was an important part of the "during interview" process, as well as

afterwards. For example, several interviews with young adults revealed that they had barely engaged with the app, which made me think that I wouldn't gain rich data from the interviews. I assumed that I would need participants who had engaged with CTC a fair bit. After I began interviews with these young adults, however, I simply adjusted my research questions to capture unproductive affordances/constraints for smoking cessation, which proved to be very rich data.

## Ensuring the quality of the study

To ensure the quality of this study, I followed the eight "big-tent" criteria for excellent qualitative researcher proposed by Tracy (2010), which includes a) worthy topic, b) rich rigor, c) sincerity, d) credibility, e) resonance, f) significant contribution, g) ethical, and h) meaningful coherence. The ways in which I addressed each of these markers of quality will be described in the discussion that follows.

A *worthy topic* for this study has been ensured in several ways. First, my background and growing expertise in mHealth research and tobacco control research aided in the identification of knowledge gaps in the field. In addition, the conduction of an extensive literature is what ultimately led me to the specific research topic, associated questions, and selected methods. I maintained flexibility and openness to the focus of this research study as I engaged with the literature so that a worthy topic could be ensured, which is demonstrated in my audit trail of evolving research questions and proposed approaches. This study makes several significant contributions to the behavioural intervention research literature in the following ways: 1) a sociomaterial lens enables specific attention to the underlying mechanisms (affordances) that lend to particular experiences from engaging with CTC for smoking cessation; 2) investigating the underlying development processes of CTC bridges activities of development and use; and 3) the qualitative approach taken in this study is one of a kind and leads the way in demonstrating

how qualitative research can be adapted and used in the mHealth research landscape. Finally, through collaboration with my supervisory committee members who have expertise in mHealth, tobacco control, population health, and various methodological approaches, I was able to establish the appropriateness of the research focus and proposed approach.

*Rich rigor* was ensured through this study by "exercising appropriate time, effort, care and thoroughness" (Tracy, 2010, p. 841). I have adapted to the complexity of the research topic by familiarizing myself with possible theoretical approaches suitable for this study and responding to the methodological flexibility that this research study has called for. For example, to conduct a study on a digital artifact (CTC) and provide a comprehensive account of this artifact, from development to use, the flexibility offered via case study methods was necessary. As I have engaged in the development of this research proposal, I have taken the time to interrogate every decision by asking critical questions (e.g., How would this fit in the overall picture? How does this change the process? Which processes would change? What does this add?). I continued to interrogate my decision making as this research project moved forward to ensure that I conducted a rich, thorough, and thoughtful research project. In addition, data collection and analysis were conducted together in order to be accountable to and gauge the depth of data being acquired. Furthermore, as stated above, I remained immersed in the data and constantly revisited and reviewed the collected data so that a dependable and in-depth account of sociomaterial activities is ensured. Given the practical implications that will be generated from this research project, I recognize that this constant interrogation of the data is especially important—I did not want these implications to be derived from "shallow" data.

*Sincerity* in the research project was ensured through self-reflexivity and transparency. Throughout the research project, I acknowledged that qualitative research data is co-constructed

between the researcher and the participants, necessitating efforts to engage in reflexivity. Reflexivity is essential for qualitative research projects (Bryman, Becker, & Sempik, 2008; Finlay, 2002). A reflexive researcher acknowledges and responds to the recognition that they bring their own experiences and beliefs to the research they undertake, which can shape the research project (Creswell, 2007). Therefore, it was important that I remained mindful of how I, as a research instrument, influenced all aspects of the research process, from design through data collection and analysis, as well as the production of written accounts. In this study, I demonstrated reflexivity by being aware of and noting how my socio-historical location (e.g., I am a nurse, a non-smoker, a Canadian, a young adult), my paradigmatic leanings in critical realism, and assumptions shape the process. Transparency, being honest about the research process, was ensured through keeping a careful audit trial, documenting all research decisions and activities. I have documented and dated my rationale, points of confusion, and decisions in relation to my research practices.

*Credibility* in this study was ensured by sampling young adults who directly experienced using CTC for smoking cessation, and sampling continued until there was repetition in the data of thematic categories and a diversity of perspectives were collected and represented in the findings (Milne & Oberle, 2005). Interviews consisted of open-ended questions so that the participants could tell their own stories. In addition, this study included a variety of data sources (fieldwork, documents, and interviews) to illustrate the ways in which CTC and young adult smokers imbricate and influence smoking cessation practices, as well as to provide a rich account of the intervention itself. I sought thick descriptions during the data collection process and showed the contextually-bound nature of sociomaterial relations between young adults and CTC through the presentation of direct quotes from the participants. In addition, in my

commitment to sex- and gender-based research, as well as to enhance diversity and multivocality in the data that will help identify similarities and differences, an equal number of young women and men were included in this study.

*Resonance* refers to the ways in which a research study resonates with an audience (Tracy, 2010). In my commitment to improve practices in relation to mHealth smoking cessation interventions, resonance was an important aspect of this project that I was conscious of through the research process. Resonance is achieved when readers feel that the research story overlaps with their own situation (Tracy, 2010). In addition, resonance is achieved when the research can provide users with a vicarious experience, which also leads to improved practices (Tracy, 2010). As I engaged with the write up of the research report, I was attentive to my potential audience so that my research findings resonate with stakeholders. A few ways that I ensured resonance in this study was by providing thick descriptions, direct quotations/testimony from the data, and writing up the report in an accessible and readable way (Tracy, 2010).

This study makes a *significant contribution* to the mHealth intervention literature by addressing research questions that were ultimately driven by identified gaps in the literature. In addition, given the relative lack of qualitative research in mHealth smoking cessation interventions, this research not only provides insights but also stimulates more questions and inspires future research topics. Moreover, the findings of this research have implications for the improvement of CTC, as well as for the development of future smoking cessation smartphone apps directed towards young adults so that mHealth smoking cessation interventions can move forward in a productive and efficient manner, especially in light of recent pushes for scale-up of mHealth interventions.

Procedural, situational, relational, and exiting ethics were considered to ensure that this study was *ethical.* To meet procedural ethical requirements, ethics approval was obtained from the University of British Columbia's Behavioural Research Ethics Board prior to data collection. In addition, participants were informed of the aim of the study, and any potential consequences of participating in the research study. In order to participate in the study, participants were required to provide written informed consent. All data collected for this study were stored in password protected files and locked cabinets. As data collection and analysis commenced, situational ethics was addressed through reflexive journaling about the process and through turning to my supervisory committee for ethical issues that arose. In consideration of relational ethics, I conducted this study in a collaborative way with study participants. This collaboration was foregrounded throughout my interactions with research participants and demonstrated through reciprocity and mutual respect. The collaborative aim of this research project was also foregrounded in the write up of the research findings (e.g., participant anonymity was maintained), which addressed exiting ethics of the research project.

*Meaningful coherence* means that a study's research design, data collection, and analysis are eloquently interconnected to the theoretical framework and situational goals of the study (Tracy, 2010). In an effort to illuminate CTC and explain young adults' experiences and engagement with CTC, a sociomaterial lens was employed in this study. I have attempted to make explicit how this theoretical approach, combined with the research questions that have developed because of the identified gaps in the literature, and how it shaped every aspect of this study. In justifying the choice of a sociomaterial perspective underpinned by critical realism, I argued that a critical realist ontological grounding was necessary whereby the material/technological tool (CTC) and the social are separate entities that come together through

imbrication. The epistemological relativism (that our understanding of the world is inevitably a construction of our own perspectives) of a critical realist stance (Maxwell, 2012) is also commensurable with the research questions, design and data collection and analysis methods, and supports my use of reflexivity throughout the research process.

# CHAPTER 4 – FINDINGS: KEY INFORMANTS' PERSPECTIVES

In this Chapter, key informants' perspectives on the design of Crush the Crave (CTC) will be presented, drawing from analysis of key informant interviews and documents related to the design and development of CTC. The findings in this Chapter address the following research question: How was CTC designed to influence smoking cessation among young adults? The findings are presented in the following two sections: 1) Overall reflections on the strengths and limitations of the app; and 2) Intended affordances to the young adult in smoking cessation. Gender-related findings will be highlighted in each section.

## Overall reflections on CTC's strengths and limitations

In this section, key informants' overall reflections on the strengths and limitations of CTC are presented. The strengths and limitations fall under five categories: 1) *technology and platforms utilized in the intervention;* 2) *foundation of app content;* 3) *underlying focus of the app;* 4) *functionality of app;* and 5) *look and feel of the app*. *Technology and platforms utilized in the intervention* relates to key informant perspectives on delivering a cessation intervention via a mobile app, with the additional support of social media. *Foundation of app content* refers to key informant perspectives on the principles that underpin the content in the app. *Underlying focus of the app* relates to their perspectives on the implied focus of the app based on the technology used and the dominant features and functions that were built into the app. *Functionality of app* relates to key informant perspectives on the ways in which the app functions to support smoking cessation. *Look and feel of the app* relates to the perspectives of key informants on the overall design of the app and how it is packaged for young adults. Table 8 presents key informants reflections on the strengths and limitations for each category and showcases some overlap

between the strengths and limitations within some categories, whereby a perceived strength by some was also perceived as a limitation of the app by others.

*Table 8. Key informant reflections on the strengths and limitations of the CTC app*

| | **Strengths** | **Limitations** |
|---|---|---|
| **Technology and platforms utilized in the intervention** | At the fore-front of an evolution of tobacco control efforts and eHealth. | Keeping pace with rapid evolution of technology and platforms and changing user preferences. |
| | Potential to reach young adults via popular channels used amongst this population. | Requires an internet or data connection to be accessed and to function. |
| | Integration with social media platforms. | |
| **Foundation of app content** | All content in the app was built on evidence and theory in relation to smoking cessation and behaviour change. | The evidence and theory in relation smoking cessation and behaviour change underpinning the app may not be applicable in the context of e-health |
| | | Built around the notion that quitting smoking follows as straightforward success trajectory. |
| **Underlying focus of the intervention** | Tailored to individuals by providing individuals with a self-led intervention. | Individualist focus by providing an individual with a self-led intervention. |
| | | Targets young adults who want to set a quit date in advance vs. those who want to quit abruptly. |
| **Functionality of the app** | Functions as an active intervention that provides young adults with opportunities to reflect and develop new ways of coping. | Requires users to actively engage with the app in order to develop knowledge and skills for smoking cessation. |
| | | All calculations in the app are based on user quit dates. |
| **Look and feel** | Branding is universally appealing. | Branding is not universally appealing. |
| | | Navigating the app is not intuitive. |

***Technology and platforms utilized in the intervention***

Key informants frequently talked about how the use of mobile technologies and social media for CTC was a major strength of the intervention. In relation to using a mobile app as the primary intervention component, key informants not only described this as a novel approach to tobacco control compared to traditional tobacco control interventions, they also described the use

of these technologies as a natural evolution of tobacco control efforts—that it was necessary in order to keep up with current trends of using digital media in tobacco control, and healthcare more broadly. Along this vein, there was often a sense of urgency to take tobacco control efforts into the realm of eHealth. Notably, this urgency was underpinned by a desire to get it right and to not just put something out there that wasn't given much thought. It was clear that the key informants were invested in delivering something that would work rather than something that was simply novel:

> This is going to be the app or some version of something like that – some portable, accessible, customizable, personalized thing. Every trend is going to that; this is the future….We need to understand how to get this right, because if we don't, the tobacco companies will and other people will, and we [will be] competing against all kinds of other things. If we can get this right, this [will become] a frontline for public health,….If we don't go there, we're losing an enormous opportunity to make a big difference in people's lives. (KI 9)

Key informants also thought that a key strength of CTC was the ways in which it harnessed social media to augment the app. They described this "integration" as something that would enhance opportunities to engage young adults, as well as assist in marketing the app. This is exemplified in the following statement by a key informant that was discussing the benefits of including various social media platforms as part of CTC:

> So, one, is that they may see that there are other places to go and there are ways of communicating with others and not just doing it on your own, and also,…having it on whatever social media they're using may drive people to use [the] app more. (KI 14)

The use of innovative technologies and platforms for CTC was also perceived as limitation given that such technologies are ever-changing, demanding continuous attention and funding. Key informants frequently articulated that this need for constant attention does not align with a typical, government-funded health intervention, whereby funding often ends after a few years; thus, constraining the "natural evolution" described previously. One key informant described how the evolving-nature of technology is one of the biggest challenges for health researchers:

> But again, social media now is…so quick, and things go by the wayside so fast that by the time we probably tried to work something out, Snapchat would be no longer the thing that young adults are using. They would be on to the next thing. So, it's so hard to keep up with technology just because it's such a quick pace nowadays. Like phones—new phones come out every six months now…similar to apps and similar to the different platforms that people are using. (KI 11)

> And what's gonna happen is, because technology changes so fast, we'll say, "Well that was the old app, now we have a new one. Now we have this, now we have that, so we're gonna need to go and then evaluate that." By the time we're done evaluating, that technology is gonna be old so… (KI 6)

Despite these challenges, key informants suggested that using innovative technologies for CTC enables efforts to meet young adults where they are at—young adults lead the way in adopting and using digital media. One key informant reflected on how young adult smokers have traditionally slipped through the cracks in relation to tobacco control efforts, mainly because the health-seeking behaviours of young adults are different from their older counterparts, with whom young adults are often grouped together in cessation initiatives (e.g., going to a physician,

counselling, etc.). She described CTC as an intervention that aligns with how young adults seek health information and support, saying that CTC "is a place that they can go to get that kind of support that is not totally out of their comfort zone". Several key informants also touted the use of such technologies as a promising approach for reaching young men. One female key informant thought that this intervention aligns with a male-centric notion of technology:

> I think the fact that it is an app automatically helps with that…because I think a lot of things that you normally see that's available for cessation is like, go make an appointment with your doctor, and males do not do that….But an app, because it's technological; guys like tech, guys like apps. I think that the fact that it is in this format is a male friendly way to do it; which we need. (KI 7)

Despite praising the technologies underpinning the CTC app for appealing to young adults, the need for an internet or data connection was recognized as a limitation. If a young adult cannot access WiFi or a data connection (due to cost or location) they are no longer able to receive support. Key informants thought that addressing this issue was critical and described efforts underway to make the app go "native," whereby the app functions without requiring an internet connection.

***Foundation of app content***

The most talked about strength of the app was that it its content and development was informed by current evidence and theory. This led many key informants to suggest that the app would be relevant to various sub-populations of young adults, and it was often described as a "one stop shop" or a "Cadillac" because it included so many evidence-informed features. As demonstrated in the below statement, key informants thought that the evidence-informed nature

of the app gave CTC an edge on the growing number of quit smoking apps available (Abroms et al., 2013; Choi et al., 2014):

> There were plenty of stop smoking apps out there but they weren't particularly good ones. They weren't…[based] on the evidence of what we know works, and they weren't based on good theory around behaviour change….There was an obvious gap there and we wanted to try and make sure there was something good available for young people who would be looking for apps. (KI 14)

It was thought that an evidence-informed app would provide a sound foundation for future developments, rather than just following the trend of "here today, gone tomorrow":

> I think…the insights as to how behaviour change works, those principles based upon theory and theory that's been proven, they remain the same….So, you know, once you've built an understanding of how to make those principles real in terms of an application, that application can be transferred to the next platform, whatever that might be. It could even be better 'cause maybe the newer technology has features in it that even further enhance behaviour change techniques that didn't exist before. (KI 3)

A few key informants, however, took a contrary viewpoint towards the staying power and transferability of clinical practice guidelines and long-standing theories in the eHealth context. One key informant was cautious about taking guidelines that were designed for a clinician in a clinic and putting it into an app for users to support self-management of health behaviour:

> That is a phenomenon that no clinical practice guideline was ever designed for....And the idea of having a clinician who, in some ways is literally in your pocket, is something that again, was never—nothing was designed for that. So what we're trying to do is grasp the best evidence that we have. (KI 9)

A few key informants talked about the quit buddy feature as an example of a concept included in the best practice guidelines that would not likely work in the app. They thought this primarily due to the fact that the quit buddy concept is an effective feature designed for more traditional cessation programs whereby two people are paired up because they are going through nearly the same exact process. Key informants thought that, in the eHealth context, it is not likely possible for a young adult to know or seek out a quit buddy to effectively co-participate in quitting, except perhaps at very particular times (e.g., the time of New Year's resolutions). Also, key informants pointed out that, while interventions informed by best practice guidelines have high success rates for smoking cessation, they often have very low uptake. This added to wariness in relying on the evidence-informed nature of CTC for its sustainability. Key informants said that how the app engages users ought to be considered just as important as including evidence-informed strategies to quitting:

> When you see advertising on television [or] the radio [and they say] according to scientists or according to doctor so and so etcetera, it espouses authority, and I think that's what we're probably trying to do with this idea of evidence-based and coming from credible sources…saying this is coming from reputable sources of authority. Now whether all young people appreciate that, I don't know. It'll be interesting to find out whether that really matters to them or not. I think what probably matters to them is you know; does it work? (KI 3)
>
> There's a lot of stuff out there in the media to say that, you know, most apps are downloaded once and used twice and never looked at again. So a concern…with any app is that it's not going to be engaging enough to get people to continue to use it. So

> that's…my general concern...I think we tried to find ways around it but whether we found enough or not, I don't know. (KI 14)

In addition, key informants questioned the applicability of the theory that informed the app. One key informant described how theories are often used with the assumption that human psychology remains the same despite changes in the social environment:

> So the good thing is you've got an [evidence-based] app, but...first…are based on a population [that] was very different. Most theories on behaviour change come from a time when…you know racism was rampant, women could not vote...times that have nothing to do with…the current generation of individuals. And there's an assumption that human psychology is static. So proceed— these [theories] might or might not be applicable to the current population in which they're being applied. (KI 15)

Another limitation predicted by the key informants was that the app was built upon the notion of a successful quit trajectory. Rather than making room for the relapses that frequently occur during quitting, the app implies that quitting is straightforward (e.g., that young adults can expect to be smokefree by the time they reach their quit date). One key informant said that they found it challenging to balance an idealized notion of quitting with the reality of the quitting trajectory during the development of the app. On one hand, accounting for relapses could help young adults with slips and lapses, and get back on track but on the other hand, it could discourage quitting because young adults might not want to try something that appears destined to fail a few times. One key informant talked about how it would be very unappealing if the app represented the "spaghetti-like" reality of quitting smoking:

> The biggest limitation that I see is that they [the features of the app] are based on a generalized model of quitting smoking, even if you think about the theoretical model, it

just kind of goes forward right? And they will acknowledge that yes people go back and forth….[But] the reason you don't draw…anything other than an arrow, aside from maybe something going backwards occasionally, is that it looks like spaghetti when you actually think about how people change....It's a complete mess...people go forward, backwards, sideways....But that's almost impossible to put on a program. And so we run this risk of creating a bit of a fiction, an evidence informed fiction, if we may. (KI 9)

***Underlying focus of the intervention***

A strength in relation to the focus of CTC that was often spoken about was the individual-focused nature of the intervention. It aimed to enable young adults to quit on their own and track and modify their smoking behaviours without consultation with others, health professionals and personal networks alike. It was suggested that this individualized focus aligns with current understanding about how young adults quit smoking, which is on their own. In this sense, it was thought that the individual nature of the app was an inherent strength for helping young adults quit smoking:

I think the overwhelming number of people who plan to quit, [quit] on their own. And [that] may be one solid point for having an app, 'cause it is something they can use on their own. They don't have to go to a group, and they don't have to take drugs. They don't have to see their doctor for prescriptions they can just try it on their own. (KI 2)

The individually-led nature of the app was also described as a strength particularly for reaching young men. One female key informant described how the self-driven nature of the app plays into many men's preferences for self-management when it comes to their health:

> I mean, men like tools…it's like a tool, it's a do it yourself, I don't have to tell anybody, I don't have to ask anyone [thing]….Yeah, I think the fact that it's a do it myself; [I don't have to] ask for help sort of thing, and it's like one stop shop. (KI 5)

In reflecting on written works and personal experience, one key informant explained that an individually-focused quit smoking intervention may be somewhat constrained in its effectiveness and utility because smoking behaviour is often maintained through one's network:

> And so, the fundamental flaw in all apps, behaviour change apps, and websites, is that we've focused…a lot on the individual, which is kind of odd when you're trying to change [behaviour] because it's within their social network. [It's] prosocial behaviour…for them—in that network and that group, it's a prosocial behaviour. So changing it in isolation is not likely to work and people [are not] likely to do the stuff individually. (KI 15)

Another key informant further expanded on this and asserted that apps not only remove human connection, but they also lack the ability to respond to emotive aspects that influence smoking:

> My concern is that social media and the use of electronic devices are fundamentally missing an incredibly integral part of why humans do the things that they do and what influences us. And when you think about all of the emotive aspects of something like smoking, particularly in young people; you know they smoke because they're angry, or because they're bored or, you know…the vast majority of the reasons have some connection directly with emotion and often, some connection with other human beings – because I wanna be part of a crowd, because I wanna really piss off my parents. And so that combination then tells me that if that's the nature of why they're smoking…then I do

> wonder about the ability of an app then to address some of those very issues, and whether an app…they would respond accordingly to the feedback that they get. (KI 12)

Key informants also talked about how, even though the app gives young adults the option to quit abruptly or to set a quit date, the app was more suited to those who wanted to set a quit date. One key informant spoke about how those who quit abruptly wouldn't need to interact with the app very much because most of the features (e.g., the smoked or craved buttons, progress graph, etc.) were designed for those who were working towards a quit date. In this regard, the app may not appeal to those who want to quit cold turkey:

> When we think now about how the app is designed to work, it was set up so that, as you were working towards your quit date, you'd be more interactive with the app than once you've achieved that quit date and let's say you had remained smoke-free. Because…other than the notifications that you've achieved certain benefits, there wasn't really a lot of need to be tracking anymore because you have already quit smoking…. So all you're going be doing is getting your notifications of your success. (KI 3)

***Functionality of the app***

In relation to the functionality of the app, CTC was often praised for its design to function as an active intervention (vs. passive) in that it went beyond simply delivering information (passive approach). Driven by principles of behaviour change theory, the app engaged users to participate in addressing their smoking behaviour (e.g., identifying triggers, patterns, and reasons to quit):

> You know it just seems to me like a much healthier solution because...they're [app users] learning how to interact with the world in a different way too. I mean they're learning

how to reach out for social support and…you know; you're tapping in to other kinds of motivation. (KI 13)

So it's not just…you hit a button every time you have a cigarette, it's going beyond that to look at—if you were going to hit a button every time you had a cigarette, why would you do that? Like what would be the outcome of behaviours like that? (KI 8)

While key informants praised CTC for being an active intervention as described above, some concerns were raised about the bidirectional data flows between the app and the user (user enters data and app responds accordingly). In an age where wearable technology and the collection of sensory data is beginning to emerge, key informants thought that the app may be a hassle because the users had to reflect on their behaviour and then actively enter data into the phone versus having this data picked up via sensors (e.g., context, location, hand movement). Some key informants thought that the app should ideally function without requiring much user effort; rather, the app should be doing the work:

I think for the most part it gives you precise locations, so trying to understand that when they're smoking. But it's hard because if they're not in the app… you have to rely on them to enter the information. (KI 6)

If a person can't get into the right frame of mind…early enough to prevent them from relapsing, they do [relapse]. So…that's the issue...how can we use the app technology and technology available in the phone to activate early warning systems? (KI 15)

Another limitation in relation to the functionality of the app is that all of the calculations and statistics (awards, leaderboard, calculators) were based on a point in time—the user's quit date. In this regard, key informants said that the data being generated may lose much of its meaning for users:

> So you're giving them awards, or you're giving them health calculations, or you're giving them whatever based on time. That is the only factor in all of these calculations. So because of that, they [data] lose all their meaning to me. (KI 10)

***Look and feel***

According to key informants, one of the biggest strengths in relation to the look and feel of CTC, was the branding. One key informant stressed the importance of this frequently "dismissed" component of eHealth intervention development and was quite proud of the work the research team put into the branding of the app:

> There is something that has to catch their eye, and we talked a lot about the design of it—like literally the design, like the logo, that sort of stuff because that sort of stuff does matter....It's a nice logo, it's different, it's a cool name…I think this team got it. (KI 9)

The branding was also described as gender neutral by one female key informant, asserting that this intervention would likely have an equal appeal to men and women, emphasizing the need to appeal to men given that men are "not as engaged" with their health compared to women:

> It's probably good that it's black and orange; I don't know what people have said, but gender wise, a lot of things have a problem attracting males of this age group, but black and white is pretty gender neutral…which is good. (KI 7)

However, some key informants thought that the branding was not gender neutral; rather, it was geared towards men, pointing to the logo, with its associated image (a masculine fist) as well the home screen default photos which included images of what appears to be four men doing an extreme sport (e.g., cliff diving, rock climbing), which a male key informant spoke to:

> Definitely the app is very much branded to your white male. Especially with the default images at the front with the rock climbing and that sort of thing so—that initial white male [feel] is unfortunately very prominent when you look at it through that lens. (KI 10)

A female key informant thought that more realistic images about people in their day-to-day lives should have been included so that it didn't feel as geared towards a small segment of the male population:

> And maybe just like a picture of a woman walking down the street with a Starbucks cup and here I am quitting for my health...like there's nothing wrong with that...it doesn't have to be hanging off a cliff. (KI 8)

The branding was also described as having a rather negative look and feel. Despite that app being developed with the intent of being positive and encouraging, one key informant pointed out that the app was designed to be opened when someone is having a craving or a smoke, which means that they are likely in a negative state of mind. He proceeded to point out that the dark colors of the app reinforce this state of mind:

> If you're in a negative state because you had a lapse or a craving or a cigarette, then you open [the] app. Well that doesn't make [you] feel good. You're only opening [the] app when you're in a negative mood…and then of course it gives you a black app at the same time. (KI 10)

One other limitation in relation to the look and feel of the app identified by key informants related to the layout of the app. Key informants thought that navigation was not intuitive and that accessing the features therein was more challenging than it should be. One key informant was especially concerned given that he was involved in developing the app and he himself had a hard time navigating it:

> Like—and I know how to use this app and it still bothers me that there are subpages of pages….So you have your navigation at the bottom, that's one way to do it and that's fine. But there should be no further navigation after that. Like when you press "more," that should be it. There shouldn't be…another button after "more". You know? It's too much. And some of them are—'cause there's "more" and then there's this 'my settings', which is in a whole list of "more" settings in here. I'm thinking that's just—I'm confused already. (KI 10)

Another key informant specifically talked about the distractions feature and how it implies that it will provide an immediate distraction when it actually sends the users to the iTunes store or the Play store. She described this page as an "aggregator":

> I also feel like there was a lot of emphasis on sending you somewhere else, instead of like…making CTC the place that you go when…you feel like you want to stop smoking or…when you feel like you have a craving that you want to crush. Instead, you know, it kind of serves as like an aggregator, which is fine in one respect, but like, why? You know? (KI 4)

**Intended affordances to the young adult in smoking cessation**

While the above section highlights key informants' opinions on the overall strengths and limitations of CTC as an intervention for helping young adults quit smoking, this section presents the intended underlying mechanisms for helping young adults quit smoking; that is, the intended affordances of CTC to the young adult for smoking cessation. In other words, this section will highlight "how" design elements of CTC were intended to influence particular outcomes, and what those particular outcomes are, whether they are a new way of behaving, new personal choices, or an experience that supports quitting smoking. Since CTC is broken down

into four design components (credibility, social support, task support, and dialogue support (see Figure 1), the affordances will be presented according to each component. The intended affordances and expected outcomes are listed in Table 9.

