

**Does Cannabis Co-use Impact Tobacco Cessation of
Treatment-Seeking Young Adults?**

A Secondary Analysis

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Abstract

Background. The impact of cannabis co-use on tobacco cessation is uncertain. This study examined whether nonuse, less-than-daily, or daily co-use of cannabis is associated with tobacco cessation outcomes among treatment-seeking 18-to-29-year-old smokers.

Methods. Between 2013 and 2015, young adult Ontarians with no contraindications could use an online platform to order free, mailout, 8-week course of nicotine replacement therapy (NRT) with supplementary self-help materials. Of 23,312 visitors, 10,823 met residency and age eligibility criteria, 8,491 ordered their preferred product (patch or gum), and 1,573 completed baseline and 6-month follow-up self-report surveys. Past 30-day cannabis use was measured at baseline. Tobacco abstinence at follow-up was defined as continuous since estimated end of treatment; reduction was defined as smoking less than 50% of the baseline consumption. Attrition was associated with being unemployed, less educated, more nicotine dependent, and more likely to have a past year quit attempt.

Results. Continuous tobacco abstinence was achieved by 10.3% of less-than-daily cannabis users, but 16.2% of daily and 15.7% of non-cannabis users (*ns*). A binary logistic regression controlling for demographic characteristics, treatment use, nicotine dependence, cigarettes per day, past year quit attempt and alcohol use revealed less-than-daily cannabis use ($AOR = .64, p < .05$), but not daily cannabis use ($AOR = 1.08, p > .05$) reduced the odds of quitting compared to nonuse. No other variables influenced odds of abstinence. Of the 1,342 participants who did not achieve abstinence from tobacco, 20.2% of daily cannabis users, 23% of less-than-daily cannabis users, and 22.7% of nonusers reduced their tobacco consumption (*ns*). A binary logistic regression revealed greater odds of reduction for smokers who smoked less and had a past year quit attempt.

Conclusion. The pattern of results suggests less-than-daily, but not daily cannabis use may inhibit successful abstinence among treatment-seeking young adults accessing free NRT mailout programs. Programs operating with limited budgets and supplies of NRT may consider directing less-than-daily co-users to other interventions. Research could explore whether changes in frequency of cannabis use occur during treatment and impact outcomes, and whether reasons for or methods of cannabis use influence tobacco cessation outcomes.

Keywords: tobacco, cannabis, cessation, young adult, nicotine replacement therapy

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Chapter 1: Introduction

Tobacco smoking is an epidemic (World Health Organization, 2020). The Tobacco Atlas, a comprehensive and definitive guide to global trends in tobacco use and consequences, compiles data from national and international governments and agencies such as the World Health Organization (WHO), the American Lung Association and the American Cancer Society (Drope et al., 2018). Categorizing countries based on the Human Development Index, and using data from WHO, the Tobacco Atlas reveals that smoking tobacco negatively impacts the world's sustainable development due to high economic costs (of nearly 2 trillion dollars annually) attributable to healthcare-related expenses (Drope et al., 2018). Less developed countries (e.g., Thailand) have a higher prevalence of smoking and higher death rates due to tobacco-related diseases compared to more developed countries (e.g., Canada). Although Canada has lower prevalence and mortality rates compared to other countries, and the prevalence of tobacco use has declined in recent decades (Reid et al., 2019), over 47,700 Canadians still die each year from tobacco-related illnesses. A recent Canadian Tobacco and Nicotine Survey (Health Canada, 2020) indicates that 10% of Canadians over the age of 15 currently smoke cigarettes; 3% of youth (15-19 years) smoke, as do 8% of young adults (20-24 years) and 11% of adults. Smoking cigarettes remains the leading preventable cause of morbidity and mortality in North America (CDC, 2020; Health Canada, 2011; Rabin et al., 2016).

Enabling smokers to quit tobacco use is a vitally important tobacco control strategy. Cessation of cigarette smoking is defined as the process of quitting or stopping smoking conventional cigarettes. Whether the cessation of nicotine use is included in the definition of cessation of cigarette smoking is open for debate within the field of tobacco research, considering that nicotine itself is far less dangerous to health than cigarettes which are an

incredibly harmful way to deliver nicotine (National Institute on Drug Abuse, 2021). Cessation of cigarette use is often deemed to be more important than the cessation of nicotine use. Accordingly, the complete stopping of smoking cigarettes may be viewed as successful cessation even if an alternative nicotine delivery system (e.g., e-cigarettes, and nicotine replacement therapy) has taken the place of cigarette smoking (National Cancer Institute, n.d.).

Tobacco control efforts often aim cessation strategies at mature adults, leaving young adults as a population that is frequently overlooked (Hammond, 2005). Meanwhile, high rates of tobacco use among young adults suggest the need for cessation intervention in this age group. Accordingly, the current study investigates cigarette smoking cessation among young adults.

Evidence suggests that how young adults use and stop using cigarettes is not necessarily consistent with how mature adults do so (Solberg et al., 2007). It is important to attend to the unique characteristics of young adults' tobacco use and cessation needs and preferences. Two areas of particular attention in this study are the co-use of cannabis and the impact of nicotine replacement therapy (NRT) as a quit aid.

The focus on cannabis co-use is relevant because of the increasing uptake of cannabis use over the last decade among the young adult population (Goodwin et al., 2018; Lowry & Corsi, 2020) and related concerns that cannabis use may adversely affect a smoker's tobacco cessation. As co-use increases among young adult smokers, tobacco cessation interventions may need to address both co-use and tobacco-only use to maintain progress in cessation efforts.

The focus on NRT as a quit aid is relevant for a number of reasons. First, use of nicotine patches or gum increases a smokers' success of quitting by 50%-70% (Hartmann-Boyce et al., 2018; Kushnir et al., 2017; Lindson et al., 2019). Second, although younger smokers are often unable or hesitant to access NRT in clinical settings (Babb et al., 2017), NRT offered through

mailout programmes are appealing to them and show favourable tobacco abstinence results (Bush et al., 2008; Cummings et al., 2006; Buller et al., 2014; Miller et al., 2005). Studying NRT mailout programmes is relevant because these types of interventions have been empirically proven to be effective with young adults (18-29 years), allowing for this study to determine whether this type of intervention is equally as effective for cannabis co-users as tobacco-only users in relation to cessation outcomes.

This secondary analysis study investigates whether co-use of cannabis is associated with tobacco cessation outcomes among treatment-seeking young adult smokers relative to those who do not use cannabis.

Chapter 2: Literature Review

2.1 Young Adults and Tobacco Use

Among individuals who smoke, one cohort particularly worthy of attention in cessation efforts is young adults. Not only are individual and societal benefits greater the earlier in the life course that smokers can be supported to quit, but young adulthood appears to be a period of flux in individuals' lives and thus a time in which cessation may be especially possible (Hair et al., 2017; Hammond, 2005). While several studies indicate that smoking progression and established patterns of tobacco use develop during young adulthood (Hair et al., 2017; Hammond 2005; Lantz, 2003; Terry-McElrath & O'Malley, 2015), there are also studies that suggest the fluctuating nature of young adults' tobacco use may offer opportunities to eliminate cigarette smoking before it progresses to a habituated or dependent behaviour (Hair et al., 2017; Terry-McElrath & O'Malley, 2015). Indeed, most young adult smokers are interested in quitting smoking and making attempts to stop smoking. For example, in a longitudinal study tracking the behaviour of 1,982 participants recruited at age 13 and followed until age 29, Tucker et al. (2005) found that between ages 23 and 29, 76% of smokers made a quit attempt. Overall, 26% of participants were successful in quitting for six months or longer during that time (Tucker et al., 2005).

It is also noted that young adults' tobacco consumption tends to be lower compared to older adults. For example, even among daily smokers, young adults report consuming an average of 10.7 cigarettes per day, significantly lower than older adults' 13.9 cigarettes per day (Health Canada, 2017). Lower levels of cigarette consumption are associated with higher odds of successfully quitting smoking (Rose et al., 1996). This underscores the importance of supporting

cessation efforts before young adults' tobacco consumption escalates and tobacco use becomes more established.

It is imperative to focus on young adult smoking cessation because of the crucial benefits quitting has to offer at both the individual and societal levels (Minian et al, 2010). Studies have shown that smoking cessation during young adulthood can result in many health benefits (Andrews et al., 2018). Specifically, cessation before the age of 30 can aid in eliminating symptoms and premature mortality associated with smoking tobacco (Andrews et al., 2018; Klein et al., 2013; Minian et al., 2010; Pirie et al., 2013; Villanti et al., 2010). In an evaluation study which examined the impact of smoking cessation systems on young adult male smokers, Minian, et al., 2010 found within one year of abstaining from smoking, the risk of heart attack decreases by 50%; within five years almost all health risks disappear, such that former smokers' level of health was the same as peers who never smoked (Minian et al., 2010). Jha et al. (2013), using a U.S. nationally representative sample of 113,752 women and 88,496 men, determined that people who quit smoking between ages 35 and 44 gained about nine years of life, while those who quit between ages 45 and 54 gained six.

Despite obvious health benefits, which are greater the earlier smokers quit smoking, the literature suggests there is a critical gap in tobacco control aimed at cessation among young adults (Ling & Glantz, 2004). Over the past decade, young adults (ages 20-24 years) have had the least steep decline in the prevalence of cigarette use compared to youth (ages 15-19 years) and older adults (ages 25 years and older) (Health Canada, 2017). Many tobacco cessation interventions currently in place are not tailored toward the young adult population (Hammond, 2005; Manian, 2010; Terry-McElrath & O'Malley, 2015). Determining the effectiveness of

tobacco cessation for young adult smokers who do (versus do not) co-use cannabis demands attention.

2.2 Cannabis Use Among Young Adults

2.2.1 Use of Cannabis

Using data collected approximately annually (2004 to 2017)¹ from nationally-representative cross-sections of Canadians, Rotermann (2019) notes cannabis has become increasingly popular and is one of the most commonly used substances in Canada. Among Canadians over the age of 15 years, the prevalence of cannabis consumption was 60% higher in 2017 compared to 2004. Over half of all Canadians over the age of 15 years have tried cannabis at least once in their lifetime (Rotermann, 2019). Prevalence of past-3-month cannabis use among young adults (20-24 years) is 21%, compared to 14% for youth (15-19 years) and 7% for adults (Leos-Toro et al., 2017). Figure 1 shows the historical trends in the prevalence of cannabis consumption among Canadians (Macdonald & Rotermann, 2017).

2.2.2 Co-Use of Cannabis and Tobacco

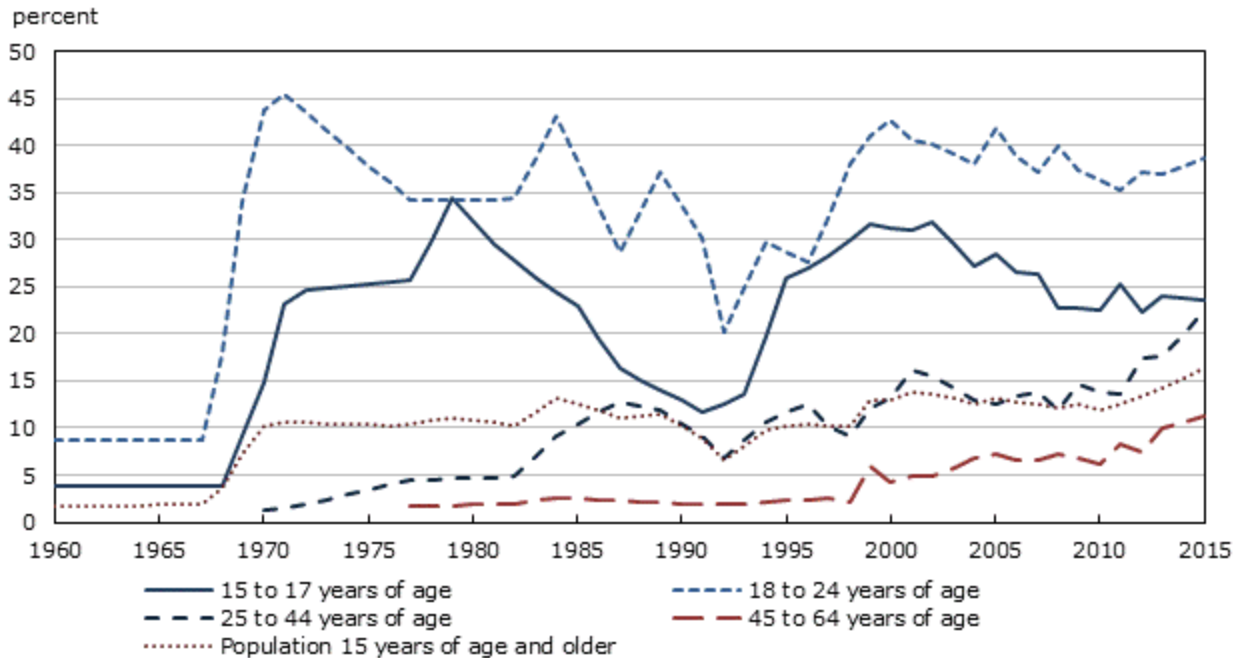
Co-use of cannabis and tobacco is common. To determine the degree of co-use among Canadians, Krist et al. (2013) analyzed two nationally representative population surveys: the 2009-2010 Canadian Community Health Survey (CCHS) and the 2010 Canadian Alcohol and Drugs Use Monitoring Survey (CADUMS). They determined one quarter (26%) of current tobacco smokers reported using cannabis within the past year, and two-thirds (67%) reported using cannabis in their lifetime.