*Table 9. Key informant perspectives on intended affordances and anticipated young adult experiences/practices associated with CTC*

| **Design Component** | **Intended Affordances** | **Anticipated Young Adult Experience/Practice** |
|---|---|---|
| **Credibility** | Promise | -Young adults would trust the intent, potential effectiveness, and longevity of app. |
| **Social Support** | Social interaction | -Young adults would feel a sense of community.<br><br>-Young adults' engagement with the app would be enhanced. |
| | Competition with others | -Young adults would experience a sense of community.<br><br>-Young adults would experience motivation to quit. |
| **Task Support** | Documentation of smoking behaviour | -Young adults' awareness of habit would be enhanced. |
| | Journaling about smoking behaviour | -Young adults' self-awareness would be enhanced. |
| | Visibility of the benefits of quitting | -Young adults would experience motivation to quit.<br><br>-Young adults' engagement with the app would be enhanced. |
| | Choice in support | -Young adults would experience personally relevant information. |

| Design Component | Intended Affordances | Anticipated Young Adult Experience/Practice |
|---|---|---|
| | | |
| | Interruption of habit | -Young adults would experience tactile preoccupation through games. |
| | Weaning from habit | -Young adults would experience cessation success. |
| **Dialogue Support** | Recognition of ability | -Young adults would experience motivation to quit. |
| | Visibility of quit progress | -Young adults would experience motivation to quit. |
| | App reminding | -Young adults would experience encouragement in quit efforts.<br><br>-Young adults' engagement with the app would be enhanced. |
| | Personalized reminding | -Young adults would experience motivation to quit. |

***Credibility***

The *credibility* design component of CTC relates to the fact that the app was developed and supported by credible agencies and research institutions. It was expected that, by showcasing well known and respected sponsoring partners (e.g., University of Waterloo, Health Canada and the Canadian Cancer Society), the app would afford young adults a promise – that CTC holds great potential to successfully help them quit smoking. This promise was expected to earn young adults' trust in CTC to help them quit smoking. Key informants thought that young adults would trust the app in several ways. First, it was suggested that users would trust the effectiveness of the app—knowing that it is backed by credible agencies and institutions would relay the message

that CTC has great potential to deliver on its promise to help them quit smoking, which is showcased in the following statement:

> Now when you look at the apps out there, they're very simple and some of them are absolutely terrible, and they're just basically very quick things that are being created just to make money,…so I think…that by having the credibility behind [CTC], it's a market differentiator…You've got 40 or 50 apps that help you quit smoking and one of them is endorsed by Health Canada and…the University of Waterloo….I think most people and most young people [would] say, "well, that's gotta be better than the other ones." (KI 9)

Also, it was thought that, by profiling the agencies behind the development of the app, young adults would understand that the sole purpose of the app was to help them in their quit efforts rather than to make money, which is also reinforced by the fact that the app is free of charge. Furthermore, key informants anticipated that the reputation of credible partners would lend to young adults' trust in the app's longevity. One key informant spoke in depth about how the backing of credible organizations would relay the message that the app will stay around and continue to be improved, that the developers are invested in the intervention:

> Well I think that all of that, you know, being at the University Waterloo and having the backing of credible organizations, more than anything, actually implies longevity….Whereas some people will come in and build an app and then forget about it and leave it and it doesn't go anywhere,. It was an idea and there were a hundred downloads and then there was nothing behind it. The difference is this seems to be an app that was designed to continue for a long time and evolve into something meaningful. (KI 8)

While key informants intended to afford young adults promise through backing by credible agencies, some key informants raised concerns about how credible sources are perceived by the young adult population. A couple of key informants explained that this design component might make the app feel authoritarian to young adults:

> It is…obviously a serious thing that they want help with. But I could also see it as in like…you know I don't want the government to tell me what to do. (KI 1)
>
> I just think this demographic I mean…they—like people don't wanna get preached at, right?....If it's, oh we're the big, you know, we're the PI's sittin' in the, you know, in the offices and really don't have a clue of what you guys are doing you know,…then I definitely think that's a deterrent, I think you have to be able to speak to them. (KI 5)

***Social support***

The *social support* design component refers to the parts of the app that aim to provide young adults with opportunities to harness support from new and existing social networks. In light of the difficult challenges that quitting smoking presents to young adults (e.g., dealing with triggers, nicotine withdrawals, and relapses), combined with literature documenting the importance of social support for quitting, key informants thought that this was one of the most important components of the app and expected that it would be heavily used by young adults.

Although several social media spaces (e.g., Pinterest, Twitter, Tumblr) were set up for CTC for this purpose, the primary focus was on Facebook and Twitter while the other social media accounts essentially became "dead space" due to limitations in resources and funds. Therefore, conversations about promoting social support in using social media tools focused on the Facebook page and Twitter. In designing this component of the app, key informants hoped that finding community would be the main outcome of using the functions and tools that were

developed for providing young adults with social support. They anticipated that this would be achieved through the following two affordances: *social interaction* and *competition.*

*Social interaction.* Social interaction was afforded via the CTC Facebook page, quit buddy, and sharing on personal social media accounts in CTC based on the designers' intentions to provide young adults who use CTC with a sense of community. One key informant described how social support was a primary focus during the development of the app, referencing the clinical practice guidelines as informing this focus in the app:

> We [spent] a little bit of time…trying to create that social support because that actually fits with the evidence guidelines. So while we could have a box of some sort—a programmed box to say, you know, "thank you for quitting," but we thought that peer support really would work. The thinking was,…well we can create…a social network space. (KI 9)

When talking about the social support component of the app, key informants put particular weight on the social interaction afforded via the CTC Facebook page for helping young adults find community because it was a place where young adults who use CTC can give and receive support for quitting:

> Facebook would be the place they went to find community. So my hope would have been [that] they would have gone to the Facebook page knowing that, "this is a place where I can feel good, this is a place where I can find someone I can talk to." (KI 4)

A few key informants also thought that the social interaction afforded via the CTC Facebook page would encourage ongoing engagement with the app throughout the quitting trajectory and thereafter. Along this vein, key informants often talked about how the Facebook page could help minimize attrition because it gives young adults a reason to go back to CTC—

they have become a member of a new network where they would be able to give and receive support.

While key informants expected that sharing on social media would reinforce a sense of community as they quit smoking by affording them with opportunities for social interaction, they also recognized that posting about quitting smoking on social media is in conflict with projecting a positive social image on these platforms. Key informants explained that social media, particularly Facebook, are success oriented in many ways and may result in "selective posting", whereby young adults would only post about their successes rather than harness support when they are struggling:

> People are somewhat…I guess afraid to post bad things, right? And negative things. So when you look at someone's Facebook feed it's always like yeah I went on a trip and I got this present—you know no one ever says like had a really [bad] day today. (KI 1)

Even if young adults did post about their struggles, it was suggested that they would still be "selective" in who they posted to and when they posted, which may limit the effectiveness of utilizing such channels for cessation interventions targeting young adults:

> And the problem with social media is that…that people will pick and choose who they go to, when they go to, what kind of feedback they want…or listen to. KI 12)

*Competition with others.* Key informants also thought that by affording users competition via the leaderboard not only would users feel a sense of community, but they would also be motivated to stay on track because it brings forward their goal to succeed in quitting smoking. In this regard, the intention was that young adults would be able to find community in their struggles, but also in their common aim for success, which was expected to get them through their struggles. These expected outcomes from affording users competition in the context of quitting smoking is reflected in the following statement:

> So the way I envisioned that working is taking a look at how well someone else has done and then wanting to get there to….I think that's a large part of why certain things do work; because they build a community of people all trying to quit smoking and live tobacco free lives and look at all of these people and they're doing the same thing I am and someone's actually succeeded. That person is like [however many] days smoke free, that's amazing. I wanna get there too. So I think it just reaffirms that you're not alone in this decision and success is possible. (KI 7)

As highlighted in the above quote, the competition afforded via the leaderboard was designed with intentions for positive experiences among young adults. Key informants did acknowledge, however, that discouragement might result from affording young adults competition via the leaderboard (e.g., young adults see success of others while they are notably struggling and falling behind):

> I think it would work for some people. I'm not sure it would work for everybody. I don't know whether it could be discouraging, as well as encouraging if you're doing your best but you see that others are doing a lot better than you are. Does that prompt you to work

harder, or does it [make you] just say, "Oh well I'll never be able to do as well as these other people so I'm just gonna pack it in?" I don't know. (KI 2)

***Task support***

Key informants described the task support functions as aiming to support the task of quitting smoking and considered these functions as the most important components of CTC, primarily because of the behaviour tracking aspect—tracking cigarettes smoked and cravings. Drawing on the success of behaviour tracking apps in supporting other areas of health behaviour change (e.g., weight loss), the designers focused on including elements that they anticipated would provide strong task support with the goals of raising awareness and capitalizing on individuals' motivations to change their behaviour. The strategies they focused on included *documentation, journaling*, *enhancing the visibility of the benefits of quitting*, *choice*, *interruption of habit,* and *weening from habit* to enable young adults to stay on track with their quit smoking goals.

*Documentation.* Constructing smoking as primarily a habit, key informants thought that young adults are often out of touch with what their smoking behaviour really looks like—suggesting it has become second-nature. Affording young adults the opportunity to document their smoking patterns through the smoke and crave buttons and the map function were, therefore, viewed as an important way to begin helping young adults become aware of their habit. One key informant reasoned that this documentation is critical to change, stating "things that you know are the things you can start to change." (KI 13)

*Journaling.* Journaling was afforded via the feedback on triggers function, whereby users were expected to not only become aware of the frequency of their smoking and cravings, but also become aware of their smoking patterns and the reasons why (e.g., why they smoke in particular contexts or in a particular emotional state). One female key informant explained:

> I mean, if they're serious about quitting, I think it helps them establish kind of a pattern of…like a pattern of their smoking behaviour, and they can really see when they struggle and when they don't…. That's something a lot of them don't really recognize….Maybe there are other triggers that you weren't aware of before...and you see, "oh my god, when I'm by myself at home studying, I'm actually going out for smokes on a regular basis." (KI 11)

It was hoped that this journaling would also help young adults know what to expect—their inclination to have a smoke in a particular context would not come as a surprise. Because of this newfound self-awareness, it was thought that young adults could be better prepared to avoid triggers to smoke, and even think about alternatives to smoking to change their behaviour.

*Visibility of benefits of quitting.* Key informants not only intended for young adults to become aware of their smoking behaviour, but also to become aware of the benefits of living a smokefree life. They expected to achieve this by affording young adults with enhanced visibility of the benefits of quitting via the calculators feature, whereby users could calculate health benefits, days smokefree, number of cigarettes not smoked, tar crushed, and money saved. Users could actually "see" the benefits in relation to quitting smoking, most of which are otherwise invisible (e.g., amount of tar not in their lungs). One key informant said that this visibility is "pretty powerful" in motivating and affirming young adults' decision to become smokefree and would be a primary reason that young adults would continue to engage with the app:

> I can't think of any real reason that you'd wanna go back [to the app] other than that you are interested in the feedback and how well you've done and whether you've achieved certain health benefits. Which, you know, based upon the discussions we've had with some people already is that it can be pretty powerful. I mean they like to know they've actually gained lung function and stuff like that….It makes them feel good. (KI 3)

*Choice.* Key informants explained that the information pages, online resources, and the quitline listed in the app afford users *choice* in the type of information and support they would like to receive to help them with the task of quitting smoking. For example, the various information pages enabled access to information on popular quit smoking topics that were relevant to their interests and needs (e.g., myths about quitting, crave crushers, etc.). Also, the online resources and quitline were expected to provide young adults with alternative, credible cessation resources. For example, if a young adult wanted counselling through a craving, they could consult the quitline.

*Interruption of habit.* The craving distractions feature of the app was included to afford young adults with a just-in-time tool to interrupt their smoking patterns by helping them to stop reaching for a cigarette in response to a smoking cue or craving. For example, if a young adult was at a bar with friends and wanted to go out for a smoke, they could pull out their phone, indicate they are craving a cigarette, and the craving distractions would come up (e.g., YouTube videos, music, or games). In this way, it was reasoned that the habitual nature of their smoking would be interrupted because users were prompted to put their mind on something else or keep their hands busy by playing a game. One male key informant said that the young adults in the focus groups were most excited about this feature:

> I'm trying to reflect on those [focus group] conversations….One of the things that people were excited about…was distractions to help deal with cravings, and the idea of keeping your hands engaged or taking your mind off the cigarette. So the idea of games etcetera was one of the key conversations that happened. (KI 3)

*Weaning from habit.* Creating the opportunity to wean off cigarettes was viewed as an important component of the app. Weaning was afforded young adults via the quit plan, whereby young adults could set a quit date of their choice as long as it was at least two weeks in advance. Rather than expecting someone to eliminate smoking immediately, the quit plan allows someone to gradually adapt to a smokefree lifestyle. Key informants described this weaning as an important evidence-informed approach to quitting that increases the chances of cessation success:

> So the customized quit plan, we felt it was very important to be able to do that…and that's taken right from the self-help literature in terms of people committing to a date. These are all things that have been shown to be tried and true in terms of the smoking cessation interventions. (KI 3)

***Dialogue support***

The dialogue support design component relates to aspects of the app that aimed to positively reinforce young adults' decision to quit smoking. Interviews with key informants revealed that all of the dialogue support features, therefore, were underpinned by an overarching expectation that they would result in motivating or encouraging young adults in their quit smoking efforts. It was hoped that the dialogue support features would "take something not fun (smoking), and make it into something fun", as described by one female key informant (KI 8). It was expected that these intended positive outcomes would result from the following affordances

that underpin the dialogue support features: *recognition*, *visibility of progress*, *app reminding*, and *personalized reminding.*

***Recognition.*** Recognition, afforded via the receipt of awards for reaching particular milestones (e.g., money saved, days smokefree, health benefits), was expected to affirm young adults' quit smoking efforts, motivate them to continue to reach their quit smoking goals, as well as keep young adults engaging on the app. In this regard, affording users recognition through the awards page was not only expected to affirm users past and present efforts, but also to influence positive future efforts:

> I think celebrating successes, whether it's one day smoke free, one month smoke free, one year…I think it's worthwhile to get badges, and again, it gives people something to…look forward to…to come back to the app. Okay I've achieved three badges, I really want to see that whole page filled. You know? (KI 7)

***Visibility of progress.*** Affording *visibility of progress* via the awards and the progress page was also expected to motivate young adults in their quit efforts. Many key informants explained that showcasing progress, whether it be health improvements achieved or number of cigarettes eliminated, results in a desire to continue along a success trajectory. One key informant described this monitoring as a form of persuasion:

> But I also think…this as a form of persuasion; when people see they're starting to have success, that's actually very rewarding for them…seeing that their smoking rates are going down. That actually can motivate them to keep at it right? (KI 13)

One key informant also thought that seeing progress may even help young adults overcome the frequent setbacks that often occur during the process of quitting:

> Well I think it's always nice to see progress…in anything that you're doing in life it's nice to see that you're moving forward. I think with smoking it's harder to see—visually see—than with weight loss….So the app I think helped build that history and that timeline where you know this is you before and you were smoking a pack a day and now you're down to four a day. So it's showing them…they can then feel like, oh great, I actually am doing better. Even though I haven't quit yet, I'm way better than I was last month. And I think that the report and the charts and stuff made it really nice for someone to see that they are making some progress….Even if…they've had a few slipups, they're still 50% better than they were three weeks ago. (KI 1)

***App reminding***. By affording young adults reminders of goals achieved (e.g., one week smokefree) via push notifications, it was expected that young adults would be continuously encouraged in their quit efforts. It was also expected that the push notifications would remind young adults to engage with the app, thereby addressing concerns related to discontinuing use. This is reflected in some of the meeting notes that were taken during the development of the app:

> [Key experts] also thought push notifications could be used for the awards to let the user know they have received one. Push notification was also suggested to encourage use of the app.

***Personalized reminding.*** Young adults were also afforded reminders of their own reasons and inspirations for quitting by enabling them to upload photos and insert a motivational quote for display on the homepage, as well as photographically document their quitting journey. It was thought that this personalization would motivate them to stay on track as they engaged with quitting smoking, as well as keep them engaged with the app:

> One of the key things that came out [of the focus groups] was the importance of personalizing it. Somehow making it personal. So we thought that was important and we thought that if users could somehow personalize it to them in some way, then they'd be more likely to engage with it. So the idea of allowing people to create their own affirmation as to why they're trying to quit smoking, as well as to upload photos to the homepage that are unique to them, their own personal photos, could…act as a way of motivating them to continue down the path to quitting smoking. (KI 3)

***Gender influences***

When key informants were asked about how they thought gender-related factors might influence the ways in which women and men engage with and use the app, they often drew on stereotypes to describe differences in the way they thought women and men would respond to the app. For example, key informants thought that affording competition would be important for men but not for women suggesting that men are competitive but women are not. Table 10 showcases which affordances were expected by key informants to resonate with women and men. Quotes from interviews with key informants are inserted below the affordance to showcase their perspectives on how gender would influence young adults' preferences and/or dislikes for particular affordances.

*Table 10. Key informant perspectives on gender-related influences on CTC app use*

| | **Women** | **Men** |
|---|---|---|
| **Like the least** | • Competition<br>-"women do not like to compete" | • Journaling<br>-"men are more into counting, not into story-telling"<br>• Social interaction<br>-"macho aspect…men don't need or want to bare their soul to someone"<br>• Personal reminding<br>-"men don't care" |

| | Women | Men |
|---|---|---|
| **Like the most** | • Promise<br>-"women are more concerned about their health…they want to do it [quitting smoking] the best way"<br>• Journaling<br>-"women are more in touch with their feelings"<br>• Social interaction<br>-"women rely more on support from others in relation to their health"<br>• Personal reminding<br>-"women like to customize to their preferences" | • Interruption of habit<br>-"men like games"<br>• Competition<br>-"men are competitive" |

## Summary

In this Chapter, the findings from interviews with key informants were presented in two sections: *1) Overall reflections on the strengths and limitations of the app;* and *2) Intended affordances to the young adult in smoking cessation.* The section detailing key informants' reflections on the strengths and limitations of CTC were presented according to five categories: *1*) *technology and platforms utilized in the intervention;* 2) *foundation of app content;* 3) *underlying focus of the app;* 4) *functionality of app;* and 5) *look and feel*. Key informants pointed to both potential strengths as well as limitations offering a balanced assessment of the app. The section presenting the intended affordances to young adults who are trying to quit smoking presents how the app was intentionally designed to help young adults' smoking cessation in order to lend to particular outcomes, whether it be a new behaviour, experience, or choice, that support quitting smoking. The intended affordances and expected outcomes were presented for each design component of CTC: credibility, social support, task support, and dialogue support. Perceptions related to the influence of gender-related factors with respect to the intended

affordances and the potential use of the app often reflected gender stereotypes. The next two Chapters will present young adults' perspectives on and experiences in using CTC for quitting smoking.

# Chapter 5 – FINDINGS: YOUNG ADULTS' USE OF CTC

Drawing from analysis of interviews with young adults, this Chapter focuses on the ways in which young adults use Crush the Crave (CTC), addressing the research question, "How do young adults engage with CTC for smoking cessation?" This Chapter is organized in the following three sections: 1) Introduction to CTC; 2) Integrating CTC into daily life; and 3) Likes and dislikes about using CTC for quitting smoking. Gender-related findings are highlighted in each section.

## Introduction to CTC

Young adults' introduction to CTC will be presented in this section. This section will consist of the following three categories: 1) *First exposure to CTC,* 2) *Motivation to use CTC,* and 3) *Quit approach with CTC.*

### *First exposure to CTC*

Most young adults described being first exposed to CTC via a Facebook recruitment ad for the CTC RCT study. A handful of young adults heard about the app through a recruitment email, sent to their personal email. Three individuals found the app while actively searching for quit smoking help on the internet and the app stores. One young man said that his Fiancé wanted him to quit smoking and found the app for him via the app store.

Apart from seven individuals (five of which were women), CTC was the first quit smoking app that participants came across. Those that had used alternative quit smoking apps often described a preference for them because, compared to CTC, they were "super simple" in that they were easy to navigate and did not require a Wifi or data connection. Other quit smoking apps used included those that were backed by credible sources (e.g., SmokeFree and QuitNow),

and some that were more user-driven (e.g., Cessation Nation), with more women describing using the former and men using the latter.

***Motivation to use CTC***

Most young adults said that the intriguing novelty of a quit smoking app was what motivated them to download and use CTC. Young adults often expressed exhaustion with the lack of success and/or negative side effects associated with using other quit strategies and welcomed CTC as a new alternative:

> I've tried absolutely everything in the world out there to try to help me quit smoking. I've even tried doing acupuncture and laser therapy. I've tried hypnotism. I've tried everything….I'm really into technology so it's…an app that's constantly by my side. My phones constantly by my side. Maybe this will help me keep an eye on my habits. (male, nonsmoker, P10)

> I'm always trying to quit but never successful…so I just figured it was no harm in trying something different. (female, nonsmoker, P19)

In addition, young adults described alternative quit aids, namely, nicotine replacement therapies, Champex, and acupuncture as unfulfilling because they targeted one aspect of smoking, primarily nicotine addiction. CTC was, therefore, described as a much-needed, all-encompassing quit support available to them:

> I've been trying to quit smoking now pretty much as long as I've been smoking. So and I mean I tried different things. I've tried the prescription Champex and that stuff gave me bad side effects so that was not a good choice, you know. I did the nicotine mints and the gums and none of it really helped because it didn't really satisfy what I needed….When I was smoking, it wasn't just the nicotine, it was everything….I mean nicotine of course is

> part of it but it's a whole like experience as opposed to just getting something into your body. So none of these other things worked for me in the past so….Yeah, I saw that [CTC ad] wherever I saw it and I'm like, "alright, well, I'll sign up for this"… (male, nonsmoker, P27)

Others described the financial incentive to participate in the study as the motivator to use the app, with more men than women describing this as their motivator to use CTC. A few others said that being able to contribute to a study to inform future efforts to help young people quit smoking is what motivated them to use CTC.

Motivation to continue to try to quit smoking and ultimately become smokefree was the main outcome that young adults were hoping to get from engaging with CTC. Many young adults described motivation as the key factor to success in quitting and were hoping that the app would provide them with "extra motivation" in addition to their intrinsic motivation to quit, as demonstrated in the following statement:

> I'm always looking for something…because I know I'm gonna quit at some point….It's gonna be one of two things: either I'm gonna say, "Screw it, I'm just gonna be a smoker for the rest of my life," or, "I'm going to quit at some point"….So I'm always trying to look [for] some extra motivation…motivation is a very key contributing factor. (male, smoker, P7)

***Quit approach with CTC***

Most young women and men opted to quit cold turkey versus following a personalized quit plan laid out by the CTC app. Those that decided to quit cold turkey said that they wanted to quit while they had the motivation and were worried that a quit plan would ultimately lend to procrastination in quitting rather than to quitting. Those that opted to quit by following a quit

plan were often unsuccessful in quitting and agreed that the quit plan enabled procrastination from quitting. This led many young adults to switch from quitting with a quit plan to quitting cold turkey:

> Every time I didn't completely stop smoking, I always had access to smoking….I found that for myself, that doesn't work for me. What worked for me was when I said, "I don't want to smoke any cigarettes starting from this moment." Because if I wanna quit smoking I'm gonna quit smoking. But just by decreasing the number, okay, good work, man, you didn't smoke ten cigarettes today, but you smoked ten cigarettes as well….So so you're still not doing good. You are trying to motivate yourself but you're still not doing good. Quitting smoking is kind of, you know, if I have access to ten cigarettes a day or five cigarettes a day, [it] can be very easy go up to 10 or 15 or 20 depending on the circumstances of the day…. For anyone who wants to quit I'd say stop the smoking from this moment. (male, nonsmoker, P18)

**Integrating CTC into quit smoking efforts**

This section includes a presentation of the ways in which young adults integrated CTC into their daily lives as they engaged in quitting smoking. This section will consist of two categories: 1) *Patterns of use* and *2) Role of CTC.* In relation to *contexts of use,* young adults' descriptions of how they used CTC during their quit smoking efforts are presented. Two themes will be highlighted in this section: *waning usage trajectory* and *recording and reflecting*. Findings in relation to perceptions regarding the *role of CTC* in young adults' quit smoking efforts will be represented using two themes: *app as object and subject* and *CTC as playing a supportive role*.

### *Patterns of use*

*Waning usage trajectory.* Use of the app among young adult women and men followed a waning trajectory, whereby they described their use of the app as most intense after it was first downloaded, and then waned over time. Young adults primarily talked about this pattern of use as aligning with their quit smoking trajectory—the less they smoked, the less they engaged with the app, which is demonstrated in the following statement:

> I think it's just because I'm not smoking now, so you know what I mean? Especially [when] I did use it mostly to track the smoking and [use] distractions and stuff. So I think now, [when] it really doesn't bother me, I kinda don't feel the need to use it. (female, nonsmoker, P19)

Young adults who were still smoking at the time of the interview also described this waning usage trajectory. Despite that they did not become smokefree, they described the app as equipping them with knowledge and strategies to address their smoking habit, which they began to incorporate into their daily life. They said that after this initial acclimation of new information, they became more confident in addressing their smoking on their own, requiring less assistance from the app:

> At the beginning, I used to use it like multiple times a day and then it got to like once a day and then—now it's like once a week….I think it's because…they say after two weeks something becomes habitual so….I could think of using the app and things—like just thinking of using the app would make me not smoke. So why am I gonna use the app when I'm already doing it mentally? (male, smoker, P21)

Some young adults did say that they began to lose interest in the app over time, which also contributed to this waning pattern of use. This loss of interest was often due to a pitfall in

the app, such as technology glitches (e.g., freezing, loss of data, cancelling out) or the inability to enter their smoking retrospectively. One young woman who still smoked described a keen interest in using the app but said she stopped using it due to the technological glitches:

> Yeah, yeah, like I really wanted to you know get in to it and start to use it. But then the fact that it just, you know, it was glitchy was such a turn off for me…that I just kind of eventually started to forget about it. (P30)

Another young woman who quit smoking explained her decrease in app use due to the fact that the app would provide suggestions and strategies often located on a different platform (e.g., iTunes store, Facebook), which could be more easily accessed directly versus through the app:

> And like even now, instead of me going to the app and going to "my distractions" and stuff, like I know kinda what is there so I'll just open up my own Facebook and scroll through it or I'll open up my Twitter. Like it kinda gave—like it's just I have it now….So I don't need to go through the app to get my distraction 'cause I kinda know what works from the app so I just directly go into it myself. (P19)

Still, a few others said that they gave up on quitting smoking so their use of the app tapered off. This is demonstrated in the following description of use by a young man who still smoked:

> It was like a fade—it like faded until I stopped using it altogether and then…it got moved from my homepage to the back and then it was eventually deleted. Mostly [because of] my giving up on the goal of quitting….  Yeah, it's basically just that you know? (P9)

*Recording and reflecting.* Young adults described using the app to log and intercept a craving or cigarette smoked, as well as to reflect upon and review their smoking habit when they were not in a vulnerable state of mind (craving or smoking). Being able to harness support and gather information during moments of vulnerability, as well as during a stable period of time, reinforced their quit smoking efforts:

> Yeah, like I mean, at the time of my cravings, it was always good to be prompted [to ask] why I wanted the cigarette—that was the most useful. But then the second most useful [part] was just during my day, on like commute, you know, I'm like bored, I open up my CTC app, and it gives me some tangible evidence of how my body has improved since I stopped smoking. I thought that was a really cool idea. (male, smoker, P3)

While young adults used the app during moments of need, their use primarily coincided with having "down time" or "free time", with young adults describing their day-to-day life as not always amenable to having their phone constantly on them. Therefore, even if they had cravings or smoked cigarettes throughout the day, they were not always able to document and reflect on these events until they had some free time. Being at work was the most common reason that young adults could not easily consult with the app.

### P*erceived role of CTC in quitting*

*App as object and subject.* Young adults' descriptions of the app suggested they viewed it as a material object, with young women likening it to a "weigh scale" and men describing it as a "tool". The app essentially helped them measure their quit smoking efforts. In describing the utility of the app, they often referred to the tracking features, which was the most well-liked aspect of the app. Young adults said that seeing the personalized tracking data made them want to see improvements in their status, which meant that they needed to quit smoking.

Many young adults also ascribed human qualities to the app, describing it as a source of social support. When they spoke about their quit smoking efforts, they explained that quitting was a personal and private endeavor. As a result, many young adults were trying to quit without the support of their social networks. The few that did harness support from their networks, did so in a very selective way, often picking one or two close people in their lives to harness support (e.g., mom, best friend). The app was, therefore, often described as a social being providing support, such as a "best friend" or a "non-judgmental" supporter. Men were particularly unlikely to harness support from their social circles, which coincided with their frequent description of the app as their only source of social support:

> My situation is a little more unique than other peoples. I just, like I say, it's—to me it's kind of a personal struggle, if you will. And I guess kinda take it on myself and go so. But yeah, but that being said, I mean, I did use the app as positive reinforcement, so there was something else there. You know, that's all I needed was that small little pat on the back to say hey, you're doin' good, don't throw away 125 days. You know? (male, nonsmoker, P29)

> What I liked about the app is it wasn't very judgmental; that was a very good part about it. If I had a crave, I could just press the crave button under the table, no one else at the table had to see it. And if I actually went out for a smoke, you know, maybe I wasn't being so forthcoming and telling my girlfriend about it, but I could go out and click on the smoke button to let the app know that I had cheated and went for a smoke. So it…you know, the app knew all, but everyone else didn't. So it was nice that way it was kind of a little bit more confidential. I'm not big about sharing everything with the world out there…I'm pretty private guy when it comes to these things. (male, smoker, P3)

*CTC playing a supportive role.* Regardless of whether or not they were successful in quitting, young women and men unanimously stated that quitting ultimately comes down to them and that the app cannot make them quit. The app was, therefore, described as something that reinforced and supported their desire to quit smoking. Men were particularly assertive about the app being secondary to their "willpower". One young man who successfully quit described the app as something that reflected and enhanced his willpower:

> I tried and tried to quit smoking, you know. I was at least feeling 10 years of smoking either full time and intermittently and …there were times I'd take a 3-month break, but always eventually ended up going back in to it, you know, full on. So—and the problem is like, trying. You can't try. You just have to do right? So, you know, the biggest factor was myself wanting to quit smoking. Regardless of family pressures or friend pressures or societal pressures or anything like that. … It's my personal belief that nobody's going to actually stop until they want to. … Like I expressed earlier, CTC was a great tool to allow me to do that, and was just an extension of my willpower and a reflection of my willpower. (P29)

## Likes and Dislikes of using CTC for quitting smoking

In this section, young adults' descriptions of what they liked the most and least about using CTC for quitting smoking are presented. Their descriptions fall under the same five categories listed in the section "Overall reflections on CTC's strengths and limitations" by key informants in the previous Chapter: 1) *technology and platforms utilized in the intervention;* 2) *foundation of app content;* 3) *underlying focus of the app;* 4) *functionality of app;* and 5) *look and feel*. *Technology and platforms utilized in the intervention* relates to young adults' descriptions about what they liked/did not like about receiving a cessation intervention via a

mobile app, with the additional support of social media. *Foundation of app content* refers to young adults' descriptions of what they did or didn't like about the app content. *Underlying focus of the app* relates to their likes and dislikes about the focus of the app based on the technology used and the dominant features and functions that were built into the app. *Functionality of app* presents what young adults liked or didn't like about the ways in which the app functioned for contributing to smoking cessation. *Look and feel* relates to what they liked or didn't like about the overall design of the app and how it is packaged for their age demographic. Table 11 presents young adults' descriptions of what they liked and disliked about using CTC for quitting smoking.

*Table 11. Young adults' descriptions of what they liked and disliked about CTC*

| | **Likes** | **Dislikes** |
|---|---|---|
| **Technology and platforms utilized in the intervention** | Mobile platform ensures that app is ready at hand. | Need for WiFi or a data connection in order to use the app and its features. |
| | Integration with social media platforms. | Technology glitches that make it challenging to access the app and/or its features (e.g., freezing). |
| **Foundation of app content** | The content of the app is positively-oriented. | |
| **Underlying focus of the app** | Provides a self-led, self-driven approach to smoking cessation. | |
| **Functionality of the app** | Provides opportunities to reflect and develop new ways of coping. | All calculations in the app are based on users' quit dates. |
| **Look and feel of the app** | The app is easy to use. | Navigating the app is not intuitive. |
| | | Branding is too dark and negative. |

### *Technologies and platforms used in the intervention*

Young adults said that their phone was almost always in close physical proximity to them and that the use of mobile technologies for a smoking cessation intervention aligned with the

needs and preferences of their age group. They described the portability of CTC, since it is delivered via an app, as one of the most liked aspects of using the CTC app:

> Just the fact that it is an app and I can bring it with me instead of like having a chart at home or something like that where it's not very portable. The app you can bring with you wherever you go 'cause chances are you're gonna have your phone on you. (female, smoker, P2)

Another aspect of CTC that young adults really liked was that CTC was integrated with Facebook. As illustrated below, young adults said it made the app more user friendly:

> And I really like too, it's like when you do delete it, if you still log in using the same information is it still keeps it…like if you log in with your Facebook, which I had…you log in with the same Facebook, it will still keep all of your information. (female, smoker, P12)

While having an intervention delivered via a mobile app was described as a great new way to reach those their age, some young adults experienced frequent technology glitches (e.g., freezing), leaving them feeling empty handed in trying to get help with quitting smoking:

> Yeah I'd get frustrated sometimes and not bother with it. But it would have been nice if the tips and the distractions part of it would have worked. I never once got that to work so I don't even know what they are…. When you need that and you want it and it's not there then… What do you do, right?....I tried to ignore [the craving] and then eventually, yes, I would smoke. I didn't know what else to do and I was craving that feeling and that habit and I did it so….Yes, it would have been nice to have those tips and have those distractions, but when they weren't there…what was I supposed to do? So I smoked. (male, nonsmoker, P4)

These glitches would frequently drive users away from the app, which is demonstrated by the following:

> It was just really frustrating because it made me log in every single time I wanted to like record anything. And I didn't wanna have to do that…and then it took forever to log in and then it would always tell me my password was incorrect even though I know I was entering it properly and it was just, like just even logging in was such a mission that it just, like it got discouraging after a couple of weeks. (female, smoker, P8)

A few young adults also lamented the fact that the app could only be used if they had a WiFi or data connection. This often resulted in limited use of the app, as well as disappointment in not being able to access the app and its features during times that they needed it (e.g., during a craving).

***Foundation of app content***

Another aspect of the app that young adults liked was that, despite it being developed and informed by evidence and scientific institutions, the content was delivered in a fun and positive way. One young woman who still smoked provided a detailed description of why the ways in which the content was delivered was so appealing to those her age:

> [The app] is not just pure scientific, "this is what you have to do, this is why you need to quit smoking, these are all the chemicals that are in it," you know what I mean? There was more of a fun aspect to it. Where it seemed like it wasn't so serious. It was maybe more geared towards my age group anyways, as opposed to like 30 or 40 year old who are trying to quit. And so I liked that about it, right? 'Cause it wasn't so stuffy, it wasn't so clinical. It was more like, "okay, we know that you wanna quit, but we're not gonna judge you too severely if you don't," right? I don't wanna say that it didn't seem as serious, it just didn't

> seem as clinical. It didn't seem like you need to quit now. No, this is a tool we're offering to help you take it upon yourself.… And you also gotta remember that like people my age…all of us in some way, shape, or have authoritarian disorders where like, as soon as you tell us to not do something, we wanna do it….Or you tell us that we have to do something, well then we don't wanna do it. And I think that this app has the perfect combination of like well, we believe that this is very important for you, but we're not gonna judge you because of it, right? (P22)

***Underlying focus of the intervention***

Young adults really liked that CTC offered young adults a self-led intervention for quitting smoking. Young adults often referred to the fact that CTC enabled them to track their smoking habit, which served to kick start their quit smoking efforts on their own accord:

> I feel it was helpful. I really like the feature where you can kind of track your money and your smoking or non-smoking I guess….It's almost like a competition, like you wanna get to that next level and be at that next level and be proud of yourself that you've gotten that far…Sometimes you don't hear the support or see the support, so to see [the tracking data] too you're kinda just like, "yeah…I can quit smoking, or maybe I can do this, it's been 60 days…I can go another 90 days….That's kinda how I felt. (female, smoker, P26)

Young men were particularly vocal about liking the self-led nature of CTC, explaining that they are very private and like to take on quitting smoking independently. Young men frequently stated that they did not like to share personal things, such as the decision to quit smoking, with anyone – friends and family alike.

***Functionality of the app***

An aspect that young women particularly liked about CTC was that it was an active intervention – it provided young adults with opportunities to reflect on their smoking and to develop new ways of coping. One young woman who smoked described the benefits of having a "give and take" intervention available to young adults:

> Yeah, so it's not just like documenting data, it's giving you something to do….And, it's like—it also takes and gives to you… it's like, "what are you doing when you crave or when you do have a cigarette…what you're feeling then,"…. Some of the other apps, most of them, you have to buy that information. Like you have to pay God only knows how much and this app, it's just like, okay it's there for you. (P12)

One aspect of the app's functionality that young adults did not like was that the calculations in the app were based on user quit dates. This served to be problematic when users forgot to log a cigarette smoked, or when the app did not allow the user to log events. One young woman described how the calculators (money saved, health regained, etc.) could be very powerful for quitting smoking but that the glitches in the app prevented her logging her smoking and cravings, which lent to inaccurate statistics displayed on the app:

> I couldn't actually log how many cigarettes and stuff I had …[so] it's not accurate. But if it was accurate it [would be] cool to see like, you know, money saved, like, "oh hey, I saved $100 smoking so far." Like you know, it's something to be proud of. (P30)

Many young adults also questioned the accuracy of the leaderboard data. In recognition of their personal data being based on their quit date and faithfulness in logging events, they often questioned if the data displayed on the leaderboard was true:

> I knew what I was doing, and I was my own leader trying to beat me…but you don't know how many other people are using it as faithfully as you are. (female, smoker, P11)

***Look and feel***

One thing that young adults, particularly young women, stated that they liked about the app was that it was easy to use. One young woman who still smoked described how ease of use was very important for maintaining engagement with the app, especially as a young mother:

> It was easy to get to, easy to use. Especially like being a mom…it was easy and simple. It wasn't overly complicated—like to start, like the start-up was [easy to] enter stuff…it wasn't overly long….[My son] only lets me use my phone for like two seconds at a time. (P25)

Despite that the app was often described as easy to use, young adults all agreed that navigating the app was not very intuitive. They often questioned why there were so many sub-pages of pages, which led to "hidden" features that they never knew about, or found out about it late in their quit smoking journey. They also expressed frustration with being sent out of the app to access certain tools (e.g., craving distractions).

While a few young men did not mind the branding of the app, most young men and all young women did not like the way the app was aesthetically packaged. They described the app as too dark, espousing a negative affect, which contradicts the otherwise positive orientation of the app. This is captured in the following statement:

> One thing that I did notice is that the background colors; they're a little dreary, like the black and the orange and like when you first click on it, just like the colors of it; it could be a little more like brighter and happier kind—not really happier, but like a different color scheme I think would work a lot better….And like black, from a psychological standpoint,

like bland and red they're like angry negative colors….So if you put more like blues and greens and like yellows and like summer colors and things like that in it, it might change people's you know mood a little bit more, psychologically without them even knowing. (female, smoker, P2)

## Summary

In this Chapter, findings from interviews with young adults in relation to the ways they used CTC as well as how young adults integrated CTC into their daily life were discussed. Evident in these findings were patterns in the way that young adults used the app, and the role that CTC played in their quit smoking efforts. Also, this Chapter presented young adults' overall likes and dislikes about using the app, which were grouped according to the following five categories: 1) *technology and platforms utilized in the intervention;* 2) *foundation of app content;* 3) *underlying focus of the app;* 4) *functionality of app;* and 5) *look and feel*. Notable gender influences on these likes and dislikes were highlighted. In the next Chapter, young adults' descriptions of how CTC helped them in their quit smoking efforts will be presented.

# CHAPTER 6 – FINDINGS: EXPERIENCED AFFORDANCES OF CTC AMONG YOUNG ADULTS

This Chapter focuses on young adults' experiences in using Crush the Crave (CTC) for quitting smoking. Drawing from analysis of young adult interviews, this Chapter addresses the final research question: How are young adults' smoking cessation experiences/practices influenced through CTC? In this Chapter, the underlying mechanisms that lent to particular experiences and practices in relation to quitting smoking while using CTC will be presented; that is, the experienced affordances of CTC among young adults trying to quit smoking. This section essentially highlights "how" young adults came to have a particular experience or change in the way they approach quitting smoking. In keeping with Chapter 4, the experienced affordances, which includes both intended and unintended affordances, will be presented according to each design component of CTC (credibility, social support, task support, and dialogue support (see Figure 1). Differences reflected in young women's and men's conversations are highlighted throughout the Chapter. Table 12 details the intended affordances, those that aligned with the key informants and resultant experiences and/or practices in relation to each design component. Table 13 lists the unintended affordances – those recognized by the users but not intended by the developers. The outcomes of the affordances are presented to showcase similarities and differences in relation to the ways in which young women and men experienced CTC.

*Table 12. Intended affordances experienced by young adults and associated outcomes*

| **Design component** | **Affordance** | **Young Women Experiences/Practices** | **Young Men Experiences/Practices** |
|---|---|---|---|
| **Credibility** | Promise | -Trust in app intent and effectiveness | -Trust in app intent and effectiveness |
| **Task support** | Visibility of the benefits of quitting | -Young adults engaged in a self-competition.<br><br>-Young adults experienced a perception shift – health implications became relevant, benefits became tangible. | -Young adults engaged in a self-competition.<br><br>-Young adults experienced a perception shift – health implications became relevant, benefits became tangible. |
| | Documentation of smoking behaviour | -Raised awareness of smoking habit.<br><br>-Experienced as discouraging. | -Raised awareness of smoking habit.<br><br>-Experienced as cumbersome to enter data. |
| | Journaling about smoking behaviour | -Young adults would be proactive about triggers. | -Experienced as conflicting with perceived self-awareness and control. |
| | Interruption of habit | -Experienced tactile preoccupation with games. | -Experienced tactile preoccupation with games. |
| | Weening from smoking | -Young adults would procrastinate in quitting.<br><br>-Experienced as comforting.<br><br>-Experienced as rigid. | -Young adults would procrastinate in quitting.<br><br>-Experienced as rigid. |
| **Dialogue support** | App reminding | -Experienced as irritating. | -Experienced as irritating.<br><br>- Experienced as motivation to quit. |
| | Personal reminding | -Experienced as motivation to quit. | -Experienced as conflicting with |

| Design component | Affordance | Young Women Experiences/Practices | Young Men Experiences/Practices |
|---|---|---|---|
| | | | perception of self-control. |
| | Recognition of ability | -Experienced as a confidence boost.<br><br>-Experienced as discouraging. | -Experienced as a confidence boost. |
| | Visibility of quit efforts | -Experienced as motivation to quit.<br><br>-Young adults would hold off from smoking.<br><br>-Experienced as affectively uncomfortable. | -Raised awareness of quit progress.<br><br>-Young adults would hold off from smoking.<br><br>-Experienced as affectively uncomfortable. |

*Table 13. Unintended affordances experienced by young adults and associated outcomes*

| Design component | Affordance | Young Women Experiences/Practices | Young Men Experiences/Practices |
|---|---|---|---|
| **Social support** | Constrained identity protection | -Information gathering vs harnessing social support<br><br>-Young adults didn't post due to feelings of vulnerability<br><br>-Young adults practiced selective posting | -Information gathering vs harnessing social support<br><br>- Young adults didn't post due t feelings of vulnerability<br><br>- Young adults practiced selective posting |
| | Inhibited competition with others | - Experienced as discouraging, divisive<br><br>-Experienced as motivating to quit | -Experienced as discouraging, divisive<br><br>-Experienced as motivating to quit |
| | Constrained co-participation | -Young adults kept quit efforts private<br><br>-Young women assigned a cigarette gatekeeper | -Young adults kept quit efforts private |

| Design component | Affordance | Young Women Experiences/Practices | Young Men Experiences/Practices |
|---|---|---|---|
| **Task Support** | Constrained retroactive input of smoking behaviour | -Experienced inaccurate personal statistics. | -Experienced inaccurate personal statistics. |
| | Mapping out smoking behaviour | -Experienced a drained battery.<br><br>-Experienced irrelevant information.<br><br>-Experienced feeling vulnerable. | -Experienced a drained battery.<br><br>-Experienced irrelevant information.<br><br>-Experienced feeling vulnerable. |
| | Status quo cessation information | -Experienced as a lecture.<br><br>-Young adults would prepare for quitting. | -Experienced as a lecture.<br><br>-Young adults would prepare for quitting. |
| | Counselling through cravings | -Experienced discomfort in talking to someone.<br><br>-Experienced quitline as "backpocket" support. | -Experienced discomfort in talking to someone.<br><br>-Experienced quitline as "backpocket" support. |
| **Dialogue Support** | Self-competition | -Experienced as motivating. | -Experienced as motivating. |

## Credibility

The credibility design component of CTC relates to the fact that the app was developed and supported by credible agencies and research institutions. Having an app that is supported by these agencies afforded young adults promise– CTC was a quality quit smoking resource worthy of young adults' trust. Both young women and men described feeling like they could trust the intent of the app knowing it was backed by credible agencies:

> It made it seem more legit. Like it was actually something making you try to quit smoking instead of, you know, maybe the other ones have ads in them and they try to

make money off them. But this one clearly isn't. It's a little more genuine, you know? (male, nonsmoker, P24).

One young woman explained that having an app backed by such institutions meant that she could trust it with her personal data:

I mean, like, through the University means…it was real. So I mean, I knew if I used it, my information wasn't going to some random Joe that was going to hack my stuff or anything. (female, smoker, P12)

Young adults also described trusting the promising effect of the app. Backing by credible agencies and research institutions gave the content of the app authority and meant that CTC would likely have a lot of promise in helping young adults reach their quit smoking goals compared to other apps that do not have backing by such institutions:

Well if it's endorsed by those types of people then it's gotta help somewhat right? Like…if it's just some app and it's not…doesn't have those people behind it, you know what I mean? It's better…to know that these people are behind it right? (male, smoker, P23)

One young women described how the backing of the app not only implied that it would have a good chance of working, but also provided reassurance that it would not cause harm:

Well it's just knowing that they…obviously they're all about health and improving health. So having them say, "alright, this is beneficial and it's approved, and it's gonna work", then it's like, okay, this might actually have a chance of working. And if they're crediting it, then that means that there's nothing—there's no harm in doing it. (female, smoker, P28)

Despite this trust in the app, young adults described frequent frustration with CTC due to technological glitches and issues with some of the functions in the app, which led many young adults to prioritize functionality over a promise. They explained that, if the app doesn't work,

they are not going to use it no matter who is behind it:

> I mean, I can see [credibility] being just an extra bonus. But like I said, it lacks the functionality that better, other ones I've found did. So it could be backed by you know, God, and it's really not gonna change it because it's still…less useful or…it's more of a burden to use it (male, nonsmoker, P27).