¹ The 2004-2017 timeframe matches the data collection period for the original NRT mailout Study.

Figure 1

Benchmarked and Adjusted Rate of Cannabis Consumption by Age Group, 1960-2015

Chart 1
Benchmarked and adjusted rate of cannabis consumption by age group, 1960 to 2015



Note: The benchmarked rate of cannabis consumption estimates are based on a methodology that incorporates growth rates between modern and historical data sources with level estimates from the Canadian Community Health Survey – Mental Health.

Source: Statistics Canada, authors' calculations.

Note. From “Experimental Estimates of Cannabis Consumption in Canada 1960 to 2015”, by R. Macdonald and M. Rotermann, 2017, Statistics Canada – Economic Insights, p.3. Copyright 2017 by Statistics Canada.

Recent data show about 92-94% of high school students who currently smoke have also used cannabis, often within the past few months (Leos-Toro et al., 2017). Drug use initiated in adolescence usually continues into young adulthood (Hair et al., 2017; Hammond, 2005; Palmer et al., 2009; Thrul et al., 2021). Therefore, adolescents who co-use tobacco and cannabis will likely continue to co-use as they enter young adulthood.

2.2.3 Reasons to be Concerned

Current tobacco cessation interventions typically focus on treating nicotine dependence while addressing any other drug use either marginally or not at all. There is growing concern that conventional cessation interventions that exclusively address tobacco consumption may be less effective for smokers who do (versus do not) co-use cannabis. This is an important consideration given the sizable (and potentially growing) number of young adult smokers who also use cannabis (McClure et al., 2019; Twyman et al., 2016; Voci et al., 2020).

If dual-use becomes the norm, then tobacco cessation interventions must work at least as well for co-users as tobacco-only users to maintain progress in cessation efforts. And for reasons offered below, there is every indication that dual-use will become a dominant pattern, especially among younger adults.

First, policies which legalize cannabis for recreational use may increase access and opportunities for use and thus utilization of cannabis among tobacco users. Since the legalization of cannabis in Canada in October, 2018, cannabis has been more widely available through government, private and hybrid retail locations in-person and online. According to a recent report released by Statistics Canada, access to legal cannabis suppliers (retail and online) has increased approximately eightfold since legalization in 2018, making cannabis easier to obtain (Rotermann, 2021). Cannabis use among Canadian young adults (20-24 years) and adults (25

years and older) has risen in parallel, however, no change was observed among youth (15-19 years) since legalization (Health Canada, 2019).

Second, there is greater public acceptance of cannabis (Hopfer, 2014), less stigma around its use (Amroussia et al., 2020; Barker & Moreno, 2021), and less fear that cannabis is harmful (Berg et al., 2015), all of which may also be associated with increased use. Greater acceptance, less stigma, and less concern of harm may be even more pronounced in younger adults since they may be too young to have experienced negative attitudes of the past.

Finally, as Schauer and colleagues (2015) note, the advent and commercialization of new devices for consuming tobacco, like vaporizers (Lanza & Teeter, 2018), overlap with similar devices being used for cannabis consumption (Cassidy et al., 2018; Cohn et al., 2016). These delivery systems may be produced by the same manufacturers, sold by the same vendors, and marketed in tandem, thus promoting co-use (Khan & Cavale, 2021; McDonald et al., 2016; Mincer, 2015; Popova et al., 2017).

Given the profound individual and public health value of smoking cessation, it is important to understand whether cannabis use interferes with smoking cessation. As more studies on this question appear, the conclusion continues to be mixed. A review of the research examining the impact of cannabis co-use on smoking cessation is presented below.

2.3 Cannabis Use and Tobacco Cessation

2.3.1 How Cannabis Use Might Impact Tobacco Cessation

Given the profound individual and public health value of smoking cessation, and the growing use of cannabis among young adult Canadians (Leos-Toro et al., 2017), including smokers, it is important to understand how cannabis use might impact smoking cessation. The mechanisms by which cigarette smokers come to co-use cannabis, their reasons for doing so, and

how they do so may impact their ability to give up tobacco. Greater nicotine addiction among co-users, substituting one substance for another (i.e., cannabis for tobacco) in ways that allow individuals to maintain smoking habits and potentially relapse, cuing effects arising from the similar routes of administration (i.e., smoking) of tobacco and cannabis, and potential for cannabis use to reduce intention to quit, may all act as barriers to quitting tobacco. Alternatively, opportunities for substance substitution and the dampening effect of cannabis use on nicotine withdrawal symptoms may facilitate quitting. These possibilities are briefly considered here.

2.3.1.1 Nicotine Dependence

Cannabis use might impact tobacco cessation by amplifying nicotine addiction. Research shows cannabis use to be associated with an increased risk of nicotine dependence among cigarette smokers (Agrawal et al., 2012; McClure et al., 2019; Okoli et al., 2008; Voci et al., 2020; Wang et al., 2016). One explanation is that chronic use of cannabis may modify nicotinic receptor activity to heighten dependence (Chen et al., 2008). In animal studies, activating the endocannabinoid system appears to increase the rewarding properties of nicotine (Rabin & George, 2015; Valjent et al., 2002). Other explanations of why those who co-use cannabis and tobacco may be at an increased risk of nicotine dependence include: higher frequency of use, earlier age of initial smoking, and potentially use of other substances or drugs. Whatever the reasons, it appears that higher levels of nicotine dependence are self-reported by adolescent smokers who also use cannabis (Rubenstein et al., 2014; Wang et al., 2016). With increased nicotine dependence, quitting smoking successfully can be more difficult to accomplish (Voci et al., 2020).

2.3.1.2 Drug Substitution

It has been suggested that cannabis (especially if smoked) might hamper smoking cessation if it becomes a substitute for smoking and thus maintains a familiar pathway back to

smoking. Lemyre et al. (2019) contend that cannabis may be easily replaced with tobacco when the former is not available or socially acceptable (e.g., at school or work), but the reverse may not be so easily done. Considering that smoking cannabis is rapidly becoming more socially acceptable than smoking cigarettes (Jayakumar et al., 2019; Vogel et al., 2018), it seems possible that cannabis could be a ready substitute for tobacco. In fact, in their study of 282 dual-users (mean age 33) recruited from an online crowd-sourcing service and marketplace, McClure et al. (2019) observed the substitution of cannabis for tobacco. Among the 222 respondents who had ever attempted to quit tobacco use, half said their use of cannabis increased during the tobacco quit attempt. It is plausible that individuals co-using cannabis and tobacco may view cannabis as a substitute to help them reduce or quit tobacco. Using substitution as a cessation aid may reflect their predisposition to rely on non-evidence-based tobacco cessation approaches of questionable efficacy as compared to evidence-based approaches known to be effective.

On the other hand, some research supports the substitution of cannabis for tobacco to facilitate quitting. Morgan et al. (2013) conducted a double-blind, placebo-controlled study to assess the impact of low-dose cannabidiol (CBD) in an inhaler form on nicotine dependence among tobacco smokers who intended to quit smoking. Participants were 24 young adult smokers, 18-35 years old, who smoked more than 10 cigarettes per day and intended to quit smoking tobacco. Morgan et al. (2013) found a substantial reduction in the total number of cigarettes smoked during a seven-day period among participants in the intervention (CBD inhaler) group, compared to no substantial reduction in the control group. Researchers noted that the substantial reduction occurred in the absence of craving. Given that craving plays a critical role in relapse, the findings suggest that individuals who administer CBD may be able to reduce

their overall number of cigarettes without an increase in nicotine craving that would trigger a relapse back to smoking. Cannabis use may thus facilitate quitting.

Balerio et al. (2004) reached a similar conclusion by studying the interaction between cannabis and nicotine in mice. Examining the consequences cannabis potentially has on the somatic symptoms associated with nicotine withdrawal, Balerio et al. (2004) found that acute delivery of cannabis (Delta9-THC) was associated with a significant decrease in nicotine withdrawal signs such as shakes, tremors and scratches. Although this study was conducted on mice, the findings indicate that cannabis use may reduce withdrawal symptoms, potentially making relapse less likely, and quitting smoking more achievable.

Overall, research suggesting cannabis substitution might facilitate tobacco cessation seems to be at odds with research showing that cannabis use may hamper quitting because it increases the potential for and strength of nicotine dependence (making cessation harder to achieve). Different mechanisms may be in play for the acquisition versus extinction of tobacco use. More research in these areas is needed, along with studies of the effect of concurrent cannabis use on smoking cessation.

2.3.1.3 Route of Administration

A similar route of administration (ROA) of tobacco and cannabis has been examined as a possible influence of cannabis co-use on tobacco cessation. Often, tobacco and cannabis use a similar route of administration, i.e., inhalation (Agrawal, 2012; Hindocha et al., 2016). Many studies indicate that a similar ROA may hamper efforts to quit tobacco smoking because it creates behavioural, social, and environmental cues for use of the substances that overlap and persist when attempts are made to abstain from just one of the two substances.

This pairing means that the use of cannabis can trigger (cue) urges to smoke in recent tobacco quitters. For example, research examining visual cues has confirmed that seeing smoking and being around other people who are smoking triggers the urge to smoke (Conklin, 2006; Conklin et al., 2013; Vicario et al., 2014). Because cannabis is primarily smoked, continued use of cannabis after quitting tobacco smoking may trigger the urge to smoke a cigarette.

Successful tobacco cessation requires the disruption of habits and behaviours associated with the action of smoking. This may extend to people, places/environments, objects, activities, and other substances (Conklin, 2006; Niaura et al., 1998; Vogel et al., 2018). Smoking cannabis may increase the difficulty of quitting cigarettes due to the persistent exposure to tobacco-smoking cues that can trigger relapse (Agrawal et al., 2012; Schauer et al., 2016). Indeed, under certain circumstances, such as a strong personal connection, items such as an ashtray can trigger smoking (Conklin, 2006).

Returning to the idea that tobacco and cannabis are often used together (i.e., on the same occasion, with the same people), it may also be the case that the behaviours are socially-mediated such that co-users develop peer and friendship networks that are heavily populated with other co-users. The social processes within these peer networks may make it harder for co-users to quit using tobacco (Degenhardt et al., 2010).

Finally, using data from the 2014 Global Drug Survey, Hindocha and colleagues (2016) examined whether ROAs determine motivation to quit cannabis and tobacco use. A sample of 33,687 adult cannabis users with varying levels of tobacco use (from no use to heavy use), reported their preferred ROAs for both substances. Overall, the concurrent use of cannabis, versus tobacco use alone, led to poorer outcomes for tobacco cessation attempts (Hindocha et al.,

2016). More specifically, though, it was determined that smokers who used tobacco ROAs for the administration of cannabis (e.g., smoked cannabis with tobacco instead of vaporizing it or consuming edibles) reported a lower motivation to reduce other tobacco use (i.e., cigarette use) compared to those using non-tobacco ROAs. These findings suggest that tobacco ROAs for cannabis are associated with lower motivation to reduce other tobacco use and more negative effects of cannabis on quitting (Hindocha et al., 2016). Tobacco ROAs for cannabis may account for the poor tobacco cessation reported in other research studies (Ford et al., 2002).

2.3.1.4 Intention to Quit

As alluded to above, there is some speculation that cannabis use may reduce the odds of successful quitting by reducing intentions to stop tobacco use. Historically, smokers' intentions to quit have been assessed using an item from Prochaska's Stages of Change theory: "Do you plan to quit in the next 30 days?" (Prochaska & DiClemente, 1983). Research by Twyman et al. (2016), Vogel et al. (2018), and McClure et al. (2019) all used this same measure of intention to quit but reached dissimilar conclusions. Twyman et al. (2016) and Vogel et al. (2018) found no association between concurrent cannabis use and smokers' intention to quit tobacco, whereas McClure et al. (2019) reported a possible adverse link.

In their cross-sectional survey with 369 socioeconomically disadvantaged adults who identified as either daily or occasional tobacco smokers, Twyman et al. (2016) examined whether cannabis use influences the intention to quit tobacco smoking. The results showed that 15% of participants had intentions to quit, but current cannabis use was not significantly associated with that intention to quit tobacco smoking.

A study by Vogel et al. (2018) included 500 young adult smokers enrolled in a smoking cessation intervention. The intervention was made up of daily contact by research staff, weekly

counselling sessions and additional Cognitive Behavioural Therapy counselling sessions, offered on an online platform (Facebook) and matched to participants' level of readiness to quit.

Participants were categorized as dual-users of cannabis and tobacco if they reported recent use of cannabis at both 3- and 6-month follow-ups. Cannabis use was not associated with the intention to quit smoking, suggesting that cannabis users did not significantly differ in intention to quit compared to non-users.

In contrast, McClure et al. (2019) found that cannabis might have a significant effect on smokers' intention to quit. They used an online crowd-sourcing service and marketplace to recruit participants first from across the US, and then a year later from southeastern states. In their final sample of 282 dual-users (mean age 33), McClure et al. (2019) found intention to quit tobacco was negatively associated with "using cannabis within 30 minutes of waking" strictly in the southeastern sample. Although McClure et al.'s findings support the possibility that a 'high-dependence' level of cannabis use may dampen ones intention to quit tobacco use, this result may be limited due to the small sample size. However, it is noteworthy because it contradicts the findings from Vogel et al. (2018) and Twyman et al. (2016).

2.3.2 Mixed Evidence of Impact of Cannabis on Tobacco Cessation

The research reviewed above suggests that there are reasons to believe that cannabis use might influence tobacco cessation. Studies examining whether this is indeed the case yield mixed results. This research is reviewed below.