## Social support

The social support design component refers to the parts of the app that aim to provide young adults with opportunities to harness support from new and existing social networks. Interviews with young adults revealed that the social support aspects in the app were least helpful as they engaged in smoking cessation. Young adults' experiences are the result of the following affordances: *constrained identity protection, competition with others,* and *constrained co-participation.*

### *Constrained identity protection*

Young adults described the features and functions that aimed to provide social support, particularly the social media components of CTC as something that did not align with how they wanted to harness social support for quitting smoking. While they did want support in their quit smoking efforts, they did not want to do so through these channels. They explained that "everyone is on Facebook" and posting on this platform would reveal their smoking status and efforts to quit. For many young adults, this conflicted with their attempts to keep their smoking behaviour concealed from their personal networks:

> I feel like smoking and quitting smoking is a very personal thing for me, and I don't want other people to know about it…really, or be involved with it. (female, smoker, P30)

> For me, personally, I guess not a lot of my family knows I smoke. I have quite a few family members on Facebook. Even though quitting smoking is a positive thing, I mean if I can avoid them knowing I smoked altogether, you know. (male, smoker, P9)

Young adults often spoke about the shift from smoking as a social norm to no longer a social norm, which contributed to feelings of shame related to smoking. This perceptual shift in smoking reinforced their decision to conceal their smoking and, therefore, not post on social media:

> Smoking in general is just so frowned upon, like…it's just, I don't know, it's private to me. Like it's something that I deal with that I don't necessarily want the support of other people from. I don't want them…all involved in my business I guess. (female, smoker, P30)

> I did not use that and it's only because I'm a personal person …The only way to describe it is I'm not in to it…[because of] embarrassment in all honesty. You know, especially in this day and age. And I'll just give you an example: at my workplace—I think we have 35 people here—nobody smokes, including myself, so, well now. (male, nonsmoker, P29)

Also, young adults frequently cited a fear of judgement as another reason to not post about their smoking. They said that if they posted about quitting they would feel pressure to succeed and if they were not successful, then they would feel judged as a failure:

> There were only three people who knew I was quitting smoking; my best friend, my dad, and my mom….Because I didn't want the added pressure of everyone going, so how's it going, huh? How's the quitting smoking going, have you quit smoking yet? Because I find the pressure of everybody looking at you and waiting for you to slip up, makes me slip up quicker….My mom is still a smoker [and] my dad quit; so they both understand

> and they're just more like, hey how's it going? Not, how's the smoking going? You know what I mean? They just…you know, randomly my dad will ask, have you had a cigarette today? No. Awesome, keep going. Instead of like, he wouldn't call me out of the blue and ask, so how's the smoking going? (female, smoker, P25)
>
> And if you don't [quit] like people might get on you and nag you or be disappointed. I don't need that. I'll be disappointed in myself, that's enough (male, smoker, P21).

In keeping with their efforts to protect themselves, young adults primarily practiced "lurking" and avoided posting on the social media channels made available through CTC. The few young adults who were open to posting about their quit smoking efforts on Facebook described being very selective in what and when they would post about quitting smoking. They said that they would only post about successes in their quit smoking efforts, when they were confident in their smokefree status:

> You know, I'm gonna kinda keep it to myself and work away at it. And then, once I have quit for good, then maybe I can go and say like, this is where I'm at this point in the app. I've quit smoking completely, or it's been 100 days or whatever the case may be if I wanna share my milestone or something like that. But [its]…nothing I would use on a regular basis for sure. (female, smoker, P26)

There was also some engagement on social media that encompassed information gathering rather than harnessing social support. For example, young adults would employ the CTC Facebook page to provide or view reviews of the app, and to receive updates in relation to the app or quitting smoking. In addition, although rarely, young adults would employ the sharing feature on personal social media to reach their entire network. For example, one young woman

who still smoked (P16) said that she would use this feature to provide a "status update" rather than updating each person individually.

Young adults also found that the quit buddy feature threatened their social identity. Several young adults laughed and stated that their friends would just "laugh at them" or "make fun of them". Thus, few young adults used the quit buddy feature.

***Inhibited competition***

The leaderboard function was discussed as a function that inhibited productive competing with other CTC users in that the competition embodied defeating each other rather than supporting each other. While a few young adults said that seeing the progress of others would motivate them in their quit smoking efforts, many said that the competitive nature of it was discouraging:

> Someone whose successful and quit smoking isn't any better than someone that's struggling with it. Like, no, I didn't-I don't like that aspect… it just makes someone feel bad. (male, nonsmoker, P10).

The inhibited competition was perceived as divisive in many respects. In other words, rather than lending to a sense of community, it lent to the opposite. One young man explained that making it a competition contradicts a needed sense of unity and community for those who are trying to quit smoking:

> Well I don't know how—if it should really be a competition right? It should be more of like for everyone to work together to help each other.…. It's not a competition to quit smoking because you're all trying to accomplish the same goal right? (male, smoker, P23)

This divisiveness was reinforced by the fact that young adults could not connect with other CTC users unless they were on the CTC Facebook page, which the majority of them were not. As a

result, young adults were not able to establish a sense of community with other app users:

> You can see but you can't actually be like Hey, …. how's your quitting smoking going? Or what have you done that you know can help me? …I think that would be kinda cool to have that as like a feature - like click here to chat with others, (male, smoker, P17)

In this regard, the leaderboard was perceived as ill-fitting for a smoking cessation app because puts a focus on competing against each other rather than making a positive behaviour change: I am not doing it to compete against others, I'm doing it to compete against myself, so. It's self improvement. (smoker, P15)

Several young women were not entirely opposed to the notion of competing for quitting, but were adamant that they did not want to compete with strangers because the latter did not embody a sense of community. Instead, they expressed an interest in competing with friends. Young women thought that there would be some comradery in competing with friends, especially because it would be underpinned by the knowledge that they were all there to support each other:

> I think it didn't matter to me too much. I think it would have been an awesome feature if I was like trying to quit with friends that were also on there. But like, just strangers, it's like I almost really didn't care, you know? (female, smoker, P14)

***Constrained co-participation in quitting***

There was a lot of confusion about what a "quit buddy" was, with young adults questioning if it could be anyone to support them or if it should be a fellow smoker who is also trying to quit. Since most young adults did not have access to someone who was also ready to quit, they often bypassed this function in the app. Young adults who did try out the quit buddy concept said that it wasn't helpful because the quit buddy was often not going through the same

process that they were in relation to quitting, which reinforced their desire to pursue quitting on their own accord: “I tried to do the quit buddy thing but the people that I was having as quit buddies were not as serious about quitting as I was so.” (male, nonsmoker, P17)

Those that did not use the quit buddy feature reasoned that a quit buddy isn’t going to help them beyond their own ability to help themselves, likely thwarting the objective of harnessing support for quitting: “[If] the person [is the] same as you, you will just discuss [smoking] with him.” (male, nonsmoker, P1)

A few young women explained that, while they didn’t know anyone that they could quit with, they assigned a non-smoking partner or spouse as their quit buddy. In this way, their quit buddy acted as a cigarette gatekeeper – someone that they had to go through first before they could smoke a cigarette. Young women described chatting with their quit buddy before smoking in an effort to distract them from their craving. One young woman assigned her non-smoking husband as her quit buddy. She said that she gave him her cigarettes so that she would have to go through him in order to smoke. She said it was almost impossible to get one out of him if she was having a craving because he hated her smoking so much.

**Task support**

The task support functions are essentially aimed at supporting young adults in accomplishing their “task” of quitting smoking (e.g., through tracking their behaviour, identifying their triggers, and so forth). Overall, young adults were enthusiastic about the task support functions for helping them in their efforts to quit smoking. Various experiences and new ways of dealing with their smoking behaviour with the goal of quitting were achieved through the following affordances: *visibility of the benefits of quitting, documentation of smoking*

*behaviour, constrained retroactive documentation of smoking behaviour, status quo cessation support, counselling through cravings, entertainment, and weening from habit.*

***Visibility of benefits of quitting***

Young adults described how the calculators displayed in the app, from money saved to amount of cigarette tar not in lungs to cigarettes not smoked, afforded them visibility into the benefits of quitting smoking. This visibility brought forward a competitive edge to their experience, whereby they wanted to see continued improvement in their numbers:

> And I also like the health things [calculators], where it's like, oh your $CO^2$ has gone back to normal. Yeah, so I found those really helpful within the app. I don't have a specific time in mind but there'd often be times where I would be craving a smoke and then I would, maybe go and look at it and realize how close I was to the next health thing or how far I had made it in decreasing my risk of a heart attack [equal] to people who didn't smoke. (female, smoker, P13)

> You do something today, and you do it tomorrow, and you do it you know Sunday, you're more likely to do it on Monday. Because if you're looking at it and you have this in your face, you say, "That's three in a row! I don't wanna stop!" (male, nonsmoker, P27)

Young adults also described a shift in their perception about the tangible benefits of quitting. Young adults spoke about how they were particularly made aware of the impact of quitting on their health, improvements that were otherwise invisible (e.g., tar in lungs). Although they knew the negative health impacts of smoking later on in life, seeing data indicating improvements in their health made them realize that smoking does negatively impact their health at their age and should be a relevant concern to them:

> Yeah, I would check that one a lot because it would keep coming up and like showing I'm this close to being…back to like a nonsmoker for this aspect of my health, or this aspect….I guess it was more of a motivation to quit because some of them it takes like years to get back to a non-smoker health state and that just really made me think about what I was doing. (female, smoker, P14)
>
> It was nice to see what my body had been doing in the meantime. It's just like, you might not feel like you've been doing a lot 'cause you've just been not [smoking], but like meanwhile, you know, your heart's looking better and your lung capacity's increasing. (male, nonsmoker, P20)

While both young women and men found all the different types of personal data displayed in the app very appealing, young men were particularly receptive to seeing the amount of money they were saving/spending on cigarettes. They explained that they didn't really pay attention to how much they spent on cigarettes but seeing the dollar amount tracked through the app provided them with tangible rewards to quit smoking:

> I was like, oh my god, I see all this money I'm saving. And at the time, I was working three jobs so I was like, holy crap, I can't justify spending this money anymore….So I would constantly look at the dollar amount…it was pretty eye opening that way. Not just the health related or the, you know, personal motivation related sense, it was more just money related. Like holy crap I'm saving a lot of money not smoking. (male, smoker)
>
> When you go back on the app and you check the health benefits, the money you've saved, and how many cravings you've had, you look back on that and think, well, look at all the money I could be saving. Well I'm saving myself in the end as well, but it's nice, that aspect. (male, nonsmoker, P3)

### *Documentation of smoking patterns*

Documentation of smoking behaviour was afforded via the smoke and crave buttons. While young women and men both described documentation of their smoking and cravings as lending to enhanced awareness of their smoking patterns, young men were not as inclined to document their smoking behaviour as women, often describing it as "cumbersome". Although women were more inclined to document their behaviour, several young women described the documentation features as discouraging because this documentation was solely focused on negative behaviour (craving or smoking). Young women explained that, if they were documenting something, it meant that they were "doing something wrong" (either struggling with a craving or admitting to a cigarette).

### *Constrained retroactive documentation of smoking behaviour*

Young adults frequently referred to how their use of the app primarily occurred when they had some down time, often at the end of the day. Therefore, this was when they would reflect on their smoking behaviour throughout the day and input their data (e.g., cravings, smokes). Because of this pattern in app use, young adults described frustration with how the app was built only for real-time input, rendering trends in their smoking behaviour to be inaccurately displayed in the app:

> But the thing that was a major downfall to me, is you could not add previous cigarettes. Like if I didn't have my cell on me when I had one, I couldn't add it later really. So it's kind of a big deal 'cause my phone's not on me all the time. But what I would do if I didn't have my phone and I had a few, I'd count them and add them later but then the app would think I like just smoked [a bunch of] cigarettes or something you know? (female, smoker, P14)

***Mapping smoking behaviour***

When referring to the map function in the app, intended to geographically map out where they smoke or have a craving, young adults said that they did not see this as helpful or relevant. They explained that geography in and of itself is not a trigger and that their smoking triggers are situational. In this regard, they thought that being able to map out where they smoke the most/least is irrelevant:

> For me, it's definitely not geographic triggers that make me wanna smoke. It's more like…like day-to-day triggers of either stress, or commuting traffic, and like bad news. You get bad news broken on you or you had a bad day it's like, yeah I'd be more tempted to pick up that cigarette. Those type of things. More than the, oh like I'm located at 24 Sussex here and, I have a temptation. (male, smoker, P3)

In addition, young adults expressed concern about draining their cell phone battery from turning their GPS on in order for the map function to work. The feature was also incompatible with their general practice of keeping their GPS off to avoid others "watching" them:

> No, I don't like turning GPS on for apps and stuff because you never know who's stealing your information and location and things like that. I dunno, I'm always paranoid with iPhones. (female, smoker, P2)

> No, I'm slightly distrusting with that kind of stuff. Like it's a good idea. I just have reservations about GPS in general. Like for instance, I don't have, say Facebook, my GPS is disabled for that as well. So it's not specifically a distrust in the app, which I thought was great, it's more of just in general, I don't practice that. (male, nonsmoker, P29)

When asked if the map feature could be modified to serve as an early warning system (versus just displaying where they smoke more or less), whereby messages would automatically

be sent to the user based on vulnerable contexts (e.g., GPS indicates that you are at a bar), young adults said that they would still not use this function. They described this as being "creepy", "stalkerish", "nagging", and, for men, was perceived as challenging their capacity to be in control: "If I want to smoke, I am going to smoke."(P6)

***Journaling about smoking behaviour***

Journaling, whereby young adults could investigate their behaviour at a deeper level than simply documenting the number of cravings and cigarettes smoked, was afforded through the feedback on triggers function. In relation to this aspect of the app, young men were adamant that the triggers function lacked benefit because they smoked when they chose to smoke, not because they are being triggered:

> I honestly don't think that a lot of people really think that much about it there. If I go for a cigarette at work it's just 'cause I wanna take a break. You know, it has nothing to do with, oh I need to go for a cigarette at this time because this is my daily routine, or like somebody pissed me off at work or whatever it is. It's just like yeah, I got off a half hour phone call, I feel like taking a break right now so I'm gonna go take a break. (male, smoker, P7)

Since they already knew what prompted them to smoke, recording their triggers was perceived as unhelpful:

> No. I would just put the craving in but the triggers, my main triggers were coffee, which I have quite a few a day, friends, drinking, after a meal.. It's the first thing I wanna do. (male, smoker, P4)

Young women, however, described how journaling through the feedback on triggers function lent to a more proactive approach towards cravings. They could anticipate when and

where they would have a craving and would implement measures to prevent smoking in these particular situations:

> I loved…how you could go in and track what your triggers were so I could actually start to notice my triggers and stay away from them. I'm craving when I'm with friends drinking, or you know, my son's acting up, and stuff like that. So I could see what was actually causing me to want to smoke and I could actually try and change them. [For example], it was my friend's birthday party and I knew we were all going to be in the same house and she smokes in her house. So I had to come prepared. I brought gum, I brought mints, I brought everything I could think of because that was one of my main times when I smoke a lot…when I'm drinking. (female, smoker, P25)

***Status quo cessation support***

The information pages and online resources listed in the app afforded young adults the status quo—describing these features as the same information presented in typical tobacco control messaging. Many young adults expressed fatigue with this information, particularly because it was perceived to encompass the message that smoking is bad for them and that they should quit smoking:

> I found the little section where it kinda gave you the websites to go and get information on it and stuff—I felt kind of like that's preached everywhere you go; that you're quitting smoking, check out this website, or read that booklet and da, da, da, da, da. Like most people that smoke know that smoking's bad for you. But they just kind of think, whatever, I'm still gonna smoke, I like to smoke, or I wanna smoke. And they do it anyways. It's always the same type of stuff I find. It's…nothing that you haven't really

> heard before in one way another. So that's the only thing I found that wasn't great about it [app]. (female, smoker, P26)

Young adults also thought that the information was too general (versus personalized) and as s a result, the information was perceived to lack authority and relevance.

***Counselling through cravings***

The access to quitline counselling through the app was conceptualized by the app users as a last resort. Although most indicated they would not likely use counselling, this feature was described as "nice to have" in the app in the event that they "really" needed it:

> I didn't personally call them but it was just—I think it was more of just knowing that like, if at any time, if I didn't have someone to talk to or if there wasn't a feature on the app that I could use, it was kind of like in my back pocket right? Like if I absolutely 100% needed to make a call, I could. (male, nonsmoker, P17)

> There was one time I actually was gonna call but then I got over my craving. I definitely think that is a good aspect to have in the app—a button right there saying that you can call them in the case of an emergency, yeah. (female, nonsmoker, P19)

Despite comfort in knowing quitline counselling was available, actual use of the quitline was associated with discomfort. Many stated that they did not want to get on the phone with someone they didn't know. The few who actually did consult with the quitline, spoke despairingly about their experience. While it did help them overcome their craving, one young women (smoker) stated it made her "feel like an addict" while a young man (non-smoker) complained about being "warned about how bad smoking is for you".

***Interruption of habit***

The craving distractions in the app afforded young adults an interruption of their smoking

habit in that it entertained them during moments of boredom, a time when they would often associate with smoking; thereby, preventing them from smoking. While there were several types of distractions in the app (games, videos, music, social media), young adults preferred games because they "kept their hands busy". In relation to the other distractions (YouTube videos, music, young adults often explained that music and videos did not "keep their hands busy", which left their hands available to hold a cigarette and smoke while they watched a video or listened to music.

***Weaning from smoking***

Although most young adults chose to quit cold turkey (particularly young men), there were a few who chose to use the quit plan laid out in the app. However, the weaning afforded via the quit plan was primarily described as something that promoted procrastination in relation to becoming smokefree:

> For me at least, setting something two weeks in advance, it's like you're preparing, and you end up buying a pack and saying this'll be my last pack, and then it's just like you kind of buy more and more. (female, smoker, P30)
>
> You know, I buy the pack at 11 in the morning and there I am at midnight with an empty pack in my hand. Well dammit, I did it again! So, the cutting down thing, it never worked for me. And I do remember it being like, so you had 15 today, try and smoke only 14 today. Well here, I had 16, that's kinda close right? And yeah it's kind of a—I almost find that those things are counterproductive because, when you're saying like, cut back, cut back, cut back, yeah okay, but you're actually making it worse because now you're forcing yourself to go a little longer with the crave. What I found is, I go an extra

three hours without smoking, I really, really want that next cigarette. (male, nonsmoker, P27)

Young adults who chose to quit cold turkey stated that they avoided the quit plan for the same reasons:

I actually think that that's [quitting abruptly] the way that it has to be done….Like it's almost like exercising and diet. You can't say you're gonna start next week. It's really like right now or never…. Like that's one thing that I think was the flaw in CTC. (female, smoker, P28).

Some young women who chose to go by the quit plan in the app said that they found comfort in knowing that they had a plan and that they could quit slowly. The thought of quitting cold turkey was often overwhelming for them:

It's nice to know that it's not gonna just cut you off, which is big for me because…being cut off completely is like, grrr, being cut off completely is scary. So being able to cut down gradually is easier because then you can get used to the, okay, well I'm only on one a day or two a day or whatever right. (female, smoker, P12)

Some young adults who tried the quit plan found that it was too rigid and expressed feeling bound by a plan that did not account for the unpredictability that comes with quitting. Young adults expressed a desire for more flexibility when it came to the quit plan:

There should be the ability to extend the deadline or change your quit date….Like if you're having a really hard time or a really bad day, and you pick up a cigarette and before you know it you've smoked like half a pack. And then you're like, oh no, I've just, you know, given up on my quit date, which is in a week. Like some people might be

discouraged by the quit date is what I'm trying to say. It might work against the app in some cases. (male, smoker, P3)

Young men frequently lamented the rigidity of the quit plan in the app because they felt that the app was determining their quitting efforts and, thereby, undermining their efforts to take control of their cessation:

> Yeah, I guess what I was trying to say was that I just wanted more control over being able to quit when I wanted….I just felt really vulnerable and I wanted like the most control as I could, and so even you know, not being able to switch my quit date just made it like okay well. I guess that's actually what happened. I wanted to quit in a week when I downloaded the app and then it said that you need to quit in two weeks. (male, nonsmoker, P20)

There were a few exceptions to this pattern. A few men appreciated the rigidity of the quit plan explaining that it actually helped them continue to mobilize their quit smoking efforts:

> Well, definitely having a date in mind…a hardcore date is helpful because, you know, as being humans, we are really good at procrastinating. So if you were to just say, "Oh you know I'm gonna quit soon, you know," soon can last years. So having an actual date set made me very aware that the end of my smoking was coming close and that…it's an actual date now so. (male, smoker, P10)

## Dialogue support

The dialogue support design component relates to aspects of the app that aimed to positively reinforce young adults' decision to quit smoking. Interviews with young adults revealed that, overall, the dialogue support features lent to positive experiences by young adults as they engaged in quitting smoking. These experiences were the result of the following

affordances that underpin the dialogue support features: *app reminding*, *personalized reminding*, *recognition of ability*, and *visibility of progress.*

***App reminding***

Reminders about quit smoking progress and the benefits of quitting, afforded via the push notifications, was described by most users as a source of irritation because every app now has push notifications. To avoid having to "swipe away" all the time to keep their phone "clean" some users simply turned off the notifications feature.

> I completely ignored them. Actually, I'm pretty sure I had the notifications that were from the app all turned off. It just felt like a pop up, like another thing for me to click close on throughout the day. I completely paid no attention to it. (male, nonsmoker, P10)

Reminding via the push notifications was well-received by a few young men but not young women. Several young men asserted that the notifications helped to keep them motivated in relation to their quit smoking goals. One young man likened them to a girlfriend trying to help him stay on track:

> I found it was almost like having my girlfriend there, in a good way. So you're like, oh I haven't done this in two days, I didn't even realize, but my phone just reminded me. Better keep it going. (male, smoker, P3)

Other young men took a more independent stance and explained that they did not "need" reminding:

> Once I put mind to something and I have some kind of motivation and I actually want to do it, I usually just do it. I don't need reminding or notifications and stuff like that. (male, nonsmoker, P5)

***Personalized reminding***

Reminders of personal motivations to quit were afforded via the personalization functions in the app (e.g., providing users with the option to upload personal photos and quotes to motivate them in their smokefree efforts). Young women found this method of reminding as motivational. Young men, however, described a general disinterest in customizing apps, and technological platforms in general. Instead, their concern related to the utility of the app in supporting their quit efforts: "I don't really customize…I just use it for what it's used for" (male, smoker, P21).

***Recognition of ability***

Many young adults found that the awards offered through the app afforded them recognition of their quit smoking efforts, which was described as a "confidence boost". The receipt of an award affirmed that they were able to reach quit smoking milestones and essentially enhanced their confidence in accomplishing their ultimate goal of quitting smoking:

> It was just a reminder just to say like how good you're doing. And if there's nobody physically around you to be like, oh you're doing such a great job, then [the app] did it for you. Like yeah, keep up the good work, you've been this many days without a craving or whatever else. It was kinda like a motivational boost. (female, smoker, P11)

***Self-competition***

Young adults also said that the awards afforded them competition with themselves by giving them goals to work towards. The progressive nature of the awards (e.g., awards for incremental increases in lung health vs. an award when lung is at status of non-smoker), not only lent to affirmation that they did and can reach their quit smoking goals, but also helped them stay motivated to continue towards their smokefree goal:

> I liked the goals. It's like, hey your heart is this much better now….It was just like, oh if I keep going for this amount of time, it'll be this much better. (male, smoker, P24)

***Visibility of quit efforts***

Young adults described the visibility of their quit smoking efforts via the progress page in the app, whereby a graph displays cravings and cigarettes smoked month to month, week to week, day to day, and hour by hour, as motivational. Seeing a decrease in their cravings and smoking was an incentive to keep going:

> It was like a visual of my day of smoking. And every day, you'd look at it, it went down and down and down, like it got better every day. So it was like a motivational thing to just look, like positive reinforcement. (female, smoker, P11)

On the other hand, however, a few young women and men, particularly women, experienced discouragement and guilt on seeing this page when they were not making steady progress:

> If you're having a bad day or a couple of bad days, seeing it on paper as a reflection [of your bad days] just like kicks you in the face even more, you know? (female, smoker, P22).

Young adults also said that the visibility of their day-to-day smoking trends on the progress page lent to postponing smoking; thereby, breaking their usual patterns of smoking behaviour:

> Sometimes, when I would be at work, and it's like, it was a stressful day, I would go on the app and remind myself, ok, I already had this many [cigarettes] today so I should probably hold off for a little while longer before I go and have another one to relieve my stress from work. So I would kinda go on it to remind myself that alright, I have already had like 10 cigarettes today so I don't want to push my limit any further. So I would just

kind of distract myself and remind myself that I have already had so many. (female, smoker, P16)

## Summary

In this Chapter, the experienced affordances of CTC among young adults were presented. This Chapter showcased how the various functions and features within the app lent to particular outcomes among young adults, including their experiences and changes in behaviour. The intended affordances and expected outcomes were presented for each design component of CTC: credibility, social support, task support, and dialogue support. Differences in conversations between young women and men were highlighted.

# CHAPTER 7 – DISCUSSION: COMPARISON OF KEY INFORMANT AND YOUNG ADULT FINDINGS

The purpose of this study was to improve understandings of how the interaction between young adults and the Crush the Crave (CTC) app influences young adults' smoking cessation efforts. This is one of the first studies to qualitatively investigate both development intentions and user experiences of a smoking cessation app. In describing key informants' perspectives on the strengths and limitations of the app and the design intentions of the app, expectations for the app and its use by young adults are illuminated. These findings provide the opportunity to juxtapose key informants' design expectations with young adults' perspectives and experiences in using the app for quitting smoking. Findings from interviews with young adults detail their perceptions of the positive and negative features of the intervention, and provide a detailed description of the experienced mechanisms within the app that influenced quit smoking experiences. While young adults' interactions with the app often aligned with key informants' expectations, there were some notable differences. In this Chapter, the findings where there were important discrepancies between key informants' intentions and young adult experiences will be discussed to provide support for the value of the present study's approach to the revelation of gaps, as well as insights into productive and unproductive approaches in the development of eHealth interventions. Through this discussion, the study's contributions to the field and future app development will be highlighted. This Chapter will then be followed by a discussion of the significance of employing a critical realist sociomateriality theory and affordances approach, as well as a gender-based analysis in the present study.

### Overarching issues in the app development processes

Despite the best intentions of developers and the involvement of end-users, two overarching issues were uncovered that directly translated into challenging user experiences with the app. The first notable issue was in relation to the development of CTC. Although CTC was designed and developed with input from young adult focus groups, the findings of the study reveal major gaps between the developers' program expectations and the actual experiences of the end-users. Apart from one pilot test run with end-users, engagement with end-users primarily consisted of pre-intervention focus groups. This raises questions about the value in relying primarily on pre-intervention focus groups in the development of ehealth interventions. Recent research has detailed the problematic position of end-users in the development of eHealth interventions—they are often peripheral stakeholders that have marginal engagement during the development (van Gemert-Pijnen et al., 2011), which was the case for CTC. Others have argued that positioning end-users in this way has the potential to lead to a mismatch between technologies and end-users daily lives, habits, and rituals (van Gemert-Pijnen et al.), lending to usability problems and high attrition rates (Baker et al., 2014; Birnbaum et al., 2015; Lupton, 2013). The findings of this study provide further support for these concerns. For example, many young adults complained about technology glitches (e.g., freezing) and the lack of intuitive design (e.g., features and functions were not easily accessed or located). Users often cited these issues as contributing to their disinterest and eventual disengagement with the app.

Secondly, while interviews with key informants revealed a commitment to incorporating functions and features that aligned with best practice guidelines for tobacco dependence (Fiore, 2008), the implementation of these guidelines into the app were often amiss in terms of effectively helping young adults in their quit efforts. This misalignment was evident with the use

of social media, a quit buddy, and leaderboard for social support, and designing the app for gradual quitting through a quit plan. These findings raise questions about how to implement best practice guidelines designed for application in clinic settings in the mobile context, as well as whether best practice guidelines need to be reassessed, particularly in relation to supporting cessation among young adult smokers.

In addition to these general issues, when findings from key informant and young adult interviews are compared in relation to each of the four design components in the app—social support, task support, dialogue support, and credibility, further insights to guide future app development are evident. In particular, areas of significant departure between developers and end-users are highlighted and discussed considering relevant research to bridge the gap between intervention development and user needs.

## Social support and CTC

The most significant difference between key informant findings and young adult findings relates to the social support design component. Even though key informants expected that the social support component would be the strongest aspect of the app because it was delivered via social media channels popular among this age demographic, from an end-user perspective, this was the weakest aspect of the app, playing out in young adults' lack of engagement with the social support functions and features. Interviews with young adults revealed that this was not because they did not need or want social support, but that the ways in which it was provided in the app did not align with their needs and preferences. While it is well documented that social support is a predictor of smoking cessation and is included in best practice guidelines for smoking cessation (Fiore, 2008), this finding raises some important questions in relation to how social support is incorporated into online-based smoking cessation interventions, such as: What

are barriers to social support in these contexts? How and from whom/what do young adults want to receive support through these media? Drawing on existing literature, the following discussion of the findings regarding the social support design component of CTC serves as a starting point in answering these questions.

Preservation of and efforts to promote a positive self-presentation pervaded young adults' discussions in relation to features and functions situated in the social support design component of the app. Before major technological developments, such as the computer and smartphone, people were concerned with their social image and strategies for promoting a positive presentation of self (Goffman, 1959). In the current era, the growth of such technologies has had a major influence on such social endeavors (Nadkarni & Hofmann, 2012), which is consistent with the ways in which young adults described using/not using social media for interacting with others about their quit smoking efforts. The use of a public social media platform (the CTC Facebook page) and their own personal Facebook page to engage others about their quit smoking efforts conflicted with their efforts to preserve a positive presentation of self. This resulted in identity protection practices, including avoidance of posting, lurking, or selective posting, which was in stark contrast to key informants' expectations for the development of a sense of community among the users through social interaction made available on these platforms. This is in keeping with literature describing health communication on social media as at odds with the need to present oneself as a positive, appealing member of the community (Newman et al., 2011; Bareket-Bojmel et al., 2016). According to researchers who examined self-presentation strategies employed by young adults on Facebook (Bareket-Bojmel et al.), this platform is widely used to enhance one's self-presentation vs. derogate oneself (e.g., presenting struggles or negative events). Interestingly, however, Bereket-Bojmel and colleagues found that those who did engage

in self-derogation were rewarded with social network support (demonstrated through increased numbers of likes and comments). In a study that examined outcomes of positive vs. honest presentation on Facebook, it was found that honest self-presentation had an indirect effect on well-being through perceived social support (Kim & Lee, 2010). Despite that Facebook has shown to be an effective channel for receiving support, the findings of the present study align with the general practices of presenting enhanced (versus honest) identities on social media, rendering these channels as a challenging medium in which to provide opportunities for social support in the context of smoking cessation.

The influence of normative pressures also appeared to be a factor in young adults' avoidance of the social support functions. Young adults frequently described talking about smoking and quitting as at odds with the non-smoking social norm manifested through their proximal and distal networks, smokefree policies, and non-smoking community cultures. Because of these normative pressures, many participants stated that their networks were often unaware of their smoking status in the first place and they were, therefore, reluctant to harness support from them. In this regard, social norms, although found to be beneficial for influencing young adults' desire to quit, appeared to influence young adults' efforts to quit on their own rather than harness support. While researchers suggest that denormalizing smoking through social, physical, and symbolic environments positively influences quit intentions (Mead et al., 2014), the findings of this study highlight how social norms may serve as a barrier to harnessing social support, a documented predictor of health behaviour change (Burns et al., 2014). Tobacco control initiatives propel and contribute to the denormalization of smoking and the tobacco control community is beginning to recognize that they subsequently stigmatize smokers (Burgess et al., 2009; Wigginton et al., 2012), leading to decreases in social support, self-efficacy, self-

esteem, and increases in stress (Gilbert, 2005). In this way, denormalizing smoking may serve to inhibit actual health behaviour change.

The quit buddy function, another social support aspect that developers integrated into the app based on evidence-based research, was also unsuccessful. Whilst key informants anticipated that social interaction provided through a quit buddy was a simple solution to providing young adults with support from their personal networks, young adults cited issues with finding someone who was also wanting to quit at the same time, already having an established support network, and discomfort in harnessing support through a quit buddy, which related to feeling like they would be "bugging" someone or would be inviting negative judgement as they engaged in quitting smoking. A recent evaluation of a text messaging-based intervention for young adults that included a quit buddy component (quit buddy was another intervention participant) revealed that it also didn't work for the same reasons (Ybarra et al., 2014). Users reported problems with their buddy's availability, including being in different stages of the quitting process, different schedules or in different time zones, already having established support, or being uncomfortable with the idea of a quit buddy (Ybarra et al.). While evidence suggests that a buddy system works well in the context of a smokers' clinic (May & West, 2000), this study's findings add to emerging evidence that a buddy system has yet to effectively translate in the context of mobile cessation interventions.

Young adults often reported the app itself as their source of social support and that the positive app reminders and recognition provided through the awards was enough support for them to be encouraged in their quit smoking goals. This finding indicates the potential value and strength that mobile health cessation interventions have for helping young adults quit smoking. While there is much focus in sending young adults off to harness social support, findings from

this study shed light on how social support was inadvertently embedded in features that afforded reminding and recognition. Functions that afford users reminders and recognition present as an opportunity to augment young adults' social support, as well as circumnavigate self-presentation issues. With smartphone technologies becoming more intelligent, these affordances could be enhanced in ways like never before (e.g., virtual supporter in the app).

### Task support and CTC

Another key difference between findings from key informants and findings from young adults relates to the ways in which young adults approached quitting. Although the app was designed to support gradual quitting, intended to afford young adults the opportunity to wean from smoking prior to the identified quit date, young adults in this study primarily opted to quit abruptly on their quit date without any prior reductions in smoking. Even those who started with the gradual quitting at first, changed to quitting abruptly. This finding complements Ubhi and colleagues (2016c) insights, who found that most participants opted to quit on the date of their registration versus planning and preparing for a future quit date. Despite thinking that the preparation involved in gradual quitting would result in better quit outcomes, there is increasing evidence that quitting abruptly is superior to gradual quitting (Cheong, Yong, & Borland, 2007; Ferriera & Steinberg; West & Sohal, 2006).

Some young adults explained that their hectic lives were not amenable to quitting gradually, citing the common presence of stressors in their day-to-day lives. This finding reveals a possible connection between young adults' life stage, which is characterized by considerable change and instability (Arnett et al., 2000), and their approach to quitting smoking abruptly. Young adult smoking patterns are also influenced by significant life transitions (e.g., evolving social networks, living arrangements, school or work settings) (Hammond, 2005). Throughout

these life changes, tobacco use may either be rejected or become an established habit (Biener & Albers, 2004). Because quitting gradually does not typically account for the stresses and context of change and often instability that are characteristic of young adulthood, in some regards, promoting quitting gradually may actually set many young adults up for failure, which holds the potential to inadvertently influence young adults to "give up" on quitting. In light of evidence that quitting abruptly is more likely to result in success compared to gradual quitting, that young adults specifically prefer this approach reveals an evidence-based approach to quitting that ought to be capitalized on for young adult smokers. Future developers of cessation apps for young adults should therefore include an option for quitting abruptly on their selected quit date and work with end-users to identify tools and resources to support this approach to quitting.

According to key informants, requiring end-users to be diligent in entering their smoking behaviour data for tracking purposes was a pitfall of the app. While young adults did find certain data entry to be tedious (e.g., documenting when they smoked), they also asserted that they didn't want the app to "take over" control of their behaviour change efforts. In fact, often, where key informants thought that the app wasn't doing enough (e.g., it didn't provide early warning reminding based on geotagging), young adults thought that it was more than enough and often too much (e.g., young adults didn't want early warnings based on context) because it made them feel a loss of control or nagged. While there is much excitement about transitioning from passive to active interventions using smartphone technologies, these findings indicate that it is important to remember that active interventions are characterized by the users' participation in the intervention for health behaviour change (Kennedy et al., 2012). It has been stressed in the literature that users should feel in control of the intervention (e.g., Gibbons et al., 2009). While smartphone apps are smarter than ever and can learn, automate, and respond to users without

their input, the findings of this study reinforce that the push-pull nature required of these interventions (Kennedy et al.) must be carefully considered when incorporating tracking and reminding in mobile-based cessation interventions.

In relation to affording users visibility of the health benefits of quitting smoking, key informants hoped that this would result in motivating young adults in their quit smoking efforts. However, young adults suggested that the primary outcome of this visibility was that their views about the relationship between health and smoking were challenged. Young adults described how "seeing" their health improvements displayed on the "health calculators" page made them realize that their health was indeed being negatively impacted by smoking, something that they didn't previously acknowledge. Both past and recent research has captured the issue of "optimistic bias" in relation to health among young adult smokers. For example, in an evaluation of the potential use of health-related factors to motivate smoking cessation among college students, it was found that almost half of smokers thought that their health was better or the same as their non-smoking counterparts (Prokhorov et al., 2003). In addition, almost all of the smokers did not think that their health was affected by smoking, and nearly half thought that quitting would bring little to no benefit to their health (Prokhorov et al.). More recently, an examination of the optimistic bias in risk perception and health-related behaviours for cancer, respiratory disorders and cardiovascular diseases among young adults revealed that young adult smokers demonstrated optimistic bias towards all three health risks (Masiero et al., 2016). A qualitative study investigating how young adults initiate smoking also revealed an optimistic bias in that young adults interviewed could not recall the health risks of smoking, struggled to assess the likelihood of developing health problems from smoking, and rarely saw health risks as personally relevant, often citing the tobacco industry's argument that the role of smoking in

disease could not be easily delineated (Gray et al., 2016). The findings of the current study reveal how affording visibility in relation to the health impacts of smoking and benefits of quitting is a breakthrough accomplishment of mobile-based interventions in young adult smoking cessation, and smoking cessation in general, and may indirectly enhance motivation for cessation.

### Dialogue support and CTC

There were also important differences in key informant and young adult findings related to the dialogue support component of the app. The aim of this aspect of the app was to motivate young adults in their quit smoking efforts. One way that key informants tried to motivate young adults was by affording users with competition through the awards (motivation through achievement) and leaderboards (motivation through comparison). Experiences of motivation among young adults, however, were varied, with the awards primarily associated with motivation and the leaderboard primarily associated with discouragement. These findings bring attention to key informants' focus on motivation as the primary outcome of competition within a smoking cessation app. While motivating behaviour change through points, statistics, and badges are an important element of gamification features, the literature indicates this is only one of three important elements of gamification for health behaviour change (Lister et al., 2014). In addition to motivation, capability and behavioural triggers must also be considered and integrated into gamification features (e.g., through problem solving, storytelling, and fantasy (Ferrara et al., 2013). Given that quitting smoking is a process known to frequently encompass struggles and relapse (Hughes et al., 2014), the importance of enhancing one's ability (self-efficacy) and awareness of smoking triggers is brought forward. Unless an individual is on a straightforward success trajectory, which is seldom the case, it is possible to see how a sole focus on motivation is unreliable for positively influencing smoking cessation through gamification. This is

consistent with recent research indicating that an exclusive focus on points, rewards, leaderboards, or badges to strengthen motivation has an unreliable impact on behaviour change (Lister et al., 2014). The findings of this study extend knowledge in this area by highlighting how the nature of quitting smoking is particularly ill-fitted for a sole focus on motivation, and how this may result in the integration of functions that not only discourage/demotivate health behaviour change, but may reinforce low-efficacy (in this case, the leaderboard).

### Credibility and CTC

Positive framing of the app and its content appeared to play an important role in uptake and use of the app. Despite some key informants concerns about uptake, young adults described how the apps focus on the benefits of quitting versus the consequences of smoking largely influenced their desire to download and use the app. Given traditional approaches that frequently played on fear (e.g., pictures of negative health consequences on cigarette packs), guilt (e.g., neonatal health consequences), or judgement (Jung & Villegas, 2011), young adults welcomed the positive and encouraging nature of the app. In the debate between positive and negative framing of content for tobacco control efforts, the findings of this study extend existing evidence that positive message framing resonates with smokers (Moorman & van den Putte, 2008; Yang, 2013) and specifically resonates with the young adult population (Mays et al., 2015).

### Summary

In this Chapter, findings where there were important discrepancies between key informant interviews and young adult interviews were discussed. Highlighted are significant differences found in relation to the key informants' expectations and young adults' experiences in relation to each design component of the app: social support, task support, dialogue support, and credibility. Given the rich findings of this study, particularly in relation to some of the stark

differences found between key informants and young adults, the inclusion of multiple perspectives is a much-needed addition to the eHealth literature. By gathering the viewpoints of key informants, both problematic and effective approaches that underlie development goals were revealed, and may now be addressed. Indeed, by harnessing data from both key informants and young adults, the findings of this study can advance the development and implementation of eHealth interventions, holding great promise to improve their uptake and impact compared to their current overall status, which is often poor or undecided (Baker et al., 2014; Black et al., 2011; van Gemert-Pijnen et al., 2011). It must be noted that most smoking cessation apps encompass a goal of reaching as many people as possible, with a focus on reach. It is evident in the findings, however, that context plays an important role in the uptake, use, and effect of these interventions. Rather than supporting the ongoing "one size fits all" approach, the findings provide a starting point for articulating contextual factors that ought to be considered in the design of smoking cessation apps for young adult women and men. Given recent promising innovations with respect to tailored and context-sensitive approaches to smoking cessation in the broader eHealth arena (e.g., Bottorff et al., 2016; Haines-Saah et al., 2015; Schwartz et al., 2014), these approaches ought to be considered in mobile-based smoking cessation interventions to promote better uptake, use, and outcomes.

In the following Chapter, the use of a critical realist sociomateraility theory and an affordances approach in this study will be discussed. The contributions of employing this theory in the study's methodology are thus presented. As well, significant findings in relation to gender will be discussed, revealing the benefits of including a gender-based lens in eHealth research.

# CHAPTER 8 – DISCUSSION: METHODOLOGY, RECOMMENDATIONS AND CONCLUSIONS

In this Chapter, the value of the theoretical underpinnings of the study are discussed in relation to study findings, namely the use of a critical realist sociomateriality theory and the affordances approach to understand human-technology interactions for health behaviour change, as well as the use of a gender-based analysis. This will be followed by recommendations for practices in the development of mobile apps, and recommendations for future research. The Chapter concludes with a description of the study's limitations.

## Role of sociomateriality theory and an affordances approach

The gaps in knowledge in relation to the underlying mechanisms of mobile-based health interventions, particularly in the area of tobacco control, are what motivated the use of sociomateriality theory and an affordances approach. While the use of sociomateriality theory and an affordances approach is a relatively novel approach to mobile health research, its use in examining Crush the Crave (CTC) enabled a detailed understanding of the underlying mechanisms (affordances) of the sociomaterial relationship (CTC app-young adult) that influenced young adults' quit smoking efforts. Researchers have described this knowledge as a "black box" because most eHealth evaluations are focused on outcomes rather than the underlying factors and mechanisms (Brendryen, Kraft, & Schaalma, 2010; Brindal, 2016; Danaher et al., 2015; Strecher, 2008). As demonstrated in the findings of this study, the specificity and depth that such an approach provides is of utmost value for understanding how to move these interventions forward. This is because the underlying mechanisms of these interventions that lend to both positive and negative experiences and practices in relation to health behaviour change are brought forward—articulating practical and tangible ways in which

these interventions may be modified to strengthen effectiveness and be scaled up. In relation to CTC, productive affordances can be capitalized upon to enhance uptake and impact (e.g., visibility of quit smoking benefits, recognition of user efforts, reminding of users' progress), and unintentionally harmful affordances/constraints of these interventions can be addressed (e.g., developing CTC for gradual quitting). In short, the use of sociomateriality theory and an affordances approach removes a lot of guess-work in relation to linking up user experiences and practices to improvements in an eHealth intervention.

The findings of this study support the specific use of critical realist sociomateriality theory. As previously stated, the sociomaterial is when the materiality of a tool, such as its functions, meld together with the social, which were separate entities until they came into relationship (Leonardi, 2013). From a critical realist stance, this relationship and the resultant affordances are dependent on context. Context influences the types of affordances experienced and also whether the functions afford or constrain action. This was strongly demonstrated in the findings. For example, in relation to the social support functions, today's social media combined with social norms and the needs of young adults lent to a constraint on young adults' ability to protect their identity and, therefore, engagement with the social support functions were rarely used. Put in a different context (e.g., different point in time, different demographic, etc.) the affordances and/or constraints of the social support components might have looked different. In addition, differences in findings between young women and men highlight how contextual factors influence the types of affordances (constraints) experienced and the impacts of these affordances.

The use of critical realist sociomateriality theory in this study also provides a foundation for supporting sustainability of evidence-informed smoking cessation smartphone apps, such as

CTC. The issue of sustainability of eHealth innovations remains an ongoing issue, with many eHealth interventions unable to demonstrate sustainability beyond the pilot phase (van Dyk, 2014). One important way to support sustainability of eHealth interventions is through evaluating these interventions to determine their effect and where improvements can be made, a key component that remains lacking (Dennison et al., 2013). In addition to quantitative research evaluating the efficacy of CTC (Baskerville et al., 2015), this study contributes explanations for the effects and practical suggestions for improving the app. By focusing on affordances (action possibilities that result from imbrication between an app and a population) rather than on the app's features, aspects that support smoking cessation via an mHealth approach are highlighted. In other words, the success of an app does not lie in the features in and of themselves but in the potential action possibilities that the features and functions embody for health behaviour change. An affordances approach reveals which action possibilities of an intervention have the most positive effect in relation to ongoing user engagement, user appeal, and the target behaviour change. Once productive affordances are identified, then features and functions can be designed to capitalize on these affordances. Indeed, the productive affordances revealed in this study may serve as a framework for improvement of existing smoking cessation apps, and development of future apps.

## Gender-related influences

CTC was designed to be "gender-neutral". A gender-neutral approach in cessation interventions aligns with the rather gender neutral and/or gender blind approach to cessation in best practice frameworks and guidelines for treating tobacco dependence (Fiore, 2008; WHO, 2003). Researchers have raised concerns about the lack of attention to gender in cessation interventions given evidence that gender-related factors play a significant role in tobacco use

(Bottorff et al., 2014; Pederson, Greaves, & Poole, 2014). For example, men have a long history with tobacco use and dependence that has been linked to gender-related factors including masculinities and gender roles. Similarly, gender-related factors have been implicated in women's smoking, with femininities and attractiveness associated with women's smoking and gendered factors such as concern for weight gain contributing to smoking maintenance (Alexander et al., 2010).

Furthermore, a gender-neutral approach puts emphasis on the end-goal (quitting among young adults), ignoring gender-related factors that may limit ones' ability to quit smoking. For example, oftentimes, young women have been reported to take up and maintain smoking/substance use to cope with current trauma or past trauma (e.g., domestic violence) (Greaves et al., 2011). Given reports that 1 in 3 women experience trauma (WHO, 2016), a gender-neutral approach fails to account for and address this issue, and other gender-based issues. Along this vein, discourses in relation to gender roles and norms (e.g., women are responsible for their personal and familial health) may be reinforced through a gender-neutral approach because gender-related diversity and difference issues remain ignored and unaddressed. It is naïve to focus on the end-goal (in this case, smoking cessation) and not account for established factors that may prevent one achieving important health behaviour changes, like quitting smoking.

Interviews with young women and men revealed some notable gender-related findings. For example, women were more likely to harness support from others compared to men, which is commensurate with reports that women identify social support as important for helping them quit smoking (Chaney et al., 2015). However, who young women want support from needs to be considered. In line with previous research (Chamberlain et al., 2013), women using CTC usually

assigned a spouse or partner as their primary source of social support (e.g., quit buddy), and positioned them as gatekeepers in that they were a conduit to accessing cigarettes. This raises concerns about the potential for an imbalance in power in young women's relationships, problematic relationship dynamics and potential abuse, as well as ongoing poor coping mechanisms for women (e.g., continued smoking) (Chamberlain et al., 2013). This finding also raises concerns about the fact that very little effort has been made to investigate and put forward effective strategies for engaging a spouse/partner for smoking cessation (Park et al., 2004). These findings point to an urgent need to address women's need for social support, their preferred sources for social support, and how to navigate it in the context of mobile-based cessation interventions.