2.3.2.1 Cannabis Use Has No Impact on Tobacco Cessation

Looking at cannabis use and tobacco cessation, Rabin et al. (2016) found that cannabis use does not reduce the likelihood of successful tobacco cessation among treatment-seeking tobacco smokers. A secondary analysis was performed to determine whether recreational

cannabis use influences successful tobacco cessation outcomes after 12 weeks of pharmacological treatment. A sample of 1,226 participants (220 cannabis/tobacco co-users and 1,006 tobacco-only users) were randomly assigned one of three interventions (placebo, varenicline, or nicotine patch) along with mandatory behavioural counselling. Study findings suggest the co-use of cannabis and tobacco does not alter successful tobacco cessation rates.

Research by Hendricks and colleagues (2012) similarly showed that cannabis use is unrelated to successful cessation. Their study used data from 739 treatment-seeking, nicotine-addicted adults who were recruited for three separate randomized controlled trials (RCTs). Interventions for the RCTs included a psychological intervention and antidepressant therapy (study 1), eight weeks of nicotine replacement therapy (NRT) (patch) and group counselling (study 2), and 12 weeks of NRT (gum) or an extended period of NRT for up to a year (study 3). Controlling for drug use, age, and years of smoking, baseline frequency of cannabis use was unrelated to successful tobacco cessation sustained at 1-year follow-up. The same was true when post-treatment cannabis use was assessed. This suggests that cannabis use, either before or after initiating a tobacco quit attempt is unrelated to eventual successful abstinence.

Adding to this evidence is a study by Streck et al. (2017) who conducted a secondary analysis on a multi-center RCT smoking cessation intervention for 1,357 hospitalized, treatment-seeking, smokers who intended to quit after discharge. This study examined the differences in tobacco cessation outcomes among participants who reported past year, co-morbid use of cannabis only, other illicit drugs, and no drugs. Baseline surveys were administered during hospitalization to collect information on participants' demographic and smoking characteristics, as well as drug and alcohol use. Participants were randomly assigned to either standard care or a sustained care post-discharge intervention plan. Those in standard care received advice to use a

free Quitline service and a personalized recommendation for nicotine pharmacotherapy that they could purchase post-discharge. Those in the sustained care intervention received a free, 30-day supply of tobacco cessation medication once discharged, plus five automated interactive voice calls which allowed interested participants to refill medication or talk to a counsellor via a Quitline. Cessation of tobacco smoking was measured at 6-month follow-up, using biochemically-verified self-reports of quitting on a 7-day point prevalence measure. Results showed that no group differed from another in their use of pharmacotherapy or counselling after discharge. Controlling for the research arm, as well as numerous demographic and behavioural variables, the researchers found that, in comparison to no drug use, use of illicit drugs was associated with lower odds of quitting, but the use of cannabis only was not. The concurrent use of marijuana and tobacco was not associated with poorer tobacco cessation outcomes.

Together, these studies might suggest that cannabis use does not impact cessation. Indeed, Balerio et al. (2004) and Morgan et al. (2013) suggest that acute THC administration might attenuate nicotine withdrawal symptoms, and thus protect against relapse back to smoking. However, it should be noted that all the studies described here include only treatment-seeking adults who have established nicotine dependence (and possibly high comorbid drug use), and who received clinical interventions. When the scope of research is expanded to different populations and different quitting contexts, the results are not so clear.

2.3.2.2 Cannabis Use Reduces Likelihood of Tobacco Cessation

Contrary to the findings of Hendricks et al. (2012), Rabin et al. (2016), and Steck et al. (2017), who found no effect of cannabis use on tobacco cessation outcomes, Voci and colleagues (2020) determined that treatment-seeking tobacco smokers who co-use cannabis recreationally had significantly lower odds of quitting, compared to non-users (after adjusting for confounders

extending to sociodemographic attributes, patterns of tobacco, alcohol and other drugs, and mental and physical health). Unlike other studies conducted in clinical settings, Voci et al. conducted a secondary analysis of data collected from patients who were participating in a large-scale, “real-world” smoking cessation intervention called Smoking Treatment for Ontario Patients (STOP). In this intervention, health professionals at 227 primary care clinics were supplied with NRT which they could then provide to patients free-of-charge according to their clinical judgement. Between January 2014 and April 2016, 35,246 treatment-seeking patients received NRT along with brief cessation counselling, at 2–4 week intervals, for a maximum of 26 weeks. The large sample size, lack of strict exclusion criteria for patients entering the study, and absence of a standardized treatment protocol may help explain the findings of Voci et al. Specifically, the provision of tobacco cessation treatment under real-world conditions (versus in a strictly controlled manner) may alter the intervention in a way that produces lower rates of quitting success among co-users. Tobacco smokers who use cannabis may not be a homogeneous group; by using a larger sample with greater diversity in patterns and reasons for co-use, Voci et al. obtained a divergent outcome (i.e., lower odds of quitting).

Looking at young adult (versus adult) treatment-seekers, researchers have noted that cannabis use is associated with lower odds of reducing and abstaining from cigarette use (Abrantes et al., 2009; El-Khoury et al., 2018; Ford et al., 2002; Schauer 2017; Vogel 2018). For example, utilizing data from a randomized controlled trial of a highly tailored, online smoking cessation intervention for young adults, Vogel et al. (2018) examined differences in smoking cessation outcomes for cannabis users and non-users. This study of 500 young adult tobacco smokers (18-25 years old), found that co-use of cannabis did not influence the likelihood of having made a quit attempt. However, participants who co-used cannabis and tobacco had lower

odds of reducing their cigarette intake and abstaining from smoking compared to those who did not use cannabis. Vogel et al. (2018) conclude that young adults who co-use cannabis and tobacco (versus tobacco alone) may have the same desire to quit but less success with smoking cessation interventions.

Looking at the cessation of tobacco use in community samples, Ford et al. (2002), El-Khoury et al. (2018), Abrantes et al. (2009), and Schauer et al. (2017), all determined that successful cessation was less likely among smokers who did (versus did not) co-use cannabis.

2.4 Purpose of Study

Tobacco cessation—especially among young adults—is an imperative strategy in efforts to reduce the population prevalence of smoking. Some literature suggests that co-use of cannabis may negatively affect tobacco cessation, however, over the last decade, findings relating to the impact of cannabis use on tobacco cessation have been inconsistent. It is important to determine whether cannabis use impacts young adult smokers' cessation outcomes. Therefore, the current study aims to investigate whether co-use of cannabis is associated with tobacco cessation outcomes among treatment-seeking young adult smokers relative to those who do not use cannabis.

For the purpose of this study, the term abstinence (rather than cessation) is used in research questions to provide clarity that the measure of cessation is operationalized as sustained *abstinence* from tobacco use over a 6-month follow-up period. Using a 6-month follow-up period is a convention in the tobacco control literature. It is consistent with behaviour change theories (especially Stages of Change (Prochaska & DiClemente, 1983; Prochaska & Velicer, 1997)) that suggest a genuine progression from smoking to non-smoking status requires six months of active effort. The stipulation of sustained abstinence from tobacco use ensures that the cessation

outcomes under investigation derive from the intervention and not a second, separate quit attempt.

Although the studies reviewed above examine co-use of cannabis almost exclusively as a dichotomy, the whole of the literature suggests that the impact of cannabis co-use on cessation may be nuanced such that a crude, dichotomous measure of co-use (i.e., use and non-use) is less desirable than a graduated one (e.g., non-use, less than daily use, and daily use). Outside the area of smoking cessation, there is evidence that the characteristics of cannabis users themselves, and the health and well-being outcomes they experience differ for daily use and less than daily use. For example, Hango and LeRochelle-Côté (2018) used nationally representative data from the 2015 Canadian Tobacco, Alcohol, and Drugs Survey and the 2014 General Social Survey to examine cannabis use in Canada. They found that a larger proportion of daily cannabis users report the presence of an emotional, psychological, or mental health disability (e.g., anxiety, depression, bipolar disorder, substance problems, etc.), compared to those who use cannabis less frequently (i.e., once a week or less) or no use at all in the last month. Literature also shows that tobacco smoking behaviours differ among daily versus less-than-daily cannabis users. For example, Pacek et al. (2018) found that daily cannabis users have a higher prevalence of cigarette smoking (54.57%) compared to non-daily cannabis users (40.17%) and non-users (15.06%). These types of differences speak to the value of exploring cannabis use according to daily, less-than-daily, and non-use categories.

2.5 Research Questions

This study utilizes secondary data from the NRT Mailout Study of young adults' use of nicotine patches and gum that was conducted from 2013 to 2015. To investigate whether co-use of cannabis is associated with tobacco cessation outcomes among treatment-seeking young adult

smokers relative to those who do not use cannabis, the following research questions were addressed.

2.5.1 Research Question 1

What proportion of respondents achieved abstinence from tobacco at 6-month follow-up?

2.5.2 Research Question 2

a. Is co-use of cannabis associated with tobacco abstinence?

b. Is co-use of cannabis associated with tobacco abstinence after controlling for both demographic (age, sex, education, and employment status) and behavioural variables (nicotine dependence, cigarettes per day, past year quit attempt, alcohol use, and treatment use)?

2.5.3 Research Question 3

Among respondents who did not achieve abstinence, what proportion of respondents achieved reduction in tobacco at 6-month follow-up?

2.5.4 Research Question 4

a. Among respondents who did not achieve abstinence, is co-use of cannabis associated with successful tobacco reduction?

b. Among respondents who did not achieve abstinence, is co-use of cannabis associated with successful tobacco reduction after controlling for both demographic (age, sex, education, and employment status) and behavioural variables (nicotine dependence, cigarettes per day, past year quit attempt, alcohol use, and treatment use)?

2.5.5 Research Question 5

Among respondents who did not achieve abstinence, do any identify cannabis use as a reason for relapse?

Chapter 3: Methodology

3.1 Overview

This study utilizes secondary data from the NRT Mailout Study of young adults' use of nicotine patches and gum that was conducted by Leave the Pack Behind from 2013 to 2015.

At the time of the study, Leave The Pack Behind was a comprehensive, province-wide, initiative designed to eliminate tobacco smoking among young adults. As part of the initiative, Leave The Pack Behind offered free nicotine replacement products (patch and gum) to young adult smokers via its NRT mailout program (described in section 3.2.1.1). From 2013 to 2015, Leave The Pack Behind collected extensive data from all service-users to explore who used the system, how they did so, and with what outcomes.

The NRT Mailout Study received ethical clearance from Brock University's Research Ethics Board in 2013 (REB 13-004). Clearance was given to researchers named in the application² to allow them full access to the database for the purpose of secondary analysis. Clearance granted retention of the data for 15 years allowing for researchers named on the application to share the anonymized data with colleagues and students working under their supervision in order to analyze the data in a collaborative manner consistent with the study described in the original application. Participants were advised of all these matters through informed consent. Therefore, analyses of the data for the current study are consistent with the ethical clearance obtained.

² Kelli-an Lawrance, Brock University; Darrell Grant, Brock University; Peter Selby, University of Toronto.

3.2 The NRT Mailout Study Data Set

3.2.1 Study Context

The following sections outline details of the NRT Mailout Study data that are pertinent to this current thesis.

3.2.1.1 NRT Mailout Programs

A wide range of smoking cessation interventions exist. They are often identified as either clinical treatments or population-based interventions. Clinical treatments typically include pharmacotherapy and behavioural therapy (e.g., counselling, group programmes, motivational interviewing). They tend to involve person-to-person delivery. Population-based interventions on the other hand are programs and services such as self-guided print and online programs, contests, and mailout NRT initiatives. Sometimes they are supplemented with tailored digital communication (such as emails or texts).

Decades of research attests to the efficacy of various treatments—including both clinical (Cahill et al., 2013; Lancaster & Stead, 2017; Stead et al., 2013; Stead et al., 2017) and population-based (Bala et al., 2017; Hartmann-Boyce et al., 2018). It is widely accepted in the practice of tobacco cessation that population-based interventions are less efficacious than clinical interventions but far superior in terms of reach (Rigotti et al., 2011). Indeed, population-level interventions seem to hold particular appeal for younger smokers who prefer self-guided, “do-it-yourself” interventions (Cummins et al., 2007; Hughes et al., 2009). Considering that pharmacotherapy is well-known to be more efficacious than self-directed quitting such as cold turkey, the option of including NRT in population-level interventions has drawn attention.

Population-based interventions in which smokers are mailed nicotine replacement products, free-of-charge, have gained considerable traction in public health practices because they can reach a large number of smokers – including those who are geographically isolated, economically disadvantaged (Zawertailo et al., 2012), and unlikely to seek clinical treatments (Cunningham et al., 2016). NRT enhances the odds of quitting relative to no NRT, regardless of whether it is delivered by mail or through clinical referral (Cunningham et al., 2016).

NRT mailout programs have been used successfully in a variety of settings, with a variety of dosing levels. For example, 6-weeks’ worth of free NRT was offered to anyone who called the Quitline as part of a statewide campaign in New York City (Miller et al., 2005). In another study, young adult college students received a 2-week “sample pack” of nicotine patches simply by submitting a request (online or by phone) (Buller et al., 2014). In a random digit dial strategy, 500 smokers who expressed hypothetical interest in using NRT were sent a supply (Kushnir et al., 2017). In all circumstances, satisfactory quit rates were obtained – generally in the range of 8% - 33%. (Spontaneous (“cold-turkey”) quit rates are conventionally pegged at 2-3% (Stead et al., 2013). Indeed, there is strong evidence attesting to the effectiveness of NRT mailout programs (Cummings et al., 2010; Cunningham et al., 2016; Voci et al., 2020; Zawertailo et al., 2013).