There were important differences in young women's and men's preferences in relation to affordances. Young women expressed an appreciation for affordances that helped them become more self-aware and develop new coping skills instead of smoking (e.g., journaling) and personal reminding about why they want to quit smoking. In contrast, most young men explained that they did not need reminding about why they should stop smoking, nor did they feel the need to journal about their smoking—they were in control and smoking was a choice. They often cited an appreciation for the app because it reinforced their preference and ability to quit on their own. In this way, many young men appeared to ascribe to heteronormative notions of masculinity in the way they approached smoking cessation and use of the app (e.g., men are tough, independent, etc.) (Galdas, Cheater, & Marshall, 2005). On a positive note, the app presents as a promising way to reach young men who smoke, a hard to reach population, because it aligns with these traditional notions of masculinity. On the other hand, however, that these traditional notions of what it means to be a man are reinforced via such interventions may prevent young men from

accessing and receiving support that they would otherwise benefit from and/or stigmatize young men who do need/harness additional support.

There were also some notable similarities in young men's and women's experiences with the app. First, although key informants expected that the dark aesthetics of the app would likely appeal more to young men than women, both young women and men alike did not like the aesthetics of the app, primarily due to the negative affect that it seemed to instigate. Both young men and women preferred aesthetics that stimulated a positive affect to align with the app content, as well as keep them positive about quitting smoking. This finding brings attention to emotional stimulation in relation to intervention design and its applicability to both women and men. Young men in this study expressed equal concern for the utility of the intervention, as well as the emotive nature of the intervention.

In addition, it is notable that, similar to young women, men experienced a perceptual shift in relation to the health impacts of smoking because of the information provided by the health calculators in the app. It is well documented in the literature that men tend to ignore health-related information compared to women, rendering them a hard to reach population for motivating positive health behaviour change (Creighton & Oliffe, 2010). This attitude towards health has been explained as reflecting alignment with heteronormative masculine ideals (e.g., men are strong, and not vulnerable) (Oliffe & Bottorff, 2006; Oliffe, Bottorff, & Sarbit, 2012). The "visibility" into personal health afforded via the data presented by health calculators, however, seemed to capture men's attention and interest in improving their health by offering objective measures by which men could track their progress. Perhaps this mirror into personal health plays into men's preferences for autonomy and self-monitoring, inadvertently influencing motivation to become smokefree. Mobilizing masculinities for positive health behaviour change

has recently become a focus in men's health research (e.g., Oliffe et al., 2009; Oliffe et al., 2012). While more research is needed, affording visibility of personal health statistics presents as a promising way to mobilize positive health practices in men via smartphone apps.

### Recommendations for practices in the development of apps

Researchers in eHealth have highlighted the need for and benefits of harnessing end-user perspectives during the design and development of eHealth behaviour interventions. For example, involving end-users has been shown to improve usability (Karat, 1994), prevents the inclusion of superfluous features (Kujala, 2003), and can be more economical in that money is not put into bad design aspects (Karat). However, what is lacking in the literature is how and when to engage end-users in eHealth intervention research. In relation to CTC, while initial development was informed by focus groups and then subsequently pilot-tested once prior to rolling out the app, several major pitfalls were encountered when young adults began to use the app. This raises questions about the appropriateness and effectiveness of the ways in which end-users were engaged during development of the app. Recently, eHealth researchers have begun to pay close attention to developmental requirements of health behaviour interventions so that these interventions can be more effectively developed and subsequently scaled up. In this vein, it has been suggested that multiple formative evaluations be conducted with end-users to test design assumptions and prototypes (van Gemert-Pijnen et al., 2011; Van Velsen et al., 2013). One way to address this need would be the inclusion of end-users on the development team in addition to conducting feature-level analyses based on log data (e.g., google analytics), such as that used by Heffner and colleagues (2015). These practical strategies will help address the need for more comprehensive and frequent end-user input, while also addressing issues in relation to time, resources and funding that are commonly associated with evaluating eHealth interventions.

The findings reveal that, while the integration of evidence-based research into an app is a good starting point, the ways in which this evidence is translated into eHealth interventions must be carefully considered. Despite that the functions in the app were informed by evidence-based research and best practice guidelines (Fiore, 2008), it was evident in this study that the delivery channel (in this case, an app), combined with the population (in this case, young adults), frequently challenged the successful uptake and impact of such functions. For example, while opportunities for social support have been articulated as an important aspect of smoking cessation interventions, the ways in which social support was integrated into the app did not suit a smoking cessation app for young adults. These findings highlight the need to identify appropriate strategies for implementing evidence-based research into online interventions that includes consideration for the needs of the target population.

The findings also point to the need to consider how the online/mobile context changes the applicability of evidence-based strategies in the best practice guidelines that worked well in traditional contexts (e.g., clinic, group counselling). In particular, the quit buddy concept did not seem to translate well in the app context, which is in keeping with other research findings (Ybarra et al., 2014). The inclusion of private online communities may be more effective for providing social support opportunities to young adults via these interventions, and there is research to support this. For example, studies have shown that private online cessation support groups, delivered via social media (e.g., Ramo et al., 2015) or as embedded forums within interventions (e.g., Richardson et al., 2013; Cantrell et al., 2016), have been successful in influencing positive cessation outcomes among young adults. Indeed, mobile-based interventions, such as CTC, bring forward a call to revisit and adapt best practice guidelines for the online context.

That young adults did not like the aesthetics of the app because it stimulated negative emotions, brings attention to the emotional side of user experience, something that has been neglected by researchers investigating human-technology interactions (Thuring & Mahlke, 2007). Thuring and Mahlke assert that researchers are primarily focused on effectiveness, efficiency and satisfaction at the neglect of other aspects, such as the aesthetics of system design and emotional experiences during system usage. In addition, researchers have found that the visual attractiveness of an app also influences perceived usability (Tractinsky, Katz, & Ikar, 2000; Thuring & Mahlke, 2007). It is urged, therefore, that future development practices in the area of mHealth foreground consideration of the aesthetics of apps alongside effectiveness and efficiency.

While existing constraints of eHealth interventions are highlighted in the findings, the benefits of using mobile technologies to deliver interventions are also highlighted because these technologies are ever-changing and advancing, offering new opportunities to engage users. For instance, tracking smoking behaviour was one of the most appealing aspects of using the CTC app. However, given that data input (e.g., documenting smoke and crave events) relied on young adults' diligence and memory, the presentation of accurate data on an individual's app page was often jeopardized, lending to frustration and disinterest in the app. This issue may be addressed through data entry opportunities via wearable technologies (e.g., smoking is picked up through hand to mouth motion). With wearable technology becoming increasingly more popular (Liamas, 2015), integrating such technology into a cessation app should be considered in future designs.

The findings also point to the need to address the ongoing "gender neutral" approach to smoking cessation interventions. Variations in the use of the app by young women and men, as well as important differences and similarities in their preferences for affordances could be

accommodated through a gender-sensitive approach when developing mobile-based smoking cessation interventions. Several researchers have made significant contributions to incorporating a gender-sensitive approach to online-based smoking cessation interventions. For example, Bottorff and colleagues (2016a) conducted focus groups with men who smoked or recently quit to inform the development of men-centered smoking cessation resources for men. The findings of the study led to the development of the QuitNow Men website, which included gender-sensitive strategies based on the findings from the focus groups, including positive messaging, connecting quitting smoking with positive masculinities, and showcasing men's testimonials about quitting (Bottorff et al., 2016a). A recent pilot study of this resource revealed QuitNow Men was an appealing resource and led 24% of men to become smokefree and 40% to significantly reduce their smoking (Bottorf et al., 2016b). Another example is the Supporting Tailored Approaches to Reducing Tobacco (START) project, which included the development and evaluation of gender- and Aboriginal-sensitive messages about the link between secondhand smoke and breast cancer risk (Richardson et al., 2013). A randomized controlled trial that evaluated non-smoking girls' responses to the messages revealed that, compared to a standard message, the tailored messages had a stronger influence on girls' knowledge and perceived risk of secondhand smoke exposure for breast cancer (Schwartz et al., 2014). Indeed, in keeping with the positive impacts of the above research, it is strongly recommended that mobile-based smoking cessation interventions be designed to address gender-related factors influencing smoking and quit efforts.

## Recommendations for future research

To date, there has been a primary reliance on quantitative research evidence for evaluating eHealth interventions. The rich findings as a result of harnessing young adults'

perspectives on the use of CTC have contextualized why certain aspects of the app worked well and others did not work well, and in doing so extend the results of the quantitatively focused evaluations of CTC (Baskerville et al., 2015). The importance of gaining knowledge about the implementation processes and experiences associated with interventions has been recognized (Brendryen, Kraft, & Schaalma, 2010; Brindal, 2016; Danaher et al., 2015; Strecher, 2008), and is supported by the findings in the present study. It is, therefore, recommended that future eHealth intervention research include multiple method designs that make use of qualitative research approaches. Given the multiple and various human, technological, and contextual factors that influence the potential success of eHealth interventions, the use of qualitative research approaches will help reveal contextual factors and underlying mechanisms that influence the uptake and impact these interventions, and help inform better intervention designs. It is also recommended that an affordances approach be incorporated into future qualitative research. Given that affordances are context-dependent, understanding affordances of interventions for different populations and contexts would help inform the development of optimal tools for various populations and contexts. Further exploration of gender-related factors in eHealth interventions is also recommended to identify where tailored approaches may be needed.

The findings of this study have also highlighted a need for research on how to effectively incorporate evidence-based guidelines for smoking cessation into eHealth interventions. For example, more research is needed on how to navigate barriers and strategies to harness and enhance engagement with social support features and functions in online cessation interventions. While review evidence suggests that social support is a positive aspect of interventions that make use of social media (Maher et al., 2014; Laranjo et al., 2015), there is a dearth of research that

has entailed an in-depth examination of contextual factors that influence access, provision, and receipt of social support through these interventions. A recent review by Balatsoukas and colleagues (2015) has shed some light on contextual factors that influence social support via online interventions, including peer pressure and information sharing. Future research should investigate in more depth contextual factors that inhibit and mobilize social support in eHealth interventions.

## Study limitations

Although the present study provides a rich account of developers' goals, end-user experiences, and explanations for those experiences through sociomateriality theory, there are some limitations of the study. Given that the intervention is an app, there were inherent limitations in observing and capturing young adults' interactions with the app in their everyday lives. In this regard, affordances/constraints that may exist but could not be captured during interviews with either samples, were not brought forward. Despite this limitation, however, it is believed that the comprehensive approach to data collection in this the current study helps address this issue. Also, given the characteristics of the sample of young adults in the present study, it is possible that alternative experiences may not have been captured. The sample includes more smokers than non-smokers, possibly reflecting the perspectives and experiences of those who were not successful in quitting smoking. Furthermore, the sample is primarily Caucasian, limiting the applicability of the findings to other population groups. Given the similarities between the current study sample to the broader RCT sample (Baskerville et al., 2015), however, the findings of this study appear to hold strong transferability to the large sample young adult smokers included in the RCT study and, therefore, Canadian young adult smokers in general.

Another limitation of the study is that the interviews with developers were conducted four years after the app was developed in 2012. In this regard, perspectives of key informants may have been influenced by current advancements in technologies, as well as their knowledge of what aspects of the app worked well and which ones did not work well. In the same way, some young adults were interviewed up to a year after they entered the RCT study, potentially limiting their ability to recall their experiences. To minimize these limitations, reflective questions were posed during interviews with both samples to assist participants in recalling events and experiences, and when necessary follow-up questions and probes were used to capture additional details. Finally, while the speed of technology and changes in the sophistication of users may limit the transferability of the findings to current innovations, the focus on affordances lent through the app versus the actual features of the app provides a stable grounding from which to improve existing and future innovations. New technologies and platforms, and enhanced user sophistication will not likely render affordances found in the present study as irrelevant. For example, affording visibility of quit smoking benefits will likely remain and can be enhanced as eHealth and user sophistication progresses. Of course, new affordances will emerge with new innovations and new contexts, but the productive and unproductive affordances found in the present study will likely hold their relevance and applicability for mobile-based smoking cessation interventions targeting young adults.

## Knowledge translation and exchange

Following the Dissemination Planning Tool (Carpenter, Nieva, Albaghal, & Sorra, 2005) several knowledge translation and exchange (KTE) activities are currently underway for this research project. This planning tool was developed to guide researchers to move beyond passive methods of KTE, such as peer-reviewed journals and academic presentations, by also

encouraging researchers to engage in more active forms of collaboration and knowledge exchange with knowledge users. While publications in peer-reviewed journals and academic presentations are part of the KTE process, these activities are complimentary to the overall KTE plan for this research project. The Dissemination Planning Tool includes five major elements, and in the following discussion, each element will be addressed in relation to this research project.

**1) Defining the research.** *What is going to be disseminated?* To date, the investigation mechanisms of smoking cessation apps for smoking cessation is lacking. Therefore, there are opportunities to disseminate the findings of this novel study in micro, meso, and macro level contexts. At the micro level, the research findings are being drawn upon to inform the improvement of CTC as a smoking cessation resource for young adults. For example, meetings have been held with the senior scientist of CTC along with other researchers that are involved in CTC to share the findings of this study and discuss strategies for enhancing this app-based intervention. At the meso level, while it is recognized that the transferability of these findings to alternative contexts is limited, the findings of this evaluation study serves as a benchmark for guiding the process of development of future app-based smoking cessation interventions. Specifically, collaborators from the Canadian Cancer Society, Leave The Pack Behind, and the Propel Centre for Population Health Impact will be encouraged to draw upon these findings in the development of future smoking cessation apps directed towards a variety of populations beginning with a webinar to showcase the findings to these collaborators. At the macro level, this research addresses questions of effectiveness in relation to app-based smoking cessation interventions, provides insight into ways to harness the power of smartphone apps for health behaviour change, and assists in the identification of research areas in need of further

development. Through the publication of reports and peer-reviewed manuscripts, which are currently underway, this research will add to the growing evidence base in relation to effectively employing mobile technologies for population-based health promotion and disease prevention.

**2) Identifying end users**. *Who will apply it in practice*? It has been suggested in the literature that the model of dissemination most relevant to health promotion research and practice is based on interaction and communication between producers and users of knowledge (Elliott et al., 2003). In this regard, researchers and end users were actively engaged in each stage of the research process, from conceptualization of the study through to project completion. User communities who were involved in the development of CTC were active participants and partners in this study, including Health Canada, the Propel Centre for Population Health Impact, Leave The Pack Behind, and the Canadian Cancer Society. Through the inclusion of partners from organizations involved with government, public health, policy-making, tobacco control, and population health research, avenues for KTE were established in this research project. This research is useful to the described end users because it contributes to finding effective and rigorous solutions to reducing tobacco use among young adults.

**3) Working with dissemination partners**. *Individuals, organizations or networks through whom we can reach end users?* Newsletters and published summaries of the research findings will be provided to dissemination partners, such as Health Canada, the Canadian Cancer Society, and the Propel Centre for Population Health Impact. Also, each participant interviewed was asked if they would like to receive a copy of the study findings at the end of each interview. Once prepared, all participants will receive a report of the findings.

**4) Communicating the research**. *How will the research outcomes be conveyed?* In addition to peer-reviewed publications, academic presentations, newsletters, and published

summaries of the research project, the findings of this study will be made available to the general public through vehicles such as social media and websites associated with the above dissemination partners. In collaboration with research team member, Dr. Bruce Baskerville, the lead scientist of CTC, findings will be promoted through CTC- and LTPB-related channels, such as the LTPB website and social media and the CTC Twitter and Facebook pages.

**5) Evaluating the success of the dissemination process**. *How will we determine what worked?* A long-term indicator of the success of dissemination will be evidence that the findings inform the development of future app-based smoking cessation interventions (e.g., as demonstrated by citations of the publications from this research as well as invitations to collaborate on enhancing the effectiveness of CTC and other related apps). Another long-term indicator will be the support and funding for further research to build on the findings. Short-term success indicators include invitations for interviews by the media, and invitations for talks and conference presentations, which are underway.

**6) Disseminating a work plan**. *Where will (did) we start?* Relationships were fostered at the beginning of the research project with end users of the research. Through this relationship building and networking, ongoing feedback and collaborations in the design and development of future research are fostered. In addition, collaborative research projects that aim to expand our health promotion knowledge and practice in the context of new information technologies will be conceptualized and undertaken.

## Summary

In this Chapter, significant findings in relation to the value of employing critical realist sociomaterality theory and an affordances approach, as well as a gender-based analysis were discussed. The strengths of employing sociomateriality theory in this qualitative study are

brought forward, namely, the revelation of underlying mechanisms that lend to various experiences and practices in relation to smoking cessation. The findings of this study confirm previous suggestions that sociomateriality theory would greatly benefit eHealth research (e.g., Lupton, 2013). In addition, the significant findings that have resulted from employing a gender-based analysis in this study have revealed the benefits and need for ongoing attention to gender in eHealth intervention research. In this regard, assumptions were interrogated and critical issues that need ongoing consideration were brought to the table. Relevant recommendations for developmental practices for mobile-based smoking cessation interventions, as well as future research in this area were also discussed.

This is one of the first studies to qualitatively investigate both development intentions and user experiences of a smoking cessation app. This is also one of the first studies in the area of eHealth research to employ sociomateriality theory. This study addresses the unfulfilled need for more comprehensive and relevant research approaches that include consideration of all the relevant technology, human, and contextual factors that influence the uptake and impact of eHealth interventions (van Gemert-Pijnen et al., 2011). Employing such an approach permitted an in-depth investigation into intended and unintended affordances, bringing forward the important role that context plays in the affordances of eHealth interventions. This study contributes to understandings of productive and unproductive approaches and assumptions that underpin development of mHealth smoking cessation interventions. In addition, this study contributes to understandings of both technological and social factors that contribute to end-user experiences and practices as they engage with these tools. This study makes a significant contribution to addressing the "black box" of knowledge in relation to how and why aspects of eHealth interventions succeed or fail. While further study is suggested, some immediate steps

can be taken to improve approaches to development and design of these interventions that encompass due consideration for the important role of context and stakeholders in eHealth interventions.

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**Appendices**

Appendix A – Keyword Search

**MedlineOVID**

1. cellular phone/
2. ((cell* or mobile or wireless) adj (phone* or telephon*)).tw.
3. (cellphone* or mobiles or mhealth or m-health).tw.
4. ((mobile or handheld or hand-held) adj2 (device* or technolog* or app* or health*)).tw.
5. (smart phone* or smartphone* or blackberry or iphone* or android phone* or google android or ipod touch or personal digital assistant* or pda or pdas).tw.
6. or/1-5
7. smoking cessation/
8. "Tobacco Use Cessation"/
9. "tobacco use disorder"/
10. tobacco/
11. nicotine/
12. (smoking or cigarett* or tobacco or nicotine).tw.
13. or/7-12
14. 6 and 13

**EMBASE**

1. exp smoking cessation/ or exp smoking cessation program/
2. (smoking or cigarett* or tobacco or nicotine).tw.
3. exp nicotine/
4. exp "tobacco use"/ or exp tobacco/
5. or/1-4
6. mobile phone/
7. ((cell* or mobile or wireless) adj (phone* or telephon*)).tw.
8. (cellphone* or mobiles or mhealth or m-health).tw.
9. ((mobile or handheld or hand-held) adj2 (device* or technolog* or app* or health*)).tw.
10. personal digital assistant/
11. (smart phone* or smartphone* or blackberry or iphone* or android phone* or google android or ipod touch or personal digital assistant* or pda or pdas).tw.
12. or/6-11
13. 5 and 12

**CINAHL**

| | |
|---|---|
| S1 | (MH "Smoking Cessation Programs") |
| S2 | (MH "Smoking Cessation") |
| S3 | (MH "Tobacco+") |
| S4 | (MH "Nicotine") |

| | |
|---|---|
| S5 | TI ( smoking or cigarett* or tobacco or nicotine ) OR AB ( smoking or cigarett* or tobacco or nicotine ) |
| S6 | S1 OR S2 OR S3 OR S4 OR S5 |
| S7 | (MH "Wireless Communications") |
| S8 | (cell* or mobile or wireless) N1 (phone* or telephon*) |
| S9 | (mobile or handheld or “hand-held”) N1 (device* or technolog* or app*or health*) |
| S10 | TI ( cellphone* or mobiles or mhealth or m-health or "smart phone*" or smartphone* or blackberry or iphone* or "android phone*" or "google android" or "ipod touch" or "personal digital assistant*" or pda or pdas ) OR AB ( cellphone* or mobiles or mhealth or m-health or "smart phone*" or smartphone* or blackberry or iphone* or "android phone*" or "google android" or "ipod touch" or "personal digital assistant*" or pda or pdas ) |
| S11 | S7 OR S8 OR S9 OR S10 |
| S12 | S6 AND S11 |
| S13 | S6 AND S11 |
| S14 | S6 AND S11 |
| S15 | S6 AND S11 |
| S16 | DE "Smoking Cessation" |
| S17 | DE "Tobacco Smoking" OR DE "Passive Smoking" |
| S18 | DE "Nicotine" |
| S19 | TI ( (smoking or cigarett* or tobacco or nicotine) ) OR AB ( (smoking or cigarett* or tobacco or nicotine). ) |
| S20 | DE "Mobile Devices" OR DE "Cellular Phones" |
| S21 | TI ( (cell* or mobile or wireless) N1 (phone* or telephon*) ) OR AB ( (cell* or mobile or wireless) N1 (phone* or telephon*) ) |
| S22 | TI ( (mobile or handheld or "hand-held") N1 (device* or technolog* or app*or health*) ) OR AB ( (mobile or handheld or "hand-held") N1 (device* or technolog* or app*or health*) ) |
| S23 | TI ( cellphone* or mobiles or mhealth or "m-health" or "smart phone*" or smartphone* or blackberry or iphone* or "android phone*" or "google android" or "ipod touch" or "personal digital assistant*" or pda or pdas ) OR AB ( cellphone* or mobiles or mhealth or "m-health" or "smart phone*" or smartphone* or |

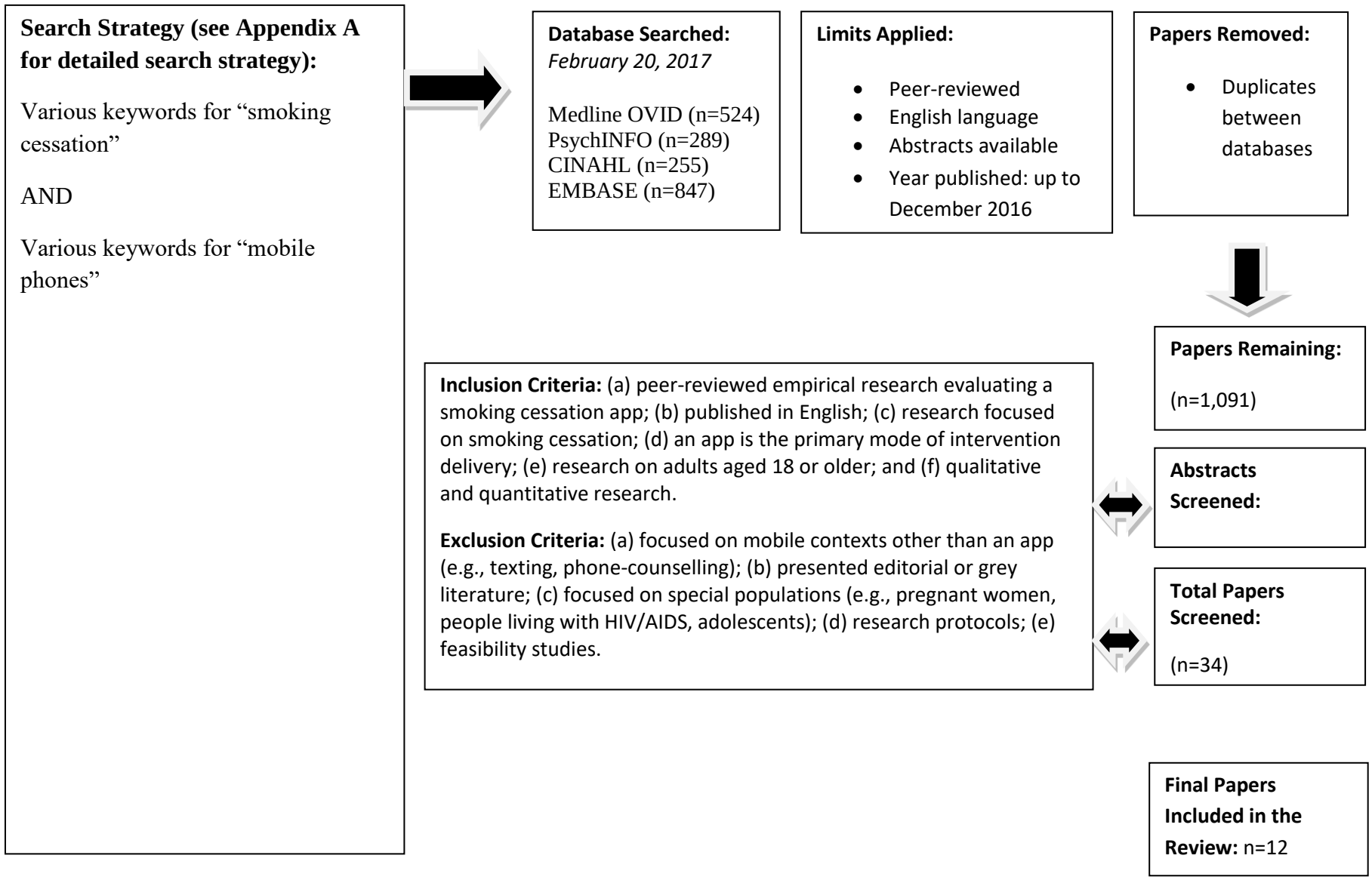
| | |
|---|---|
| | blackberry or iphone* or "android phone*" or "google android" or "ipod touch" or "personal digital assistant*" or pda or pdas ) |
| S24 | S16 OR S17 OR S18 OR S19 |
| S25 | S20 OR S21 OR S22 OR S23 |
| S26 | (S20 OR S21 OR S22 OR S23) AND (S24 AND S25) |

**PsychINFO**

| | |
|---|---|
| S1 | (MH "Smoking Cessation Programs") |
| S2 | (MH "Smoking Cessation") |
| S3 | (MH "Tobacco+") |
| S4 | (MH "Nicotine") |
| S5 | TI ( smoking or cigarett* or tobacco or nicotine ) OR AB ( smoking or cigarett* or tobacco or nicotine ) |
| S6 | S1 OR S2 OR S3 OR S4 OR S5 |
| S7 | (MH "Wireless Communications") |
| S8 | (cell* or mobile or wireless) N1 (phone* or telephon*) |
| S9 | (mobile or handheld or “hand-held”) N1 (device* or technolog* or app*or health*) |
| S10 | TI ( cellphone* or mobiles or mhealth or m-health or "smart phone*" or smartphone* or blackberry or iphone* or "android phone*" or "google android" or "ipod touch" or "personal digital assistant*" or pda or pdas ) OR AB ( cellphone* or mobiles or mhealth or m-health or "smart phone*" or smartphone* or blackberry or iphone* or "android phone*" or "google android" or "ipod touch" or "personal digital assistant*" or pda or pdas ) |
| S11 | S7 OR S8 OR S9 OR S10 |
| S12 | S6 AND S11 |
| S13 | S6 AND S11 |

| | |
|---|---|
| S14 | S6 AND S11 |
| S15 | S6 AND S11 |
| S16 | DE "Smoking Cessation" |
| S17 | DE "Tobacco Smoking" OR DE "Passive Smoking" |
| S18 | DE "Nicotine" |
| S19 | TI ( (smoking or cigarett* or tobacco or nicotine) ) OR AB ( (smoking or cigarett* or tobacco or nicotine). ) |
| S20 | DE "Mobile Devices" OR DE "Cellular Phones" |
| S21 | TI ( (cell* or mobile or wireless) N1 (phone* or telephon*) ) OR AB ( (cell* or mobile or wireless) N1 (phone* or telephon*) ) |
| S22 | TI ( (mobile or handheld or "hand-held") N1 (device* or technolog* or app*or health*) ) OR AB ( (mobile or handheld or "hand-held") N1 (device* or technolog* or app*or health*) ) |
| S23 | TI ( cellphone* or mobiles or mhealth or "m-health" or "smart phone*" or smartphone* or blackberry or iphone* or "android phone*" or "google android" or "ipod touch" or "personal digital assistant*" or pda or pdas ) OR AB ( cellphone* or mobiles or mhealth or "m-health" or "smart phone*" or smartphone* or blackberry or iphone* or "android phone*" or "google android" or "ipod touch" or "personal digital assistant*" or pda or pdas ) |
| S24 | S16 OR S17 OR S18 OR S19 |
| S25 | S20 OR S21 OR S22 OR S23 |
| S26 | (S20 OR S21 OR S22 OR S23) AND (S24 AND S25) |

Appendix B – PRISMA search strategy



Appendix C – Narrative Description of CTC

**THE APP**

The app is available in both Ios and Android. The app is available in English and French. When you first download and open the app, the following statement appears: "You're one step closer to quitting. Let this app help you quit by: tracking when and why you smoke; making a quit plan; helping with cravings and slips; tracking and rewarding your quit success; getting support when you need it; connecting you with a community; and empowering you with knowledge, support and other resources". This statement is followed by a preamble stating that some questions about their smoking habit will be asked in order to tailor the app to their needs. Individuals are then asked to agree to the End User License Agreement (EULA). Individuals are also provided with the option to choose French or English at this point.

At the login page, users are asked to login through Facebook or through a user account. New users are asked to create an account. To create an account, individuals must enter a username, password, their age, and sex. They are also asked to check a box if they are interested in being contacted for further research.

Users are then asked to enter details about their smoking status, including when they want to quit (today, in the near future, already quit), number of cigarettes smoked per day, number of years smoking, cost of last pack of 25 cigarettes, and any quit aids used (nicotine gum, patch, inhaler, lozenges, bupropion, varenicline, other self-help programs, quitline, online counseling, in-person counseling, none).

The next step is setting up a quit plan, which is where users are asked to enter what is motivating them to quit and also to enter a quit buddy. Users are asked to set a quit date. It is suggested in the app that setting a quit date in the next 2-6 weeks is the best "way to go" according to evidence. Users then must enter their quit date, which must be at least 2 weeks away, if they are cutting down to their quit date or if they are quitting cold turkey, and why they are quitting (for their family, health, appearance, finances, other). A quit plan is then generated. If a user selected to cut down to quit date, then a plan for reducing amount smoked leading up to the quit date is provided. Users are then encouraged to hit the "crave" button when they are getting a craving, and to hit to "smoked" button if they have a cigarette to record their progress. They are also encouraged to get to know the quit help page, which is where they can access someone to talk to, a craving distraction, help dealing with stress, and the opportunity to connect with the CTC community. They are also encouraged to check their awards and share them with friends.
To personalize their homepage, users are encourage to upload personal photos and to write themselves a motivating message. Users can update or revise any of the information they entered by going to "My Settings" and editing the information.

Now users are at the "Home" page. Every time a user logs into the app, the home page will be the first page that comes up. The home page contains the motivating message, the personalized photos, the "crave" and "smoke" buttons, the countdown to quit day, and the daily cigarette allowance according to the quit plan. When a user hits the "crave" button, various motivating messages pop up and "distract the crave" options (games – tops free games listed in app store, texting quit buddy, music – playlist by CTC, and videos – playlist by CTC) are presented. When

a user hits the “smoke” button, a motivating message comes up and the user is asked to record their triggers (who they are with, where they are, how they are feeling).

The “Awards” page provides awards for days smokefree (e.g., day 1, 1 week, 1 month, 100 cigarettes not smoked), money saved (e.g., $100 saved), health achieved (e.g., breathe easier, nicotine free, happy heart), and earning your own (e.g., providing feedback about CTC). Users are encouraged to share their awards via Facebook, Twitter, or quit buddy.

The “Progress” page graphs number of cigarettes smoked (red), number of cravings (yellow), and the cigarette allowance (green). Users can track their progress by hour, day, week, and month. Users can also visit the “health calculators” page, which lists number of days till quit date, number of cigarettes not smoked, money saved, money on track to save this year, tar crushed, number of cravings, number of slips/smokes, time most vulnerable for craving, and percent of health benefit.

The “Quit Help” page provides users with access to the toll free quitline, craving distractions, information on quit aids (e.g., NRT), suggested crave crushers (e.g., yoga, deep breathing, positive visualization), tips on how to handle triggers, withdrawal and cravings, and slip ups, facts and dispelling myths around quitting, online resources (e.g., leave the pack behind), the CTC community via Facebook and Twitter, and their quit plan.

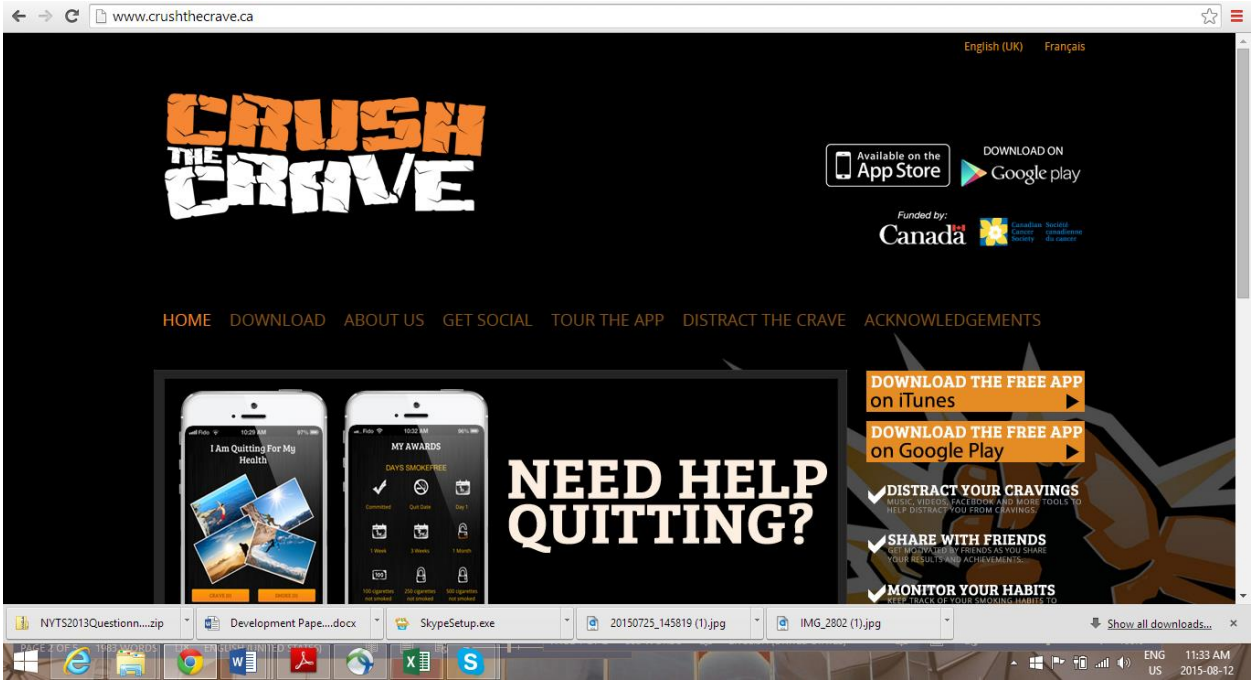
In addition to the above main pages, the app has a “more” section. This is where users can: view their map, which tags the locations where they crave or smoke the most; be tagged in a photo or

video; upload photos for use by CTC (e.g., a picture of them crushing the crave through yoga); find buddies through the CTC Facebook page; find a description of how to use the app; find a description of who is behind CTC; view user settings; send feedback about the app; and view the leaderboard, which lists other CTC users and provides their age, sex, and number of days smokefree.

**WEBSITE**

CTC has a website (www.CTC.ca), which provides a comprehensive description of the app. Individuals can download the app right from the website. In addition to providing a "tour" of the app, the website provides individuals with access to the various social media that are connected to the app, including Facebook, Twitter, YouTube, Tumblr, LinkedIn, Reddit, Google+, and Pinterest.

*Figure 5. CTC website.*



## SOCIAL MEDIA

While CTC is linked to a variety of social media, only the Facebook Page, Twitter Page, and YouTube channel is directly accessible through the app. Out of all the social media channels, it appears that the CTC Facebook and Twitter pages are the most active in terms of frequency of posts (for Facebook) and tweets (for Twitter), and generate the most user engagement (e.g., comments, likes, followers). However, the Facebook page is the only social media site that has been studied for its role in helping young adults quit smoking (see Struik and Baskerville, 2015). Research is needed to investigate the role of the other social media sites associated with CTC. A brief description of each social media site associated with CTC will be provided in the following sections.

### THE FACEBOOK PAGE

The CTC Facebook page is a social networking site where other app users, as well as non-app users, and the CTC research team can connect and engage with each other through posts (which can include text, photos, and videos), comments, and "likes". Individuals can "like" the Facebook page and/or a post. As of August 12, 2015, the CTC Facebook page has received 33,534 likes. According to a recent framework analysis of the Facebook page content, researchers reported that the primary purpose of the page content was to enable individuals to give and receive social support, as well as to promote CTC (Struik & Baskerville, 2015). It was found that almost all of the posts to the page were made by the CTC team, with users very rarely initiating a post (Struik & Baskerville). The Facebook page is accessible directly through the app, and is listed in the "Quit Help" section as "The Crave Community". On average, a post is made to the Facebook page every other day.

*Figure 6. CTC Facebook page.*


*Figure 7. CTC Facebook page visitor post.*

*Figure 8. CTC Facebook page moderator post.*


THE TWITTER PAGE

The CTC Twitter Page is a social media site where tweets, which could contain text, photos, and videos, are shared. Since August 5, 2015, the CTC Twitter page has been following 259 other Twitter users and has 566 followers. When a Twitter user follows CTC, each tweet made by CTC shows up on their timeline and vice versa. Therefore, the more followers, the more reach. In addition to following CTC, other individuals on Twitter can comment on a tweet and join the conversation, retweet the tweet so that the tweet is posted on their Twitter page and thus shared with their followers, "favorite" (same as "like") a tweet to let the author know that they like the tweet, and assign a hashtag (e.g., #quitsmoking) so that the tweet is included as part of a catalog of tweets that contain the same hashtag. On average, a tweet is posted on the CTC Twitter page every other day, with a total of 1,430 tweets made since March, 2012. Along with the Facebook page, the Twitter page is accessible directly through the app, and is listed in the "Quit Help" section as "The Crave Community".

*Figure 9. CTC Twitter page.*

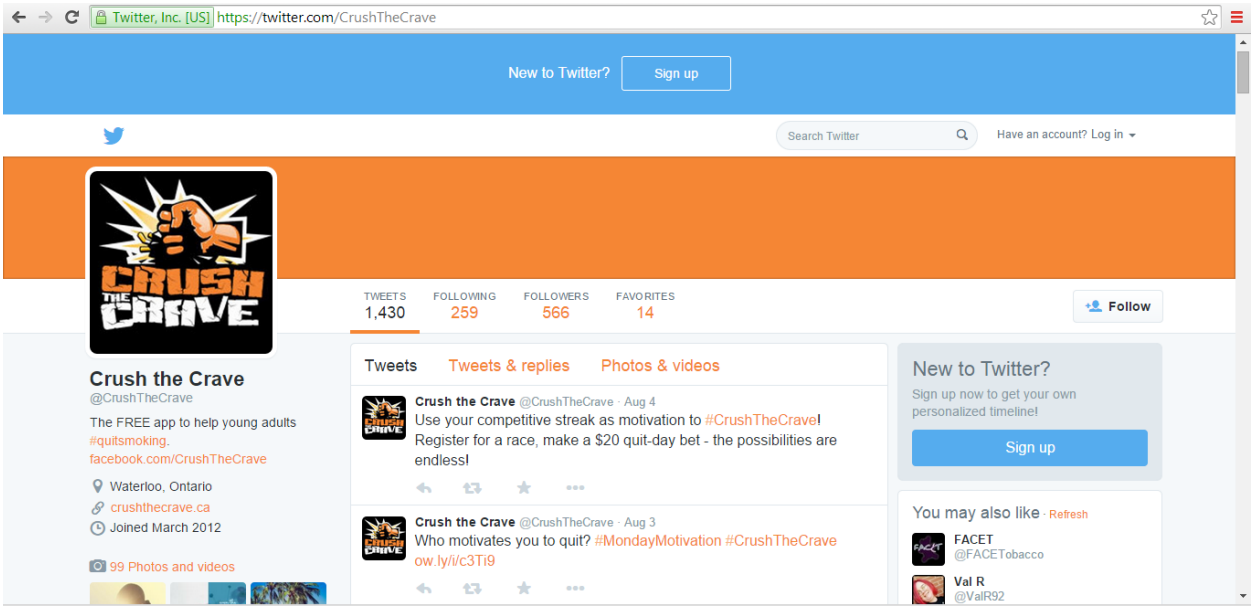


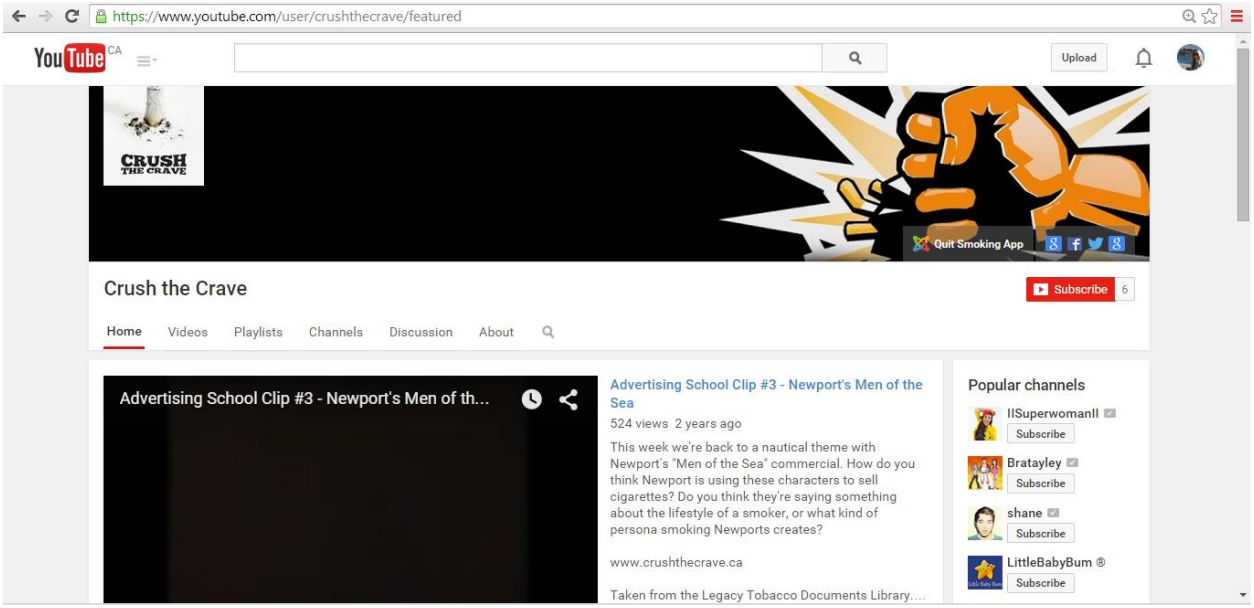

*Figure 10. CTC tweet.*


## THE YOUTUBE CHANNEL

The CTC YouTube channel displays uploaded videos and playlists created by the CTC team (e.g., craving distractors, music). Although subscription (only 6 subscribers) and user engagement is minimal (as of August 5, 2015), individuals could subscribe to the channel,

comment on the videos, start a discussion, and access other CTC social media links. The YouTube channel is also accessible through the app under “Quit Help”→ “Distract The Crave”, which is where the music and videos are displayed.

*Figure 11. CTC YouTube.*




OTHER SOCIAL MEDA

CTC is linked to the images sharing social media site, Pinterest, where images, called “pins” have been uploaded or added to themed pinboards (collection of pins) created by CTC. Other Pinterest users can comment, “heart” (same as a “like”), or “repin” CTC images onto a themed pinboard that they have created (e.g., Non-Smoker). Users can also follow CTC on Pinterest and be alerted to new pins posted by CTC. CTC is also linked to Tumblr, which is a blogging platform where individuals can create a blog and blog through text, photos, videos, music, and so forth. Tumblr users can then comment on, “heart” and/or include other blogs, such as the CTC blog, in their blog. Tumblr users can also follow the CTC blog, and any new blogs by CTC will show up in their dashboard.

LinkedIn, a professional social networking site, is also connected to CTC and users can post about CTC: www.linkedin.com. CTC also contains a link to Reddit, which is a bulletin board-based social networking site, where users can post content (e.g., CTC-related content) and other users can share and comment on the post. Reddit users can also vote on the content, which will determine the placement of the content (the more positive votes, the more likely the content will be viewed by other users): www.reddit.com. Finally, CTC is linked to Google+, which is a blog-based social networking site that connects individuals with similar interests and pursuits (e.g., quitting smoking). The CTC Google+ blog contains posts, photos, and videos related to the app. Other Google+ users can share and comment on CTC on their Googe+ accounts, as well as follow the CTC blog.

Appendix D – Key Informant Interview Guide

*Open by asking the key informants to reflect on their experiences in the development and implementation of CTC pause giving them time to reflect…then say with these experiences in mind, there are some questions that I have….*

Thanks again for agreeing to participate. I know you had some concerns about whether your input would be helpful given your time with CTC and how long it has been since it's been rolled out but hearing about your input, big or small, will be a very important part of the study so I appreciate that you came to the table and are willing to participate.

Aim of study. Now, before we begin, do you have any questions or would you like any additional details?

And I have to ask one last time: Do you agree to participate in this study knowing that you can withdraw at any point with no consequences to you?

**Development and Implementation:**

1. Please tell me about your role on the CTC team.
2. Please tell me about what led to the development and implementation of CTC as a quit smoking smartphone app for young adults? *Let the conversation unfold noticing what is talked about. When there is a pause, use the following prompts to further discussion:*
    - How did you hope that young adults would use the app?
    - In your opinion, what are some of the best things about the app for helping young adults quit smoking? How would they help them quit.
    - In your opinion, what are some limitations of the app? How might these limit young adults quit smoking efforts?

**Affordances of CTC:**

Now I am interested in hearing about your thoughts about how CTC might influence young adults' smoking cessation efforts. *I will be referring to the CTC design diagram to guide this discussion.*

3. The first component relates to the credibility of CTC as one of the key design features (e.g., evidence-informed, user input) *(refer to app design diagram*).
    - What was the thinking behind ensuring that the app was informed by the input of young adults and backed by credible agencies and research?
    - From your point of view, how do you think being research based and receiving the backing of credible agencies would benefit young adults in engaging with the app to help them quit smoking?
    - How do you think being research based and receiving the backing of credible agencies might hinder young adults in engaging with the app to help them quit smoking?

4. The second key design feature relates to the task support functions (e.g., customized quit plan, tracking smoking and craving) *(refer to app design diagram).*
    - What was the thinking behind including these functions to influence young adults' cessation efforts?
    - On what basis were these particular functions selected?
    - In which ways do you think these functions can strengthen young adults' smoking cessation efforts? Can you provide me with a possible scenario?

- What did you think might be some of the challenges or limitations of these functions for helping young adults quit smoking? Can you provide me with a possible scenario? How was the app designed to minimize these?

5. The third key design feature relates to the social support functions in the app (e.g., connecting to social media, leaderboard) *(refer to app design diagram).*
    - What was the thinking behind including these functions to influence young adults' cessation efforts?
    - On what basis were these particular functions selected?
    - In which ways did you think these functions would strengthen their social support for quitting smoking? Can you provide me with a possible scenario?
    - What did you think might be some of the challenges or limitations of these functions for strengthening young adult smokers' social support as they engage in smoking cessation? Can you provide me with a possible scenario? How was the app designed to minimize these challenges or limitations?

6. The final design feature that I would like to talk about relates to the dialogue support functions in the app (e.g., supportive texts, awards) *(refer to app design diagram).*
    - What was the thinking behind including these functions to influence young adults' cessation efforts?
    - On what basis were these particular functions selected?
    - In which ways did you think these functions would strengthen young adults' smoking cessation efforts? Can you provide me with a possible scenario?

- What did you think are some of the challenges or limitations of these functions for helping young adults quit smoking? Can you provide me with a possible scenario? How was the app designed to minimize these challenges or limitations?

**Gender influences:**

CTC was specifically designed for use by young adult women and men. I am interested in your thoughts about the preferences of these target groups in relation to the CTC and its features.

7. What features, if any, were included to address women's preferences? In your opinion, what do think young women will find most appealing about the app? Least appealing?

8. What features, if any, were included to address men's preferences? In your opinion, what do you think young men will find most appealing about the app? Least appealing?

**Conclude interview:**

9. Is there anything important to tell me about CTC® that I haven't already asked about?

Appendix E – Young Adult Interview Guide

*Open by reminding participants of the aim of the study.*

**Tobacco use in their lives:**

1. Please tell me how you began smoking?

2. How old were you when you had your first cigarette?

3. How old were you when you started smoking regularly?\

4. At the present time, would you say that you are: a) not at all addicted to cigarettes, somewhat addicted, or very addicted.

5. What has happened since you started smoking that you became interested in reducing and quitting smoking.

6. How did you hear about CTC and what motivated you to use the app/participate in the study?

*Let the conversation unfold noticing what is talked about. When there is a pause, use the following prompts to further discussion:*

- What has it been like for you to use this app?
- Looking back over the time you have used the app, what were some of the things you liked best about using this app to reduce and stop smoking?
- What did you like least about the app?