3.2.1.2 Leave The Pack Behind’s Program

At the time of the study, Leave The Pack Behind was a well-established, comprehensive, multi-sectoral tobacco control initiative tailored to young adults, and offering a variety of smoking cessation supports including an NRT mailout program. Using an extensive range of promotional strategies in traditional and social media channels, Leave The Pack Behind steered young adult Ontarians who smoked cigarettes to its online, NRT ordering platform. There,

visitors could access NRT information, assess their eligibility to receive free NRT from Leave The Pack Behind, and (if eligible), order an 8-week supply of nicotine patch or gum.

The NRT was delivered to young adults as part of an intervention package that included the following:

1. A small guide that recapped instructions for correct product use, repeated researchers' contact information, reiterated that study participation is not a substitute for medical consultation, and listed other sources of smoking cessation support.
2. Seven brief, automated emails, including three administrative emails that encouraged smoking cessation and provided information about nicotine patches and gum, and four motivational emails offering cessation support.
3. Self-help smoking cessation print materials tailored to their age and life circumstances. The exact amount of NRT (i.e., patch or gum) included was based on participants' responses to the screening questionnaire, in accordance with the product monograph and clinical guidelines. Intervention materials are detailed in Table 1.

3.2.2 Survey Administration

The landing page for the Leave The Pack Behind online ordering system included detailed information about the NRT Mailout Study and indicated that individuals who declined to participate in the study were eligible to receive NRT from other Leave the Pack Behind sources. All consenting participants were automatically directed to a very brief screening questionnaire to determine their eligibility for receiving free nicotine products and entering the study. See Table 2 for screening questions.

Participants with cardiovascular disease, those who were pregnant or breastfeeding, and those not meeting Ontario residency or young adult (18-to-29) age requirements were advised

Table 1*Materials Included in the Intervention Package*

Resource	Description and/or Example(s) of Resource
Nicotine patch/gum	<p>Individuals smoking ≥ 10 cigarettes per day received: 4-weeks of 21 mg/day, 2-weeks of 14 mg/day, and 2-weeks of 7 mg/day.</p> <p>Individuals smoking < 10 cigarettes per day received: 6-weeks of 14mg/day, and 2-weeks of 7 mg/day.</p>
Instruction booklet	<p>An easy-to-read guide that includes: (1) instructions for proper use of nicotine replacement products (including how to respond to common side effects or to changes in health); (2) FAQs about nicotine patch and gum; (3) referral information for the provincial quitline; and (4) detailed information about the research study.</p>
Age-tailored self-help booklet about quitting	<p>Smoke Quit: A 2-booklet resource specifically tailored to life circumstances of young adult students. Demonstrated to enhance quitting success and reduce cigarette consumption among non-quitters (Travis & Lawrance, 2009).</p> <p>Hey Something's Different: A single booklet specifically tailored to life circumstances of young adults not in school; modelled on the Smoke Quit booklets.</p>
Support emails	<p>Four support emails that include instructional videos, quit tips, stress management tactics, and referrals to other cessation resources and supports. Sent: Week 1, Week 2, Week 4, Week 6.</p> <p>Three administrative emails to encourage smoking cessation and provide information about nicotine patches and gum.</p>
Referral to provincial quit line	<p>Contact information for the free, non-judgemental service of the provincial quit line (Smokers' Helpline) is promoted on the registration and confirmation screens, in the emails and instruction booklet, and on a business card included in the intervention package.</p>

that they did not meet eligibility requirements for the study but may still be able to access free nicotine patch or gum by visiting their on-campus healthcare professional if they were an Ontario post-secondary student, or by contacting the *STOP* project or a participating community health centre or family health team if they were an Ontario resident. They were thanked for their interest and asked if they wish to provide their email address for entry into a prize draw for a \$10 gift card to Chapters.

Participants who were eligible to receive the free nicotine replacement product were automatically directed to the baseline survey and order form. The baseline survey included measures of: demographic characteristics; smoking/quitting history and future intentions; personal health; use of various substances (e.g., cannabis, alcohol, shisha/waterpipe); and beliefs and experiences with nicotine patches and gum. The order form was integrated into the survey and allowed individuals to indicate whether they wanted to receive nicotine patch or gum and to provide a mailing address for the intervention package.

Upon submitting their completed baseline questionnaire, participants saw a thank you message, and a prompt to enter the draw for a \$10 gift card to Chapters. They were also advised of the delivery timelines for the nicotine patches or gum.

The requested product (i.e., patches or gum) was ground-mailed to participants within 48 hours of their order. All participants received the standard 8-week course of treatment per the product monograph.

Along with their patches or gum, all participants received the intervention package materials described above.

Approximately 6 months after joining the study, participants received up to three automated emails inviting them to complete the electronic follow-up survey using

Table 2*Screening Questionnaire to Determine Eligibility to Receive NRT and Enter the Study*

Screening Questions	Response Options
I am a resident of Ontario	Yes No*
Age	(Insert age in years)
For the past 3 months, I have smoked cigarettes every day or almost every day.	Yes No*
I am:	Male Female (not pregnant or breastfeeding) Female, pregnant or breastfeeding*
In the past 2 weeks, I have had the following heart problems or circulation problems: (Check all that apply)	Heart attack* Life-threatening arrhythmias* Severe or worsening angina pectoris* Recent cerebral vascular incident* I have not had any heart problems or circulation problems in the past 2 weeks

**If the respondent provided an answer that signifies ineligibility for obtaining nicotine patches or gum from the Leave The Pack Behind ordering platform, the screening survey was discontinued.*

the hyperlink provided. Participants who did not respond to the automated email invitations for the follow-up surveys were telephoned by a trained, experienced *Leave The Pack Behind* research assistant. Up to 3 telephone attempts to reach a participant were made.

Using the same protocol, most respondents were also contacted approximately 8 weeks after joining the study in order to determine whether they had used the NRT they received. This served as an intervention check.

3.2.3 Participant Recruitment

A total of 23,312 individuals visited the online ordering site. Of those individuals, 14,456 completed the screening questionnaire resulting in 10,823 meeting all eligibility criteria for ordering NRT. As shown in Figure 2, 8,491 of these individuals completed the baseline survey with 5,025 (59%) ordering patches and 3,466 (41%) ordering gum. A total of 1,593 participants completed the 6-month follow-up survey. Ultimately, the final sample was reduced to 1,573 participants because 20 participants failed to provide a valid response to the follow-up item, “How many days has it been since you last smoked even a puff of a cigarette?” Without an answer, it was not possible to categorize their tobacco abstinence status at the 6-month follow-up (according to the formula described in section 3.3.3.1).

3.2.4 NRT Mailout Study Questionnaires

Please refer to Appendix A for the baseline questionnaire, Appendix B for the intervention check questionnaire, and Appendix C for the 6-month follow-up questionnaire. Measures related to only the current study are described below.

3.3 Measures

3.3.1 Baseline

Participants were asked to self-report the following at baseline in order to describe the sample and control for potential confounders.

3.3.1.1 Demographic Measures

Age. Participants reported their age in years and had to meet the 18-to-29 age inclusion criteria for the original NRT Mailout Study.

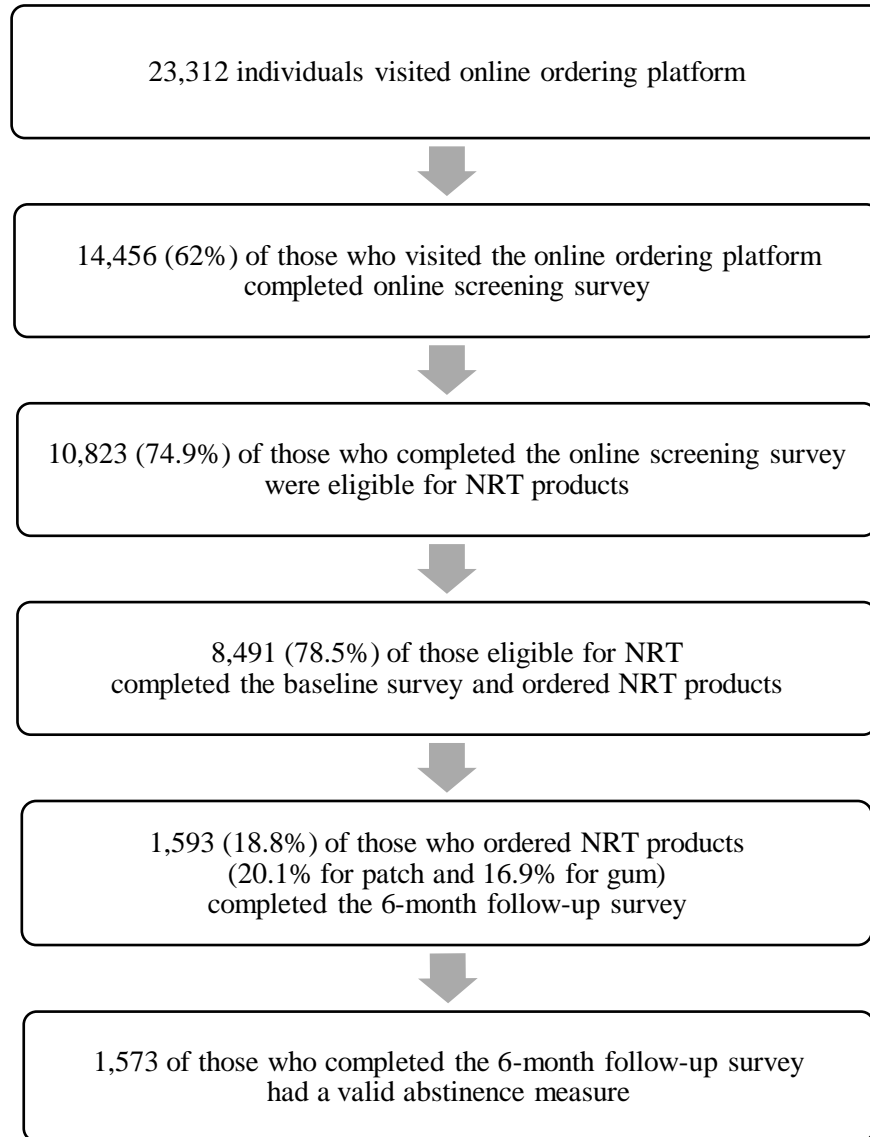
Sex. Consistent with medical screening for NRT use, participants reported sex (male; female (not pregnant or breastfeeding); female (pregnant or breastfeeding)). Participants who were pregnant or breastfeeding were excluded per NRT products monographs advising against use by these individuals.

Education. Participants reported their “Highest level of education” as: *Some elementary or some high school; High school; Some college or some university; College diploma; University or a post-graduate degree*. To be consistent and allow for comparisons with previous literature (e.g., Hair et al., 2017; Jayakumar et al., 2019; Kaza et al., 2020; Schauer et al., 2015; Voci et al., 2020; Zawertailo 2013), responses for the last two categories were combined (i.e., college diploma or university/post-grad degree).

Employment status. Participants reported whether they were: *attending college; attending university; attending trade school/adult education/private college, or not currently in school*. They also reported their “Current employment status” as: *Full time; Part time; Not currently working*. Participants who reported being in school were categorized as student, while those who reported not being in school were categorized as employed (either full-time or part-time), or unemployed based on their answer to “current employment status.”

Figure 2

Recruitment and Follow-Up for Obtaining Final Sample



Defining participants as employed, unemployed, or student is consistent with previous literature and allows for comparison (Voci et al., 2016). It is important to differentiate between those who are students and who are not because young adult students experience different environments, stressors and triggers for/reacting to their smoking behaviours compared to their community peers (e.g., non-students of the same age). Unlike the community setting, the post-secondary setting is uniquely tailored to young adults. For example, some institutions' health services include flexible hours and provide additional services during peak-stress periods, such as during exams, that cater directly to students' schedules (Valliantos et al., 2019).

Finally, students and non-students have different smoking behaviours. Literature suggests that non-students have a higher prevalence of tobacco use, cannabis use and co-use compared to students. Specifically, literature by Welte et al. (2011) and Lenk et al. (2012) suggests that tobacco use is strongly associated with not being a student compared to being a student. In addition, Ramo & Prochaska (2012) found that non-students have a higher rate of co-use of cannabis and tobacco, and exclusive use of cannabis was significantly higher among non-students than students. This evidence supports the use of the categories selected here.

3.3.1.2 Smoking History and Behaviour Measures

To assess individuals' tobacco use, a number of items are used pervasively in the literature and in population surveillance surveys such as Ontario Tobacco Research Unit Monitoring Reports (OTRU, 2020), Canadian Tobacco Use Monitoring Survey (now called Canadian Tobacco Alcohol and Drugs Survey) (Health Canada, 2018), Canadian Community Health Survey (Statistics Canada, 2020) Centre for Addiction and Mental Health Monitoring (CAMH, 2021). In 2013, after a rigorous process of reviewing the literature and consulting with experts, Ontario Tobacco Use Monitoring Survey identified core indicators and questions for

Smoke-Free Ontario smoking cessation service providers (Diemert et al., 2013). The recommended measures were used here.³

Cigarettes Per Day. This standard measure of tobacco use frequency required respondents to enter a number in response to the question, “How many cigarettes do you smoke per day?”

Past year quit attempt. Past year quit attempt was measured using the question “In the last 12 months, did you stop smoking for at least 24 hours? (*Yes, No*). Smokers who have tried to quit in the past are more likely to be successful in subsequent attempts, making this an important control variable in analyses of cessation interventions.