- Have you ever used an app for smoking cessation other than CTC?
- What did you think of the design of the app?

**Affordances of CTC:**

*Ask the participants to reflect on their experiences with quitting smoking and the role that CTC has played in these experiences. Then say that I have a few questions about how CTC influenced their smoking cessation efforts.*

7. We know there are a lot of quit smoking apps out there. Can you tell me what influenced you to download and use CTC? *Let the conversation unfold noticing what is talked about. When there is a pause, use the following prompts to further discussion:*
    a. In the "Who we are" feature of the app, as well as on related CTC social media, it is acknowledged that CTC was developed at the University of Waterloo and has received the approval of credible agencies, such as Health Canada and the Canadian Cancer Society. In which ways, if at all, did this influence your impression of the app/to download and use CTC?
    b. What are the benefits of having an app backed by such credible agencies?
    c. Do you perceive any limitations of having an app that is backed by such credible agencies?
8. Please tell me about how you used the [quit plan page; health calculators page; my map feature where you can see where you smoke the most and least, craving and smoking tracker; quitline and/or online resources (e.g., Quit4Life and Leave the Pack Behind); the information pages (e.g., alcohol and tobacco, exercise, weight gain); feedback on triggers]. *Let the conversation unfold noticing what is talked about. When there is a pause, use the following prompts to further discussion:*

a. Please tell me about a time when x function helped you stay on track and/or reach your goal.
b. Tell me about a time when x function was not helpful, if at all?
c. Would you want it to intervene?

*9.* The app also provides users with the ability to see how they are doing and receive positive reinforcement through providing graphical displays of progress in the my progress page; providing awards for achievements in the awards page; and receive supportive texts and reminders to encourage them in their quit efforts. Please tell me about how you used the [progress page; awards page] part of the app. Please tell me about how the supportive texts and reminders influenced your quit smoking efforts. *Let the conversation unfold noticing what is talked about. When there is a pause, use the following prompts to further discussion:*

*a.* Please tell me about a time or times that you used [function used] and how it helped you achieve your goal.
*b.* Which functions did you try that were not helpful in reducing your smoking/quitting? How? Please tell me about a time when you tried [function] but it didn't help you.

*10.* CTC also includes the option of connecting to friends and social networks to share your experiences and harness support, [such as the CTC Facebook page; the ability to see the progress of other smokers who are using the app through a leaderboard; interactive craving distractions, such as texting a quit buddy, playing a game, listening to music and watching videos]. How, if at all, did you use this part of the app? *Let the conversation*

*unfold noticing what is talked about. When there is a pause, use the following prompts to further discussion:*

- Please tell me about a time or times that you used [function used] and it helped you achieve your quit smoking goal by strengthening your social support.
- What functions did you try but were not helpful for receiving support? Please tell me about a time when you used [function] and it did not lead you to the support were wanting to reduce/quit? How?
- Do you have sources of sources support that you draw upon within your networks of family and friends?
- Did you use any of the social media sites that were linked to the app (Facebook, Pinterest, Twitter, Google+, Tumblr, Reddit, YouTube, etc.)? Which ones? How did they help?

*11.* Which social media sites do you use?

*12.* How often do you use social media?

*13.* What social media platforms do your male/female friends use? Why do you think that is?

*14.* In relation to apps, how often do you use apps in general?

*15.* Did your use of the app change over time as you began to quit smoking (e.g., did you stop using some functions and start using others?)? If so, how (please walk me through the transition/s)? What prompted these changes in use?

*16.* Were there certain places or times that you used the app more? When/where?

*17.* Were there certain places or times that you would not use the app? When/where?

18. What functions did you use the most? Are there any functions that you did not use at all? Which ones?

19. Do you currently use the app?

20. You have told me that you have [reduced/quit/no change in] smoking since you were first introduced to CTC. What do you think has been the biggest influencing factor? Overall, how helpful has CTC been to you?

**Question for smokers:**

21. What would it take for you to quit smoking? What would it take for the app to help you quit smoking?

**Gender Influences:**

*We are interested in understanding how gender plays a role in smoking cessation and I have a few questions for you in relation to gender.*

22. What about quitting makes you feel most like a man/woman?
23. Why do more men than women smoke? How does that influence your quit smoking efforts?
24. Why might other women/men be interested in using CTC?
25. What do you think that women like you [for guys: men like you] would find most appealing about using this app? Least appealing?
26. Thinking about young men [for guys: young women] who smoke – what do you think they would find most appealing about using this app? Least appealing?
27. How could CTC be more appealing to women/men?

**Final Question:**

28. We are interested in what might be missing in the app that would be particularly helpful. Based on your experiences, what would you suggest be enhanced in or added to CTC? How do you think these suggested additions would have strengthened your quit smoking efforts?

Appendix F – Key Informant Email Invitation

a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

**Email Invitation for Key Informants**

**date**

Hello [Name],

I am pleased to be inviting you to consider participating as a key informant in a research study that is being conducted on the smoking cessation smartphone app, CTC®. The project title is: **Young adult smoking cessation and smartphone technology: A qualitative investigation of the 'CTC' mobile app.** The purpose is to learn about how CTC® is used among young adults and how use of the app has influenced their smoking cessation efforts. I will be interviewing young adult women and men who are using/have used CTC®, collecting artifacts documenting young adults' activity with CTC®, collecting documents related to the development of CTC®, and interviewing key informants involved in the development of CTC®. This research project forms part of my PhD dissertation work and findings will be used to develop descriptions of how CTC® is used among young adults and how the app enables/constrains their smoking cessation efforts.

Key informant interviews will support gaining an understanding of how CTC® was developed and implemented. This perspective is essential to broaden understandings of young adults' engagement with CTC® and how their experiences align with the underlying goals of development. Specifically, you were identified as [details related to that individual]. Your participation would involve an interview and discussion with me, Laura Struik, the principal investigator of the research study. The interview and discussion will last approximately 60 minutes and will include talking about your role in the development of CTC® and how you think CTC® will influence young adults' smoking cessation efforts. This interview will be done via

your preferred method (telephone or online), and at a time that is most convenient to you. To thank you for your contribution to this study, you will receive a $5.00 Starbucks gift card.

Any information provided by you to the researchers will be kept strictly confidential. **Your participation in this study is voluntary. You may decide not to participate or you may withdraw from the study at any time and it will not impact you in any way.** If you withdraw from the study, you may elect to withdraw any or all of the information you have provided.

If you are interested in participating in this project or would like additional information, please contact me using my contact information stated below or click on the following link: [webpage]. Please note, if I have not heard from you within two weeks of the posting of this letter, I will resend this invitation and if you do not respond to this reminder, I will assume you are not interested or are unable to participate in this project.

Thank you for considering your participation in this project. I would be most pleased to hear from you.

Sincerely,

**Ms. Laura Struik**, BScN, MSN, PhD(c), RN
Principal Investigator
Doctoral Student, University of British Columbia
Phone: 250-XXX-XXXX
Email: laura.struik@ubc.ca

Also on behalf of:
**Joan L. Bottorff**, PhD, RN, FCAHS, FAAN
PhD Supervisor, Chair in Health Promotion and Cancer Prevention, Director of the Institute for Healthy Living and Chronic Disease Prevention, Professor at the School of Nursing, University of British Columbia's Okanagan Campus

**N. Bruce Baskerville**, PhD, CE
PhD Committee Member, Senior Scientist at the Propel Centre for Population Health Impact, Research Associate Professor in the Faculty of Applied Health Sciences, University of Waterloo

**John Oliffe**, PhD, RN

PhD Committee Member, Professor at the School of Nursing, University of British Columbia

**Susan Crichton**, BSc, MA, PhD

PhD Committee Member, Director of the Innovative Learning Centre, Director of the Faculty of Education, Associate Professor in the Faculty of Education, University of British Columbia's Okanagan Campus

Appendix G – Consent Form for Key Informants

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THE UNIVERSITY OF BRITISH COLUMBIA

**Consent Form for Key Informants**

**Research Project Title:** ***Young adult smoking cessation and smartphone technology: A qualitative investigation of the 'CTC' mobile app.***


**Principal Investigator:** Laura Struik, BScN, MSN, PhD(c), RN
Doctoral Student, University of British Columbia's Okanagan Campus

**Co-Investigator:** Joan L. Bottorff, PhD, RN, FCAHS, FAAN
PhD Supervisor, Chair in Health Promotion and Cancer Prevention, Director of the Institute for Healthy Living and Chronic Disease Prevention, Professor at the School of Nursing, University of British Columbia's Okanagan Campus

**Co-Investigator:** N. Bruce Baskerville, PhD, CE
PhD Committee Member, Senior Scientist at the Propel Centre for Population Health Impact, Research Associate Professor in the Faculty of Applied Health Sciences, University of Waterloo

**Co-Investigator:** John Oliffe, PhD, RN
PhD Committee Member, Professor at the School of Nursing, University of British Columbia

**Co-Investigator:** Susan Crichton, BSc, MA, PhD
PhD Committee Member, Director of the Innovative Learning Centre, Director of the Faculty of Education, Associate Professor in the Faculty of Education, University of British Columbia's Okanagan Campus


**Purpose of the Study:**

The purpose of this study is to learn about how CTC® plays a role in young adults' smoking cessation efforts. This study is part of research conducted for a doctoral thesis of Laura Struik (researcher). The final doctoral thesis document will be available as a public document through

the University of British Columbia. Findings will be used to develop descriptions of how CTC® was designed to influence young adult smoking cessation, how CTC® is used among young adults, and how the app enables/constrains their smoking cessation efforts. Results will be prepared into a PhD dissertation, reports, scientific papers, and presentations. Individual responses will be presented in aggregate (group) form so that it is not possible to identify individual participants. You have been asked to participate in this study because you are a key informant who has been directly involved in the decision-making processes related to the design, development, and implementation of CTC®. Any information provided by you to the researchers will be kept strictly confidential. **Your participation in this study is voluntary. You may decide not to participate or you may withdraw from the study at any time and it will not impact you in any way.** If you withdraw from the study, you may elect to withdraw any or all of the information you have provided.

**Study Procedures:**

If you take part in this study, you will be asked to spend about 60 minutes with the researcher via your preferred method (can be telephone or online with the option for video) and at a time that is convenient for you. You will be asked to talk about your role in the development and implementation of CTC® and your perceptions of how the app might influence young adults' smoking cessation efforts. The interviews will be audio-recorded by the interviewer and later transcribed. In addition, you may be asked to provide documentation in relation to the development and/or implementation of CTC®. Any drawings, text, or other discussion data collected may be used in the research report, as well as for educational purposes.

**Risks:**

Given the limited number of individuals involved in the design, development, and implementation of CTC®, there is a possible risk of being identified by colleagues when the key informant discussions are analyzed and written up in the final report by the researcher.

**Potential Benefits:**

You may not receive any direct benefits for participating in this study, however, the information you provide will assist in improved understanding of CTC® and its role in young adult smoking cessation. This information can help direct further research and provide insight to the improvement and development of smoking cessation smartphone apps directed towards young adults.

**Remuneration:**

As a token of appreciation for participating in the study, each participant will each receive a $5.00 Starbucks gift card.

**Confidentiality:**

Any information we obtain form you will be held strictly confidential. No information that discloses who you are will be released or published without your further and specific consent. No records which identify you by name or initials will be allowed to leave the researchers' offices. Your name will not be associated with the information collected in the interviews. A code number will be used to identify you. The information will be stored in a locked file cabinet and computer files will be password protected and stored in an encrypted device and/or file folder. You will not be identified in any reports of this research. All documents (including electronic files, audio tapes and transcriptions) will be retained for a minimum of five years after publication and provided a secure storage location on UBC's Okanagan campus. Audio-recordings of interviews will be destroyed after that period of time.

**For More Information:**

If you have any questions or would like further information, you may contact Laura Struik, the principal investigator, by phone at 250-XXX-XXXX or email at laura.struik@ubc.ca. You may also contact Laura Struik's PhD supervisor, Dr. Joan Bottorff, by phone at 250-807-8627 or email at joan.bottorff@ubc.ca

If you have any concerns or complaints about your rights as a research participant and/or your experiences while participating in this study, contact the Research Participant Complaint Line in the UBC Office of Research Ethics toll free at 1-877-822-8598 or the UBC Okanagan Research Services Office at 250-807-8832. It is also possible to contact the Research Complaint Line by email (RSIL@ors.ubc.ca ).

**Consent:**

- I have read and understand this consent form.
- I have received a copy of this consent form.
- I consent to participate in this study.
- I consent to the interview being audio-recorded.

Signature_____ Today's Date_____

Printed Name_____

Researcher or Delegate's Signature_____ Date_____

- If you cannot sign and return the consent form, you may provide consent by responding to this email stating the following: *"I have read the consent form and am providing consent to participate in this study by this affirmative email response."*

**Request for follow-up information:**

I would like to receive a copy of the brief report of findings and results from the study.

Yes_____

No_____

Please send the report to:

Name:_____

Mailing Address:_____

_____

_____

_____

Postal Code:_____

Appendix H - Email Invitation for Young Adults

**From:** UBC <laura.struik@ubc.ca>

**Subject:** (participant's name), what did you think of CTC?

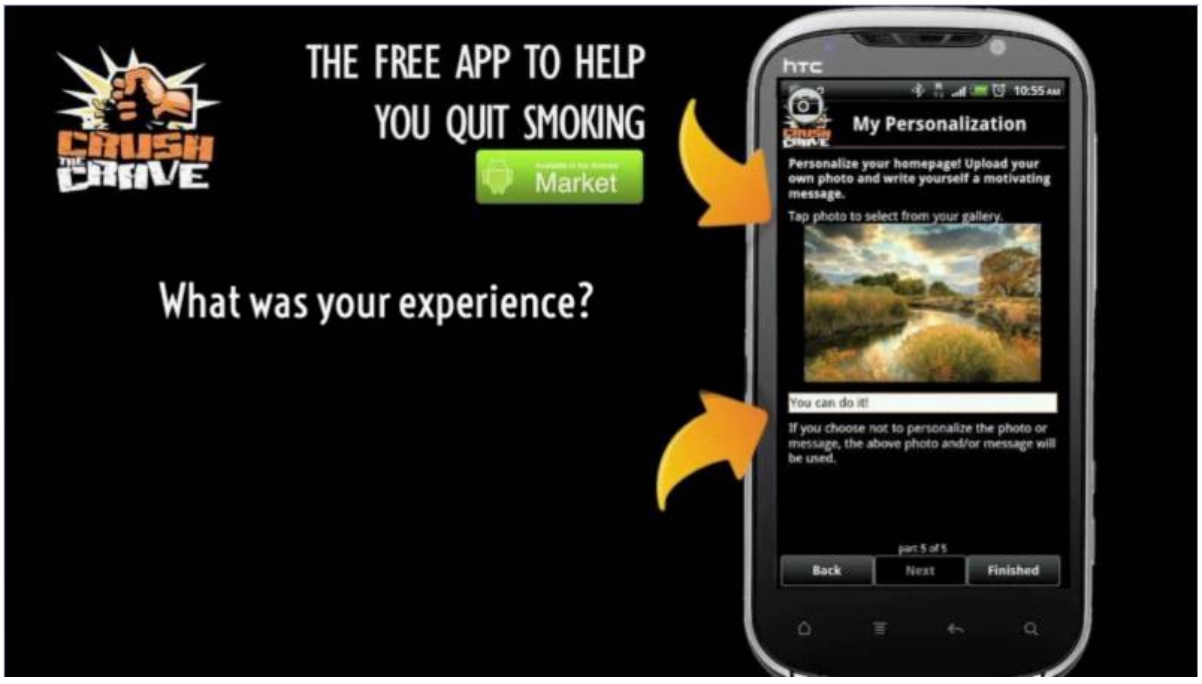
**Reply:** laura.struik@ubc.ca

Did CTC work for you?

***You've recently used CTC.***

**Tell us what you think!**

***And receive $50 for sharing with us!***




**Why we are contacting you**

You've agreed to be contacted to share your experiences with using the app in the CTC quit smoking study.

**About the study**

We want to know what young adults think about CTC as a tool for helping them quit smoking. What worked well? What didn't? What needs to be improved?

**What is involved?**

- A 1 hour telephone interview.
- A brief questionnaire.

**Want to know more?**

Contact Laura Struik (PhD Candidate at UBC's Okanagan campus)
at laura.struik@ubc.ca or at 250-XXX-XXXX

a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

**Forward email**



UBC | address line 1 | city | state | zip code | country

Appendix I – Consent Form for Young Adults

a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

**Consent Form for Young Adults**

**Research Project Title:** ***Young adult smoking cessation and smartphone technology: A qualitative investigation of the 'CTC' mobile app.***


| | |
|---|---|
| **Principal Investigator:** | Laura Struik, BScN, MSN, PhD(c), RN<br>Doctoral Student, University of British Columbia's Okanagan Campus |
| **Co-Investigator:** | Joan L. Bottorff, PhD, RN, FCAHS, FAAN<br>PhD Supervisor, Chair in Health Promotion and Cancer Prevention, Director of the Institute for Healthy Living and Chronic Disease Prevention, Professor at the School of Nursing, University of British Columbia's Okanagan Campus |
| **Co-Investigator:** | N. Bruce Baskerville, PhD, CE<br>PhD Committee Member, Senior Scientist at the Propel Centre for Population Health Impact, Research Associate Professor in the Faculty of Applied Health Sciences, University of Waterloo |
| **Co-Investigator:** | John Oliffe, PhD, RN<br>PhD Committee Member, Professor at the School of Nursing, University of British Columbia |
| **Co-Investigator:** | Susan Crichton, BSc, MA, PhD<br>PhD Committee Member, Director of the Innovative Learning Centre, Director of the Faculty of Education, Associate Professor in the Faculty of Education, University of British Columbia's Okanagan Campus |

**Purpose of the Study:**

The purpose of this study is to learn about how CTC® plays a role in young adults' smoking cessation efforts. This study is part of research conducted for a doctoral thesis of Laura Struik (researcher). The final doctoral thesis document will be available as a public document through the University of British Columbia. Findings will be used to develop descriptions of how CTC® was designed to influence young adult smoking cessation, how CTC® is used among young adults, and how the app enables/constrains their smoking cessation efforts. Results will be prepared into a PhD dissertation, reports, scientific papers, and presentations. Individual responses will be presented in aggregate (group) form so that it is not possible to identify individual participants. You have been asked to participate in this study because you are a young adult who has been using CTC® for quitting smoking. Any information provided by you to the researchers will be kept strictly confidential. **Your participation in this study is voluntary. You may decide not to participate or you may withdraw from the study at any time and it will not impact you in any way.** If you withdraw from the study, you may elect to withdraw any or all of the information you have provided.

**Study Procedures:**

If you take part in this study, you will be asked to spend about 60 minutes with the principal investigator via your preferred method (telephone or online with the option for initiating video), and a time that is most convenient to you. You will be asked to talk about your use of CTC® and your perceptions of the role that the app has played in your smoking cessation efforts. The interviews will be audio-recorded by the interviewer and later transcribed. We will access information in the questionnaires that you have completed for the CTC quit smoking survey study about your smoking patterns and app use. Any text or other discussion data collected may be used in the research report, as well as for educational purposes.

**Risks:**

If you participate in this study, there are no risks greater than what you would experience in your daily life.

**Potential Benefits:**

You may not receive any direct benefits for participating in this study, however, the information you provide will assist in improved understanding of CTC® and its role in young adult smoking cessation. This information can help direct further research and provide insight to the

improvement and development of smoking cessation smartphone apps directed towards young adults.

**Remuneration:**

As a token of appreciation for participating in the study, each participant will each receive $50.

**Confidentiality:**

Any information we obtain form you will be held strictly confidential. No information that discloses who you are will be released or published without your further and specific consent. No records which identify you by name or initials will be allowed to leave the researchers' offices. Your name will not be associated with the information collected in the interviews. A code number will be used to identify you. The information will be stored in a locked file cabinet and computer files will be password protected and stored in an encrypted device and/or file folder. This information will only be accessible by the research team. You will not be identified in any reports of this research. All documents (including electronic files, audio tapes and transcriptions) will be retained for a minimum of five years after publication and provided a secure storage location on UBC's Okanagan campus. Audio-recordings of interviews will be destroyed after that period of time.

**For More Information:**

If you have any questions or would like further information, you may contact Laura Struik, the principal investigator, by phone at 250-XXX-XXXX or email at laura.struik@ubc.ca. You may also contact Laura Struik's PhD supervisor, Dr. Joan Bottorff, by phone at 250-807-8627 or email at joan.bottorff@ubc.ca.

If you have any concerns or complaints about your rights as a research participant and/or your experiences while participating in this study, contact the Research Participant Complaint Line in the UBC Office of Research Ethics toll free at 1-877-822-8598 or the UBC Okanagan Research Services Office at 250-807-8832. It is also possible to contact the Research Complaint Line by email (RSIL@ors.ubc.ca ).

**Consent:**

- I have read and understand this consent form.
- I have received a copy of this consent form.

- I consent to participate in this study.
- I consent to the interview being audio-recorded.

Signature_____ Today's Date_____

Printed Name_____

Researcher or Delegate's Signature_____ Date_____

- If you cannot sign and return the consent form, you may provide consent by responding to this email stating the following: *"I have read the consent form and am providing consent to participate in this study by this affirmative email response."*

**Request for follow-up information:**

I would like to receive a copy of the brief report of findings and results from the study.

Yes_____

No_____

Please send the report to:

Name:_____

Mailing Address:_____

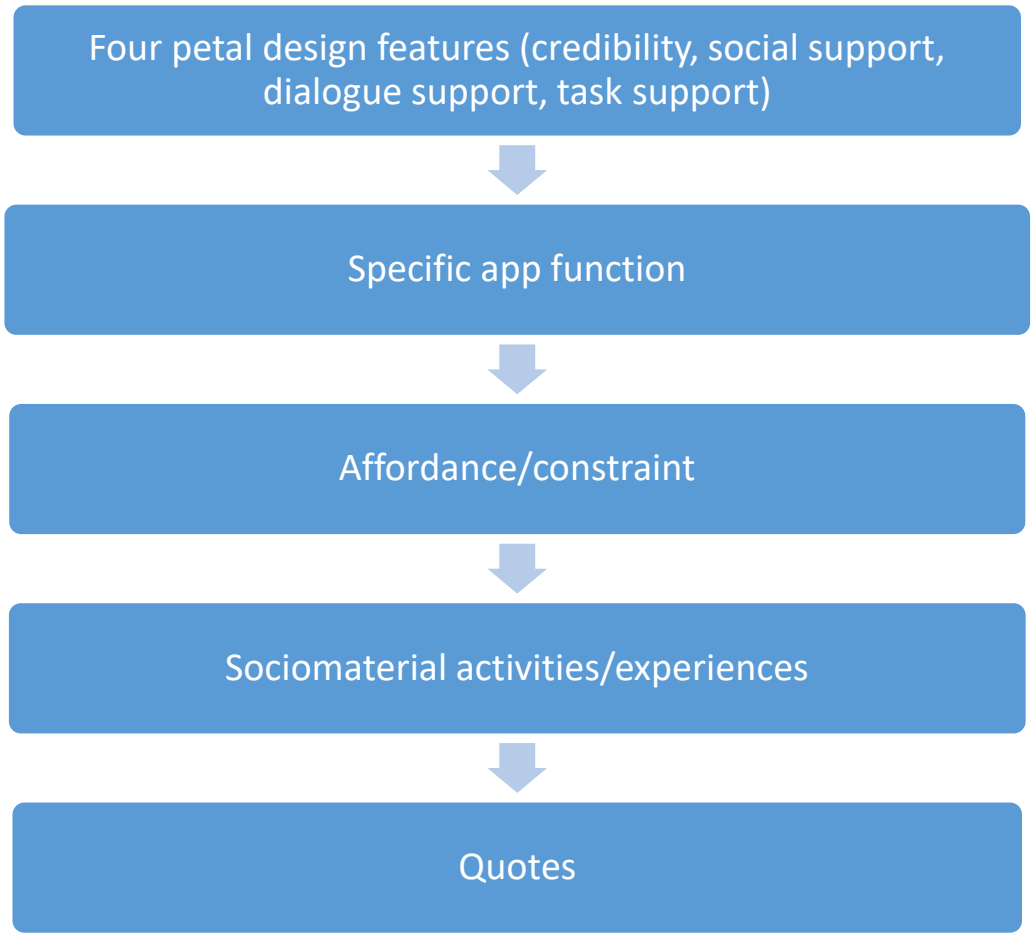
_____

_____

_____

Postal Code:_____

Appendix J – Analytical Framework for Coding Data



Appendix K – Application of Analytical Framework Example – Social Support and Young Men