Nicotine dependence. Fagerström’s test for nicotine dependence (Fagerström & Schneider, 1989) is recognized as the standard instrument for assessing nicotine dependence (Baker et al., 2007). The single item, ‘time to first cigarette,’ is frequently used to estimate nicotine dependence and is a recommended indicator (Diemert et al., 2013). Therefore, in the NRT Mailout Study, respondents were asked: “How soon after you wake up do you smoke your first cigarette?” Participants who selected *Within 5 minutes* or *6 to 30 minutes* were categorized as more dependent, while those who selected *31 to 60 minutes* or *After 60 minutes* were categorized as less dependent. This is consistent with previous literature and allows for comparison among studies (Buller 2014; McClure et al., 2019; Zawertailo et al., 2013). Smokers with higher levels of nicotine dependence commonly experience more intense withdrawal symptoms and higher rates of relapse suggesting that this variable should be controlled in assessments of smoking cessation interventions.

³ Leave The Pack Behind, the sponsor of the NRT Mailout Program, was a Smoke-Free Ontario smoking cessation service provider at the time of the study.

3.3.1.3 Cannabis Use Measure

Cannabis use was measured using the question, “In the past month, how often did you use marijuana?” (*Not at all, 1-3 times a month, Once a week, More than once a week, Every day*). For analyses related to the research questions, responses are trichotomized into nonuse (*Not at all*), less than daily use (*1-3 times, Once a week, and More than once a week*), and daily use (*Everyday*).

3.3.1.4 Alcohol Use Measure

Alcohol use was measured using the question, “In the past month, how often did you consume alcohol?” (*Not at all, 1-3 times, Once a week, More than once a week, Everyday*). For analyses related to research questions, responses are dichotomized into nonuse (*Not at all*), and use (*1-3 times, Once a week, More than once a week, and Everyday*). Alcohol is a commonly used substance by young adults (Gubner et al., 2018). Its use often co-occurs with tobacco and/or cannabis (Vogel et al., 2018). A dichotomous alcohol use measure is consistent and allows for comparison with previous literature (Vogel et al., 2018).

3.3.2 Intervention Check

3.3.2.1 Treatment Use Measure

Based on the type of product received (i.e., patch or gum), participants’ treatment use was measured using the question, “Did you use at least some of the nicotine patches you received?” (*Yes, No*) or “Did you use at least some of the nicotine gum you received?” (*Yes, No*). Participants who responded “yes” were categorized as having used NRT treatment.

3.3.3 Six-month Follow-up

All smoking cessation and reduction measures described below are standard items used pervasively in the literature and in national surveillance surveys, and recommended as core indicators of Smoke-Free Ontario smoking cessation service providers.

3.3.3.1 Cessation and Abstinence Measures

To assess smoking cessation and abstinence, standard measures were used. Specifically, respondents reported 7-day point prevalence cessation: “In the past 7 days, have you been completely smoke-free, without even a single puff?” (*yes; no*). Those who reported cessation, were asked, “In the past 30 days, have you smoked a cigarette, even a puff?” (*yes; no*), and “How many days has it been since you last smoked even a puff of a cigarette?” Respondents entered a numerical value to indicate the number of days since they last smoked.

Participants were conditionally categorized as abstinent if they responded *no* to having smoked in the past 7-days *and* reported at least 120 days since they last smoked a cigarette. A marker of 120 days was established to be the determining point of achieving abstinence because the original NRT Mailout study supported participants to quit by the end of the 8-week treatment period using the NRT provided. There was a total of 120 days between when this treatment concluded and the 6-month follow-up period. To be considered abstinent, respondents had to be smoke-free for at least this long. In addition, all participants who met these criteria also had to report past-30 days smoke-free to be definitively categorized as an abstainer.

This study primarily explores abstinence. Although cessation is a key step in achieving abstinence, at 6-month follow-up, cessation (measured by 7-day point prevalence) could be completely unrelated to the NRT intervention. It could be a “brand-new” quit attempt triggered by a different intervention or set of circumstances. For the same reason, the 30-day point-

prevalence measure could be unreliably associated with the intervention. The abstinence measure created for this current study is stringent and enhances confidence that the intervention (and smoker characteristics/behaviours during the intervention) is responsible for the outcome observed.

3.3.3.2 Tobacco Use Among Non-Abstainers

Reduction in tobacco consumption. Participants who failed to achieve abstinence were asked, “How many cigarettes do you smoke per day?” Changes in participants’ smoking were determined using the reported number of cigarettes smoked per day at baseline and 6-month follow-up. Participants were categorized into one of two groups based on whether or not they successfully reduced their cigarette consumption. Successful reduction was defined as smoking less than 50% of their baseline consumption at 6-month follow-up. A cut point of 50% was used as an indicator of success because a reduction of greater than 50% has measurable positive implications for a smoker: individuals who achieve a greater than 50% reduction have greater odds of quitting in the future, compared to those who do not achieve a greater than 50% reduction (Asfar et al., 2011; Hughes et al., 2006). Reducing smoking to less than 50% of initial consumption is also associated with improved health (e.g., increased lung function) and fewer smoking side-effects (e.g., reduced cough and shortness of breath) (Hughes et al., 2006; Pisinger & Godfredsen, 2007).

Reasons for non-abstinence / relapse. Participants who did not achieve 7-day point prevalence cessation were asked, “What do you think caused you to start smoking again?”. Participants expressed their answer in their own words.

3.4 Analytic Strategy

3.4.1 Software

Data were analyzed using IBM SPSS Version 28.

3.4.2 Data Input and Preparation

3.4.2.1 Attrition Analyses

Attrition analyses were conducted to determine whether participants lost to follow-up differ from those retained in the final sample. Possible differences were assessed using a t-test analysis for interval-level variables (age, cigarettes per day) and a chi-square analysis for categorical-level variables (gender, education, employment status, nicotine dependence, past year quit attempt, alcohol use, and cannabis use). To accommodate the large sample size (and excessive power), alpha was set at .001 (two-tailed).

3.4.2.2 Cleaning and Screening

Although 1,573 participants completed the 6-month follow-up survey and had a valid measure for abstinence, not all had complete data. Frequencies were conducted for all baseline and follow-up variables to determine if there were out-of-range or missing values. Inspection of the output indicated no out-of-range values. However, a number of missing values were indicated, see below.

3.4.2.2.1 Missing Data. Missing data is a common occurrence in research (Kang, 2013; Li et al., 2015; Tabachnick & Fidell, 2013; Trzesniewski et al., 2011). Incomplete or completely missing data can happen for many reasons. For example, survey data may be missing due to the respondents' inability or refusal to answer, equipment malfunction, or simply human error (Trzesniewski et al., 2011). Although the reason why data may be missing cannot be determined in this secondary analysis study, it is important to identify the pattern and quantity of missing

data to determine the best method for handling the missing data values. The pattern of missing data (e.g., missing at random, missing completely at random, or not missing at random) is predictable using other variables in the study and allows the researcher to determine how serious the level of missingness truly is. Specifically, values that are missing at random pose a less serious risk to validity of findings, whereas values that are nonrandomly missing pose a greater level of seriousness (Tabachnick & Fidell, 2013).

Once the pattern and quantity of missing data are identified, then the method of handling missingness can be determined. For example, if there is a small, non-significant proportion of missing data present (less than or equal to 5%) and these data are missing at random, then almost any procedure for handling missing data can be used as it would yield similar results (Tabachnick & Fidell, 2013). However, if a larger proportion of data is missing, especially if missingness is not random, then a more complex procedure may be required (i.e., multiple imputation) (Trzesniewski et al., 2011).

The current study had very few missing values for age, sex, education, employment status, cigarettes per day, past quit attempt, nicotine dependence, cannabis use, and alcohol use. More substantial amounts of data were missing for treatment use, and cigarettes per day (6-month follow-up). The following information outlines the methods that were used to handle these missing data. Quantity and treatment of missing data are summarized in Table 2.

Frequent Category Replacement. For education, employment, past year quit attempt, cannabis use and alcohol use, the amount of missing data was approximately less than 2% per variable. Therefore, the method for handling missing values for these categorical variables was “most frequent category (mode)” replacement (Nikfalazar et al., 2019).

Last Observation Carried Forward. In tobacco research, last observation carried forward is commonly used to replace missing data for consumption or abstinence (Nelson et al., 2009). In this approach, the last valid observed value (for number of cigarettes smoked, for example) is used in place of the missing value (Barnes et al., 2010; Hedeker et al., 2007; Jackson et al., 2014; Liu-Seifert et al., 2010; Nelson et al., 2009). For the current study, the number of cigarettes smoked per day at baseline was used to replace values missing at 6-month follow-up for study participants who were still smoking (i.e., did not achieve abstinence). (At baseline, all study participants had scores; at follow-up, 28.7% of non-abstainers had missing scores). Baseline and follow-up measures of cigarettes per day were used to determine reduction status at follow-up among participants who did not abstain from tobacco smoking.

Multiple Imputation. Multiple imputation is an increasingly popular method for dealing with missing data (Halpin et al., 2016; Jakobsen et al., 2017; Lee & Simpson, 2013). Specifically, multiple imputation can be used when there is a substantial proportion of missing data (greater than 5% missing) and when the “most frequent category” or mean substitution is judged to compromise the trustworthiness of the data analytic approach (Jakobsen et al., 2017). In this approach, missing values are identified and replaced with a randomly generated sample of plausible values (based on the observed data), resulting in completed datasets (Jakobsen et al., 2017).

For the current study, a multiple imputation method was used to replace participants’ missing values for the treatment use (intervention check) variable. First, missing values were identified, and a logistic regression was run to determine the association between missingness and complete data. Missing values were determined to be non-random as missingness was associated with age and past year quit attempt. Missing values were replaced by imputation. The

multiple imputation analysis used the following observed variables as predictors: age, sex, cigarettes per day, past year quit attempt, education, employment, nicotine dependence and alcohol use. Per the analytic procedure, a new dataset containing multiple iterations of the missing values was combined into a single multiple-imputation result (Jakobsen et al., 2017).

3.4.3 Analytic plan

3.4.3.1 Sex-based Analysis

First, a sex-based analysis was conducted to determine whether the level of cannabis use (*nonuse, less-than-daily use, daily use*) differentially influences abstinence based on sex (*male, female*). An adjusted logistic regression model was conducted with abstinence (*yes, no*) as the dependent variable and controlling for demographic (age, sex, education, and employment status) and behavioural variables (nicotine dependence, cigarettes per day, past quit attempts, alcohol use, cannabis use and treatment use) and the interaction term (sex*cannabis use). Findings indicated no interaction meaning that levels of cannabis use did not differentially influence males' and females' odds of achieving abstinence in the current study.

Second, a sex-based analysis was conducted to determine whether the level of cannabis use (*nonuse, less-than-daily, daily use*) differentially influences reduction based on sex (*male, female*). An adjusted logistic regression model was conducted with reduction (*yes, no*) as the dependent variable and controlling for demographic (age, sex, education, and employment status) and behavioural variables (nicotine dependence, cigarettes per day, past quit attempts, alcohol use, cannabis use and treatment use) and the interaction term (sex*cannabis use).

Table 3*Treatment of Variables with Missing Values*

Variable and response options	Number and proportion of cases with missing data		Treatment of missing data
	n	%	
Baseline			
Age	0	0.0	
Sex	0	0.0	
Education Some elementary or some high school High school Some college or some university College diploma or university/post-grad degree	11	0.7	Replaced with most frequent category (i.e., Some college or some university, selected by 32.9% of participants who responded)
Employment status Student Unemployed Employed	5	0.3	Replaced with most frequent category (i.e., Employed, selected by 68.2% of participants who responded) ^a
Cigarettes per day	0	0.0	
Past year quit attempt Yes No	21	1.3	Replaced with most frequent category (i.e., Yes, selected by 62.3% of participants who responded)

Variable and response options	Number and proportion of cases with missing data		Treatment of missing data
	n	%	
Nicotine dependence Less dependent More dependent	18	1.1	Replaced using a proxy measure based on participants' own cigarettes per day score ^b
Cannabis use Nonuse Less-than-daily use Daily use	25	1.6	Replaced with most frequent category (i.e., nonuse, selected by 70.7% of participants who responded)
Alcohol Nonuse Use	28	1.8	Replaced with most frequent category (i.e., 1-3 times, selected by 42.3% of participants who responded ^c
Intervention Check			
Treatment use Nonuse Use	308	19.6	Replaced using multiple imputation ^d
6-Month Follow-up			
Cigarettes Per Day	385	28.7	Replaced using participants' own "last observation carried forward" (i.e., their baseline measure of cigarettes per day)

^a Participants were initially categorized as student or non-student (in response to a question about current school attendance). Those who reported not being in school were further categorized as employed or unemployed based on their answer to a measure of current

employment status. All missing values came from non-students. Therefore, the most frequent category for non-students (i.e., *Employed*, selected by 68.2% of non-students who responded) was used to replace the missing values for the employment status variable.

^b Missing values were replaced such that participants who smoked less than 10 cigarettes per day were identified as non-dependent, and those who smoked 10 cigarettes per day, or more were identified as dependent. This is consistent with product monograph and clinical practices for defining and treating dependence. Because there were no missing values for cigarettes per day at baseline, it is possible to assign participants' baseline scores for all 18 missing values.

^c Participants' past-month alcohol use was initially assessed as *1-3 times*, *Once a week*, *More than once a week*, and *Everyday*. Missing values were replaced with the response with the most frequent category (i.e., *1-3 times*, selected by 42.3% of participants who responded). Dichotomization occurred after missing data were replaced.

^d Missing values were identified and replaced using the multiple imputation technique described in the narrative.

Findings indicated no interaction observed, meaning that levels of cannabis use did not differentially influence males' and females' odds of reducing tobacco consumption in the current study.

3.4.3.2 Analysis Addressing Research Questions

To address the current study research questions, the following analyses were conducted with alpha set at .05, two-tailed.

Research Question 1. To address research question 1, “what proportion of respondents achieved abstinence from tobacco at 6-month follow-up?”, a frequencies analysis was conducted to determine the number and proportion of respondents who achieved abstinence from tobacco.

Research Question 2. To address research question 2a, “Is co-use of cannabis associated with tobacco abstinence?” a chi-square test was conducted with cannabis use and abstinence.

To address research question 2b, “Is co-use of cannabis associated with tobacco abstinence after controlling for both demographic and behavioural variables?”, an adjusted logistic regression was run. Based on evidence of their possible association with successful quitting, the following covariates assessed at baseline were included: age, sex, cigarettes per day, past year quit attempt (*yes, no*), education (*some elementary or some high school, high school, some college or some university, college diploma or university/post-graduate degree*), employment status (*student, unemployed, employed*), nicotine dependence (*less dependent, more dependent*), cannabis use (*nonuse, less than daily, daily use*), and alcohol use (*nonuse, use*). Education, employment, and cannabis use were dummy-coded. Whether participants used the NRT (*yes, no*) was also controlled for based on the possibility that use of the nicotine product received might systemically differ between smokers who do and do not co-use cannabis.

Research Question 3. To address research question 3, “Among respondents who did not achieve abstinence, what proportion of respondents achieved a successful reduction in tobacco at 6-month follow-up?”, a frequencies analysis was conducted to determine the number and proportion of respondents who achieved successful reduction defined as smoking at least 50% fewer cigarettes at follow-up compared to baseline.

Research Question 4. To address research question 4a, “Among respondents who did not achieve abstinence, is co-use of cannabis associated with successful tobacco reduction?” a chi-square test was conducted with cannabis use and reduction.

To address research question 4b, “Among respondents who did not achieve abstinence, is co-use of cannabis associated with successful tobacco reduction after controlling for both demographic and behavioural variables?”, an adjusted logistic regression was run. Based on evidence of their possible association with successful reduction, the following covariates assessed at baseline were included: age, sex, cigarettes per day, past year quit attempt (*yes, no*), education (*some elementary or some high school, high school, some college or some university, college diploma or university/post-graduate degree*), employment status (*student, unemployed, employed*), nicotine dependence (*less dependent, more dependent*), *cannabis use nonuse, less-than-daily, daily use*), and alcohol use (*nonuse, use*). Education, employment, and cannabis use were dummy-coded. Whether participants used the NRT (*yes, no*) was also controlled for based on the possibility that use of the nicotine product received might systemically differ between smokers who do and do not co-use cannabis.

Research Question 5. To address research question 5, “Among respondents who did not achieve abstinence, do any identify cannabis use as a reason for relapse?”, responses to the questionnaire item, “What did you think caused you to start smoking?” were analyzed using

conventional (manual) content analysis techniques. Content analysis is used to determine trends and patterns of words used, their frequency, and their relationship. In this study, the focus was mostly on exploring the types and frequencies of words and phrases that might indicate cannabis use was a factor in the participant's relapse to tobacco use. Ample literature suggests that relapse is often attributed to stress (Buczowski et al., 2014), socialization (Pisinger et al., 2010), alcohol use (Weinberger et al., 2013), and cannabis use (Weinberger et al., 2020). Therefore, types and frequencies of words and phrases related to these concepts were also explored. Finally, allowances were made for emergence of other content. In the content analysis, unique occurrences of words and phrases were counted such one answer could yield multiple types and/or counts of specified concepts.

Chapter 4: Results

4.1 Attrition Analysis

Attrition analysis was conducted to determine the difference between those lost to follow-up and the retained study sample. Results are presented in Table 4.

Findings indicated those lost to follow-up over-represented smokers who were unemployed, less educated, more nicotine dependent, smoking more cigarettes per day, and less likely to have made a quit attempt in the past year compared to those retained in the final study sample.

4.1.1 Sample Description

The final sample included 1,573 treatment-seeking young adults (18-29 years old), whose average age was 24.2 years ($SD = 3.4$). Participants smoked an average of 14.20 cigarettes per day at baseline ($SD = 8.4$). A full description of the sample is presented in Table 4.

4.2 Abstinence Outcomes

Research Question 1. What proportion of participants achieved abstinence from tobacco at 6-month follow-up?

Of the 1,573 study participants, 14.7% achieved abstinence from tobacco at 6-month follow-up.

Research Question 2A. Is co-use of cannabis associated with tobacco abstinence?

A chi-square analysis revealed no association of cannabis use with tobacco abstinence, $X^2(2, N = 1,573) = 5.63, p = .06$. Abstinence was achieved by 16.2% of daily cannabis users, 10.3% of less-than-daily cannabis users, and 15.7% of nonusers.

Table 4*Attrition Analysis to Detect Differences between Participants Lost to Follow-up and Retained in the Study*

Variable	Lost to follow-up		Retained (final sample)		<i>p</i>
	<i>n</i>	%	<i>n</i>	%	
Sex					.032
Female	3,641	52.6	875	55.6	
Male	3,277	47.4	698	44.4	
Highest education					<.001
Some elementary or some high school	685	9.9	127	8.1	
High school	2,375	34.3	414	26.3	
Some college or some university	1,950	28.2	529	33.6	
College diploma or university / post graduate degree	1,908	27.6	503	32.0	
Employment status					<.001
Student	2,324	33.6	698	44.4	
Unemployed	1,486	21.5	273	17.4	
Employed	3,108	44.9	602	38.3	
Past year quit attempts					<.001
No	3,071	45.1	572	36.9	
Yes	3,736	54.9	980	63.1	

Variable	Lost to follow-up		Retained (final sample)		<i>p</i>
	<i>n</i>	%	<i>n</i>	%	
Nicotine dependence					<.001
After 60 minutes	482	7.0	187	12.0	
31 to 60 minutes	866	12.6	244	15.7	
6 to 30 minutes	2,619	38.2	588	37.8	
Within 5 minutes	2,884	42.1	536	34.5	
Past-month cannabis use					.555
Not at all	4,845	71.1	1,112	71.8	
1-3 times	654	9.6	140	9.0	
Once a week	265	3.9	54	3.5	
More than once a week	410	6.0	106	6.8	
Everyday	643	9.4	136	8.8	
Past-month alcohol use					.005
Not at all	2,045	30.0	390	25.2	
1-3 times	2,757	40.4	666	43.1	
Once a week	1,099	16.1	260	16.8	
More than once a week	784	11.5	201	13.0	
Everyday	134	2.0	28	1.8	

Variable	Lost to follow-up		Retained (final sample)		<i>t</i>	<i>df</i>	<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
Age	24.5	3.4	24.2	3.4	2.8	8,489	.006
Cigarettes per day	16.9	9.3	14.2	8.4	11.1	2,521.8	<.001

Note. $p < .001$ is considered significant.

Research Question 2B. Is co-use of cannabis associated with tobacco abstinence after controlling for both demographic and behavioural variables?

A binary logistic regression analysis was conducted to examine whether cannabis use is associated with the likelihood of achieving tobacco abstinence. For this analysis, cannabis use was dummy coded such that less-than-daily and daily use were compared to nonuse as the reference group. In addition, employment status was dummy coded such that students and unemployed participants were compared to employed participants as the reference group. Education was dummy coded such that those who had a high school, some college or some university, and those with a college diploma or university/post-graduate degree level of education were compared to participants with some elementary school or some high school level of education as the reference group.

Stratifying by sex was not necessary given that level of cannabis use (*nonuse, less-than-daily use, daily use*) did not differentially influence abstinence based on sex (see section 3.4.3.1). However, the variable for sex was included as a covariate in logistic regression analysis.

After adjusting for potential confounders (including age, sex, cigarettes per day, past year quit attempt, education, employment status, nicotine dependence, alcohol use and treatment use), less-than-daily cannabis use, but not daily cannabis use, was found to be significantly associated with decreased odds of abstaining from tobacco compared to those who reported no-cannabis use (see Table 5). The odds ratios for age and cigarettes per day approached significance, such that older age and lower consumption were associated with higher odds of abstinence. No other variables—including NRT use—had significant odds ratios.⁴

⁴ Supplementary chi-square analysis revealed that expected pattern of NRT use supporting cessation. Among the 1,458 people who used the NRT they received, 15.1% achieved abstinence. Among the 115 people who did not use NRT, 9.6% achieved abstinence.

4.3 Reduction Outcomes

Research Question 3. What proportion of participants achieved a successful reduction in tobacco at 6-month follow-up?

Of the 1,342 participants who did not achieve abstinence, 22.6% achieved a successful (> 50%) reduction in tobacco at 6-month follow-up.

Research Question 4A. Is co-use of cannabis associated with successful tobacco reduction?

A chi-square analysis revealed no association of cannabis use with tobacco reduction, $X^2(2, N = 1,342) = 0.42, p = .81$. Successful (> 50%) reduction was achieved by 20.2% of daily cannabis users, 23% of less-than-daily cannabis users, and 22.7% of nonusers.

Research Question 4B. Is co-use of cannabis associated with successful tobacco reduction after controlling for both demographic and behavioural variables?

A binary logistic regression analysis was conducted to examine whether cannabis use is associated with the likelihood of achieving a successful reduction in tobacco. For this analysis, cannabis use was dummy coded such that less-than-daily and daily use were compared to nonuse as the reference group. In addition, employment status was dummy coded such that students and unemployed participants were compared to employed participants as the reference group. Prior to assessing this research question, a sex-based analysis was conducted to determine the interaction between cannabis use and sex.

Stratifying by sex was not necessary given that level of cannabis use (*nonuse, less-than-daily use, daily use*) did not differentially influence reduction based on sex (see section 3.4.3.1). However, the variable for sex was included as a covariate in logistic regression analysis.

Table 5*Logistic Regression Predicting Likelihood of Achieving Abstinence at 6-Month Follow-up*

Variable	<i>B</i>	<i>SE B</i>	<i>p</i>	<i>AOR</i>	95% CI	
					<i>LL</i>	<i>UL</i>
Age	.05	.03	.07	1.05	1.00	1.10
Sex (male)	-.01	.15	.96	.99	.74	1.33
Highest education ^a						
High school	.44	.31	.15	1.56	.85	2.86
Some college or some university	.18	.32	.58	1.19	.64	2.21
College diploma or university/ post-graduate degree	.06	.32	.86	1.06	.56	2.00
Employment status ^b						
Student	-.08	.17	.65	.92	.66	1.30
Unemployed	-.01	.21	.97	.99	.65	1.51
Cigarettes per day	-.02	.01	.06	.98	.96	1.00
Past year quit attempt (yes)	.02	.16	.92	1.02	.74	1.39
Nicotine dependence (more dependent)	.10	.18	.58	1.11	.77	1.59

Variable	<i>B</i>	<i>SE B</i>	<i>p</i>	<i>AOR</i>	95% CI	
					<i>LL</i>	<i>UL</i>
Alcohol use (use)	-.07	.17	.70	.94	.67	1.31
Treatment use (use)	.49	.33	.14	1.62	.85	3.10
Cannabis use ^c						
Less-than-daily cannabis use	-.45	.21	.03	.64	.42	.97
Daily cannabis use	.08	.25	.76	1.08	.67	1.78

Note. $n = 1,573$. Dependent variable for this logistic regression analysis was abstinence (yes, no). CI = Confidence Interval. AOR = Adjusted Odds Ratio. $p < .05$ is considered significant.

^a The categorical variable of education was dummy coded such that those who had some elementary or some high school educations were assigned as the reference group to further examine participants who attended high school, some college or some university, or received a college diploma or university/post-graduate degree.

^b The categorical variable of employment status was dummy coded such that those who reported employed status were assigned as the reference group to further examine participants who reported student and unemployment status.

^c The categorical variable of cannabis use was dummy coded such that participants who identify as nonusers were assigned as the reference group to further examine less-than-daily and daily users.

After adjusting for potential confounders (including age, sex, cigarettes per day, past year quit attempt, education, employment status, nicotine dependence, alcohol use and treatment use), cannabis use was not found to be significantly associated with successful (>50%) reduction (see Table 6). The odds ratios for variables cigarettes per day and past year quit attempt were significant, such that smoking fewer cigarettes per day and reporting a past year quit attempt were associated with higher odds of successful reduction.

Research Question 5. Among respondents who did not achieve abstinence, do any identify cannabis use as a reason for relapse?

Among the 1,342 respondents who did not achieve abstinence 888 participants provided responses to the question, “What do you think caused you to start smoking again?” Content analysis conducted solely by the researcher revealed one participant identified cannabis use as a factor in their relapse. The participant’s response stated, “Socializing; smoke pot for depression, when don’t have pot, smokes; when working.” Table 7 shows the types and frequencies of other reasons participants offered to explain why they relapsed.

Table 6*Logistic Regression Predicting Likelihood of Successful Reduction (>50%) at 6-Month Follow-up*

Variable	<i>B</i>	<i>SE B</i>	<i>p</i>	<i>AOR</i>	95% CI	
					<i>LL</i>	<i>UL</i>
Age	-.03	.02	.19	.97	.93	1.02
Sex (Male)	-.21	.14	.14	.82	.62	1.07
Highest Education ^a						
High School	.12	.28	.66	1.13	.66	1.94
Some college or some university	.38	.27	.16	1.47	.86	2.51
College diploma or university/ post-graduate degree	.35	.29	.22	1.42	.81	2.49
Employment Status ^b						
Student	.01	.16	.95	1.01	.73	1.39
Unemployed	.21	.20	.28	.28	.84	1.83
Cigarettes Per Day	.06	.01	<.001	1.06	1.04	1.08
Past Year Quit Attempt (Yes)	.33	.15	.03	1.39	1.03	1.87

Variable	<i>B</i>	<i>SE B</i>	<i>p</i>	<i>AOR</i>	95% CI	
					<i>LL</i>	<i>UL</i>
Nicotine Dependence						
More dependent	-.08	.17	.64	.92	.65	1.30
Alcohol Use (Use)	.11	.16	.50	.1.12	.81	1.54
Treatment Use (Use)	.34	.28	.22	1.41	.82	2.41
Cannabis Use ^c						
Less-than-daily cannabis use	.07	.17	.69	1.07	.77	1.50
Daily cannabis use	-.11	.26	.67	.90	.54	1.48

Note. N = 1,573. Dependent variable for this logistic regression analysis was reduction ($\leq 50\%$, $>50\%$). CI = Confidence Interval.

AOR = Adjusted Odds Ratio. $p < .05$ is considered significant.

^aThe categorical variable of education was dummy coded such that those who had some elementary or some high school educations were assigned as the reference group to further examine participants who attended high school, some college or some university, or received a college diploma or university/post-graduate degree.

^bThe categorical variable of employment status was dummy coded such that those who reported employed status were assigned as the reference group to further examine participants who reported student and unemployment status.

^c The categorical variable of cannabis use was dummy coded such that participants who identify as nonusers were assigned as the reference group to further examine less-than-daily and daily users

Table 7*Types and Frequencies of Terms and Phrases Participants Used to Explain their Relapse*

Content	Key terms and phrases	Frequency ^a
Stress	stress, anxiety, stressed out, stressing, stressful, stressor.	490
Other	words and phrases that do not fit into the established categories.	242
Socializing	socializing, party, partying, social, being around “smokers”/people who smoke, friends, partner smokes, people smoking, peer pressure, peers, activities.	168
Alcohol use	alcohol, drinking, wine, booze.	41
Cannabis use	pot	2

^a Frequency of key terms and phrases.

Chapter 5: Discussion

The aim of the current study was to investigate whether co-use of cannabis is associated with tobacco cessation outcomes among treatment-seeking young adult smokers relative to those who do not use cannabis. In the retained sample of 1,573 treatment-seeking young adult tobacco smokers who received 8 weeks of nicotine patches or gum plus motivational emails as part of a mailout program, 14.7% self-reported complete abstinence from smoking at six months post-enrollment. When participants were categorized according to their cannabis use, quit rates were 16.2% and 15.7% for daily cannabis users and nonusers, respectively, but 10.3% for less-than-daily cannabis users. After controlling for demographic and behavioural characteristics, less-than-daily cannabis use was associated with lower odds of achieving continuous abstinence compared to non-cannabis users.

There were several noteworthy features of these findings. First, although older age marginally increased the odds of abstinence, and smoking more cigarettes per day marginally decreased the odds, no other variables (except cannabis use) reached significance. These findings show that NRT mailout programs may be equally effective for young adult smokers regardless of their education, employment status, or even behavioural risk factors such as alcohol use and nicotine dependence. Given that the young adult population is known for being hard to reach, this is valuable information for service providers seeking ways to support cessation in this cohort.

The finding that NRT use was not significantly associated with higher odds of tobacco cessation in this treatment-seeking sample was unexpected given the widespread evidence supporting the effectiveness of NRT. In this study, results showing NRT use to be unrelated to successful abstinence may be an artifact of the poor quality of the dichotomous “yes/no” measure

that asked whether the participant used any of the NRT. Moreover, almost 20% of cases were missing on this variable and the value was imputed which could lead to classification error. Considerable research suggests that NRT enhances quitting success only to the extent that it is used correctly (Buller et al., 2014; Cunningham et al., 2016; Kushnir et al., 2017; Miller et al., 2005; Zhang et al., 2015). The measure employed here did not likely capture this important aspect of treatment use. On the other hand, a supplementary analysis revealed the expected trend toward higher rates of abstinence among NRT users than nonusers. Furthermore, the overall abstinence rate of around 15% for NRT-users in this sample is highly consistent with abstinence rates observed in studies of NRT across various settings (Hartmann-Boyce et al., 2018). Therefore, implications of the study results are addressed from the assumption that NRT produced the “proven” positive effect among those using it.

A second noteworthy feature of the findings is that the overall self-reported abstinence rate for this study was congruent with previous literature examining NRT mailout programs among treatment-seeking tobacco smokers (Cummings et al., 2010; Cunningham et al., 2016; Kushnir et al., 2017; Zawertailo et al., 2013). For example, research by Kushnir et al. (2017) examining the effects of different NRT quantities on cessation at 6-month follow-up, showed abstinence rates of 15.7% for those who used the entire supply of patches, 9.0% for those who used only some, and 5.7% for those who did not use any nicotine patches. In a study looking at the effectiveness of free NRT, advice, and self-help materials on quit rates of motivated smokers, Zawertailo et al. (2013) report a 6-month rate of abstinence of 21.4%. Among a sample of adults who requested and received up to 8 weeks of free NRT by mail, sustained abstinence at 12-month follow-up was self-reported by 12% to 27% of participants (Cummings et al., 2010). Finally, in a study examining the effects of mailout NRT patches on tobacco cessation among

nontreatment-seeking adult smokers contacted at random, Cunningham et al. (2016) report abstinence rates of 7.6% at 6-month follow-up. Overall, an NRT mailout program appears to be as effective for young adult smokers as adult smokers.

A final noteworthy feature of the findings is the stringent measure to assess whether complete, sustained, abstinence was achieved at 6-month follow-up. Participants were categorized as abstinent from tobacco only if they reported being smoke-free in the past 7-days *and* in the past 30 days, *and* from the time treatment concluded to the 6-month follow-up period (i.e., at least 120 days smoke-free). Establishing the 120-day criteria for number of days smoke-free links abstinence directly with the treatment. It enhances confidence that the treatment, and not some other factor, was the basis for successful abstinence. The use of (and required congruence among) three survey measures enhances the reliability of the self-report measure of abstinence. All together this stringent measure helps overcome the potential self-report bias of participants claiming complete, sustained, abstinence when that is not the case.

5.1 Achieving Abstinence from Tobacco

Most research examining cannabis use among tobacco smokers has dichotomized cannabis use as simply use/non-use. While some recent investigations have categorized cannabis use as recreational or therapeutic (medical) (e.g., Voci et al., 2020), there is no literature examining cannabis use among treatment-seeking tobacco smokers which measures the frequency of cannabis use similarly to this study (i.e., nonuse, less-than-daily use, daily use).

The finding that less-than-daily cannabis users had lower odds of achieving tobacco abstinence after treatment compared to non-cannabis users and daily cannabis users was a unique contribution of this study. Although it was unique, perhaps it should not be a surprise. Previous literature indicates other differences between daily and less-than-daily cannabis users (Caulkins

et al., 2020; Diep et al., 2022; Goldenberg et al., 2017; Lake et al., 2019; Mauro et al., 2018; Zeisser et al., 2011). For example, when Lake et al., (2019) compared “daily”, “occasional”, and “non” users of cannabis, they found that daily users reported more therapeutic motivation for cannabis use, including management of pain, stress, nausea, and mental health, and the desire to improve sleep. Occasional users, on the other hand, reported more recreational motivation or the desire to get “high.” When considering daily versus less-than-daily use of a substance or engagement in a behaviour, it presumably does not matter what that substance or behaviour is. A cohort that uses cannabis, sunscreen, condoms, alcohol, illicit drugs or even exercises occasionally (i.e., on a less-than-daily basis) compared to a cohort that uses the same things on a daily basis or in a formed habitual way is sure to be dissimilar in a variety of other ways.

While the current study did not determine the specific reasons why participants were using cannabis, it can be speculated that the participants using cannabis daily may have had more therapeutic reasons (including prescribed or self-prescribed use) and that the less-than-daily cannabis users may have had more recreationally-based reasons. Furthermore, daily cannabis users might have been using cannabis in a much more secluded or even more therapeutic way, rather than consuming cannabis socially. Finally, daily cannabis users would presumably be more dependent on cannabis since they are using it at such a high frequency (Caulkins et al., 2020; Zeisser et al., 2011).

Overall, it may be that young adults who are using cannabis on a less-than-daily basis are socializing and behaving in different ways than daily cannabis users or non-cannabis users do. And it may be these differences are reducing their odds of tobacco cessation. Specifically, less-than-daily cannabis users may be more likely to be using cannabis in a social setting, and similar to the phenomenon of “occasional” or “social” smoking, may not identify themselves as “true”

cannabis users (Freedman et al., 2012; Hoek et al., 2013; Song & Ling, 2011). Because they don't see themselves as cannabis-users they may not sufficiently prepare themselves for the possibility that their cannabis use would interfere with their ability to quit tobacco. Daily users, on the other hand, might be more likely to admit to themselves that possibly their cannabis use could pose a barrier to quitting smoking. They may prepare for this more effectively than less-than-daily cannabis users do and thus experience more success at quitting tobacco.

If less-than-daily cannabis users are using the product in a more social setting, it might also be that they surround themselves with other smokers whether they smoke tobacco or cannabis or both. Using cannabis in social settings with friends or others who promote or encourage that same behaviour may trigger their own smoking behaviour. Thus, despite their desire to quit, and their use of NRT, less-than-daily cannabis-users may be more exposed to, or less able to resist, the social cues triggering tobacco use.

Finally, it could be that less-than-daily cannabis users are using a different type of route of administration for their cannabis use, compared to daily cannabis users. Less-than-daily cannabis users may be smoking cannabis which perpetuates their exposure to triggers and therefore may entice them to continue or resume tobacco smoking behaviours. Daily cannabis users, on the other hand, may be using cannabis through other ROAs that are less likely to involve combustion (e.g., cannabis oil, edibles). If daily cannabis users are using different ROAs than less-than-daily, they may be able to avoid impact that smoking cannabis would have on their quit attempt.

5.2 Achieving Reduction from Tobacco

Although quitting smoking is the ideal goal for individual and population health, harm reduction is another important pillar of tobacco control efforts. Harm reduction occurs when

smokers reduce cigarette consumption or switch to a safer nicotine delivery system (Hatsukami & Carroll, 2020).

Against the stringent criteria of reduction by half, 22.6% of participants who did not achieve abstinence self-reported a successful reduction in tobacco use six months after enrollment. This suggests the NRT mailout program produced harm reduction effects. Of note, the trichotomous measure of cannabis use was not associated with successful reduction of tobacco use in either the chi-square analysis, or the binomial logistic regression controlling for demographics, behavioural measures, and treatment use. Furthermore, it was determined that frequency of cannabis use did not alter smokers' odds of reducing their tobacco use. On the other hand, smoking fewer cigarettes per day and reporting a past year quit attempt were associated with higher odds of successful reduction. These latter two findings align with previous literature (Begh et al., 2015; Klemperer et al., 2019; Yong et al., 2008). Overall, these results suggest NRT mailout programs have harm reduction qualities regardless of many of young adult smokers' characteristics and behaviours, including their use of cannabis.

5.3 Tobacco Use Relapse

While all participants in this study were seeking treatment to quit, the current findings showed that most tobacco smokers who quit relapsed. Relapse is a very common occurrence (Public Health Ontario, 2018). Of interest, in response to an open-ended question about why they relapsed, only one participant mentioned cannabis use as a reason. On the other hand, large portions of respondents indicated stress, alcohol use, or socialization to be their reason for relapse.

5.4 Implications for Treatment

In the current study of a traditional NRT mailout intervention, young adult tobacco smokers whose frequency of cannabis use was less-than-daily at baseline experienced a depressed rate of tobacco cessation compared to peers who were non-users or daily users of cannabis. This is important to note as recreational cannabis use—including less-than-daily—has increased among young adults since the legalization of cannabis (Health Canada, 2021; Lowry & Corsi, 2020). The rise in cannabis use has been especially steep among young adult Ontarians and seems likely to be sustained as the number of retail sources for cannabis climbs sharply in this province (Health Canada, 2021).

Cessation service providers should consider that these findings might have implications for screening criteria for NRT mailout programs. Specifically, it may be prudent to identify treatment-seekers who are less-than-daily cannabis users to steer them towards other cessation services (where they may be more likely to experience success). Screening for less-than-daily cannabis use could allow the supply of NRT to be directed to tobacco smokers who might have higher odds of quitting. This is especially important for NRT mailout programs that are operating with limited budgets. Offering tobacco treatment cost-effectively is consistent with demands for (financial) accountability, while simultaneously providing treatment-seeking individuals access to affordable, effective treatment. Removing barriers to accessing important public health services such as cessation services can increase quality of life (Arundel et al., 2020; Public Health Ontario, 2019).

Apart from this screening for less-than-daily cannabis users, study results suggest screening for other characteristics may not be needed for NRT mailout programs. Results indicated that covariates such as sex, age, education, employment, alcohol use (at baseline), and

nicotine dependence did not significantly alter the odds of achieving abstinence from tobacco, and therefore, suggest that NRT mailout programs may be equally effective across demographic or other behavioural characteristics of treatment-seeking young adult smokers. The lack of significant association among the covariates and quitting success was unique to the current study and warrants replication. For now though, findings suggest that perhaps all young adults may benefit equally from access to NRT mailout interventions.

As the cohort of cannabis-users increases in size, clinicians need to be aware of how to better assist this population that may need increased support with tobacco cessation. Although cannabis users are typically seen as a vulnerable segment of the tobacco-smoking population (Hindocha & McClure, 2020; McClure et al., 2020), clinicians may be reluctant to address tobacco cessation within the context of cannabis use. The current findings may offer clinicians assurance that they can successfully intervene with daily cannabis users. They alert clinicians to the possibility that daily users can be as successful as non-users. They also alert them that less-than-daily cannabis users might need additional help to recognize the interaction between their cannabis use and tobacco smoking, and the potential inhibitory effect of the context surrounding their use of cannabis on their ability for tobacco cessation.

Given how little is known about the role of cannabis use in tobacco cessation, it is important to explore the possibility that cannabis use might increase during efforts to quit. This study assessed cannabis use only at baseline because the aim was to compare cessation outcomes of traditional NRT mailout programs for treatment-seeking smokers who were using only tobacco versus tobacco and cannabis at the time they NRT and initiated their quit attempt. It certainly is valuable to further consider whether and how cannabis use might change during a

quit attempt. This, along with ways to assist tobacco smokers to manage their cannabis use while and after quitting requires attention.

Of course, these comments about treatment implications are offered with a caveat. Namely, whether less-than-daily cannabis use has a more detrimental effect than daily use on abstinence when NRT is used under *clinical supervision* is speculative. The current study explored self-directed use of NRT received through a population-level mailout program. On top of that, there was no assessment of whether recipients' use of the NRT was correct or not. This is likely a factor in successful quitting (Buller et al., 2014; Cunningham et al., 2016; Kushnir et al., 2017; Miller et al., 2005; Zhang et al., 2015)). Ultimately, the success of clinician-guided NRT use with those who use cannabis at a less-than-daily or daily rate warrants further investigation.

5.5 Strengths and Limitations

5.5.1 Study Limitations

Several limitations were identified in the current study methodology. First, this study was subject to attrition bias due to the substantial, systematic loss of participants at follow-up. Specifically, respondents lost to follow-up overrepresented individuals who were less educated, unemployed, more nicotine dependent, smoked more cigarettes per day, and less likely to have made a quit attempt in the past year. Of note, this limitation has implications for future research as these segments are commonly lost to follow-up and therefore, might be a particular population in need of different cessation support. These implications will be discussed below. Past research indicates that individuals with a lower level of education have decreased odds of quitting (Gilman et al., 2008; Ruokolainen et al., 2021; Zhuang et al., 2015) and decreased odds of reducing their smoking intake (Goding Sauer et al., 2018; Sengupta, 1996) compared to those with a higher educational status (Kaza et al., 2020; Reid et al., 2010; Yi et al., 2017). Similarly,

unemployed individuals have lower odds of successfully abstaining from tobacco compared to employed individuals (Burgess et al., 2009; Kriegbaum et al., 2011). Reid et al., (2010) found that frequent cigarette smokers (i.e., those with higher nicotine dependence, those who smoke more cigarettes per day) have significantly lower odds of stopping smoking than infrequent (less dependent) smokers.

This study was subject to substantial attrition, as 77.3% of baseline participants were lost to follow-up. Systematic loss of these particular segments at follow-up is relatively common in cohort studies such as this. For example, in a study examining the association between adherence to free NRT and successful quitting, Voci et al. (2016) reported a follow-up rate (at 6 months) of less than 33%. In research examining the effects of NRT on quitting among young adults, Buller et al. (2014) reported a 26-week post-test response rate of 33.5%. Due to attrition, the study results may have been influenced. It can be speculated that the overall quit rate observed here is higher than it would have been if those lost to follow-up (who are known to experience less success quitting) had been retained in the study sample. In addition, these individuals are also known for having lower odds of successfully reducing their smoking intake (Goding Sauer et al., 2018; Sengupta, 1996). Therefore, it can be speculated that the current study reduction rate would have been lower had these individuals been included.

A second limitation is the constraints to performing an analysis of secondary data due to the predetermined availability of particular survey measures. Although this study focuses on whether cannabis co-use impacts tobacco cessation, it was only possible to examine only frequency of cannabis use (none, less-than-daily, daily). It could not be determined how individuals were using cannabis (e.g., combustion, edibles, beverages) and why they were using cannabis (e.g., recreational, therapeutic (medical) use, stress relief). Having access to more

information would have allowed for a better understanding of the nuances of cannabis use in relation to smoking cessation. In the current study, for example, it would have been enlightening to know whether it was purely frequency of use or purpose of use or a combination of frequency and purpose (e.g., daily use and therapeutic use) that was related to participants' abstinence outcomes. As such, the context surrounding cannabis use should be taken into consideration for future research.

Given the complex relationship that has emerged between vaping and tobacco use, the absence of a measure for vaping might be seen as a limitation in this study. Indeed, there is research that suggests smokers who use/switch to vapes may be more likely to achieve tobacco abstinence than those who do not (Chan et al., 2021; Fu et al., 2021). Not knowing how vaping might have influenced the NRT use, cannabis use, and abstinence outcomes of the treatment-seeking young adult smokers in this study is a gap. On the other hand, at the time of data collection for this study, vaping was a relatively uncommon practice: in 2013, 3.9% of young adults reported current use of vapes (Czoli et al., 2015). Promotion of vapes as a cessation aid was still limited (Reid et al., 2015). Thus, the pervasiveness and impact of vaping in this study might have been minimal.

Finally, respondents' answers were collected using a self-report survey which may be subject to systematic errors, including biases reflecting participants' desire to provide the more socially acceptable answers or participants' inability to express themselves accurately. In this regard, it is important to note that the original NRT mailout study was conducted prior to the legalization of cannabis in Canada. Therefore, it may be speculated that participants who identified as cannabis co-users may have been less likely to respond truthfully due to the illegal status of cannabis at the time of data collection. However, research has also indicated that young

adults have been found to report valid and reliable measures for their cannabis use (Ramo et al., 2012). Due to the illegal status of cannabis at the time of data collection, it can be speculated that participants may have been less likely to respond truthfully about their cannabis use. However, young adults have been found to report valid and reliable measures for their cannabis use (Ramo et al., 2012). It is possible that cannabis use was underreported by participants given the large number of cannabis non-users in the study sample. Moreover, frequency of use could also be underreported. As a result, it can be speculated that if cannabis use and frequency of use were underreported, a greater number of the participants were cannabis users which may affect the results. If cannabis use was more prevalent and/or frequent in the study sample, the results could show cannabis use at baseline is associated with lower odds of successful tobacco cessation among treatment-seeking young adult smokers.

5.5.2 Study Strengths

In addition to the study limitations above, there were a number of strengths to acknowledge for this study.

First, the current study trichotomized cannabis use (as daily, less-than-daily, and nonuse), rather than dichotomizing it as was common in previous research. This approach identified differences between cannabis users in that less-than-daily cannabis users were less successful than daily cannabis users when it comes to their ability to achieve successful abstinence from tobacco. It is interesting to note that in one of the few other studies to trichotomize cannabis use, Lake et al. (2019) found that illicit drug use by daily cannabis users resembled that of non-users, whereas less-than daily cannabis users' illicit drug use was higher. Findings like these are obscured if cannabis use is only dichotomized. The trichotomization of cannabis use allows for

more nuanced perspectives and insight indicating a need for researchers to better assess the context surrounding cannabis use and frequency of use.

Second, although attrition was substantial in the current study, the retained sample was a large study sample collected in a real-world setting. Data collected from real-world studies can provide stakeholders with information about utilization patterns, participant characteristics, and health and treatment outcomes from outside the confines of a clinical trial. This is especially the case if patterns of attrition in the study are similar to patterns of attrition likely to occur in normal delivery of interventions. Providing stakeholders such as funders, service-providers, clinicians, doctors and participants with this information can make measurable improvements within the healthcare setting. For example, obtaining data which can help compare treatment outcomes and options among participants in a real-world naturalistic setting can provide insight into which treatments and dosage levels are more beneficial for different individuals. This enhances the capacity to refine and develop treatment guidelines and support tools.

Related to the strength of having a large sample in a real-world setting is the corollary that the sample is diverse, including younger-to-older young adults (18-29 years), across various education levels, and different employment statuses. Unlike many studies, especially those conducted in a clinical setting, this intervention study had virtually no exclusion criteria (other than contraindications for NRT use) and was available to young adults residing anywhere in Ontario. Overall, results may apply very broadly to treatment-seeking young adult smokers.

5.6 Future Research

While the aim of the current study was to determine *whether* cannabis use influenced cessation outcomes for an NRT mailout program, it would be interesting to explore *why*. As noted above, it may be that daily (compared to non-daily) cannabis users were better able to

“brace themselves” against the possibility that their cannabis use would trigger tobacco-smoking urges (and thus relapse). Future research could explore whether this “bracing” is why daily cannabis-users experienced better tobacco cessation outcomes than nondaily users.

There is also the possibility that cannabis use serves a compensatory role as suggested by Lemyre et al. (2019) and McClure et al. (2019). Determining the circumstances under which “compensatory cannabis use” during a cessation attempt supports cessation would, at a minimum, require an assessment of changes in cannabis use over the course of the quit attempt.

It may be that recreational cannabis use and therapeutic (medical) cannabis use are associated with tobacco abstinence in unique ways. Investigating adult smokers’ cannabis use, Voci et al. (2020) suggest that recreational cannabis use is associated with lower odds of quitting compared to medical use. This question surrounding context of use remains unanswered for young adults but might help explain the observed differences in quit rates between less-than-daily and daily cannabis users.

In addition to exploring why treatment-seeking smokers are using cannabis at various points in their quit attempt, future research should also investigate *how* tobacco smokers are using cannabis. For example, identifying routes of administration used for cannabis (e.g., combustion versus oral consumption) may illuminate whether a specific ROAs used for cannabis impacts tobacco cessation differently. Hindocha et al. (2016) determined that tobacco-smokers whose ROA for cannabis included using a joint, blunt, pipe, or vaporizer with tobacco were less likely to achieve tobacco abstinence than those who used the same ROAs without tobacco. In addition to examining frequency of cannabis use, it may be important to consider ROA as well.

Although attrition in this study was not associated with baseline cannabis use, it was associated with smoking more cigarettes per day and being less educated, unemployed, more

nicotine dependent, and less likely to have made a quit attempt in the past year. Considering that the loss of individuals with these characteristics is common within tobacco intervention studies (Buller et al., 2014; Rigotti et al., 2022), future research should focus efforts on learning more about why these individuals are commonly lost to follow-up. It may be that these individuals are particularly hard to retain because NRT interventions do not work as well or as easily as they expect. This may lead them to abandon both the intervention and the study. Unfortunately, this can maintain inequities across segments of the young adult population. In virtually all research into tobacco cessation interventions, understanding attrition is a critical area for future research. Young adults' reasons for abandoning a study (and potentially an intervention) can better inform service providers seeking ways to support cessation in these cohorts.

Finally, future research should examine young adult smokers' use of NRT across non-, less-than-daily, and daily cannabis use. Non-users, less-than-daily users and daily users of cannabis may use NRT differently based on their expectations of whether and how their cannabis use (or non-use) might impact their ability to quit smoking. A more comprehensive measurement of how long and how correctly recipients of NRT are using the product is important to explore.

5.7 Conclusion

Mailout programs offering free NRT with motivational messages can be delivered to young adult smokers with virtually no barriers to access. Research suggests that NRT mailout programs are cost-effective (Cummings et al., 2006; Cummings et al., 2010; Miller et al., 2005) and effective at supporting young adult smokers to quit (Cummins et al., 2007; Hughes et al., 2009). This secondary analysis of data collected in a large study of an NRT mailout program designed specifically for young adults revealed that smokers who co-use cannabis on a daily basis were generally as successful as non-users at achieving abstinence from tobacco smoking.

By exploring co-use of cannabis among participants as a trichotomy (nonuse, less-than-daily use, and daily use), this intervention was also able to show that less-than-daily cannabis use is associated with poorer cessation outcomes when behavioural and categorical factors are taken into consideration.

It is unclear from the current results as to why this is the case, and likely calls for further attention to the context of cannabis use before practical decisions are made about how to manage this in the delivery of NRT mailout programs. Where service-providers have particularly limited supplies of NRT, they may wish to consider whether to screen for less-than-daily cannabis use. NRT may not be as effective for treatment-seeking young adult smokers who use cannabis less-than-daily compared to daily or non-users.

Supporting cessation—especially among young adults— is an imperative strategy in efforts to reduce the population prevalence of smoking. The current study’s findings advance the discussion about smoking cessation achieved by cannabis-using young adults who take part in NRT mailout programs. Examining cannabis use in more nuanced ways, for example, by including frequency, reasons, and method of use is needed to fully understand why mixed evidence exists on whether cannabis co-use impacts tobacco cessation.

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Appendix A: Baseline Questionnaire

**Congratulations! You are eligible to receive free nicotine patches or gum.
Please answer the next few questions and you'll be on your way.**

1. How old were you when you first tried smoking?
How old were you when you started smoking occasionally?
At what age did you start smoking regularly?

2. Have you smoked more than 100 cigarettes in your lifetime?
Yes
No

3. How many cigarettes do you smoke per day?

4. How soon after you wake up do you smoke your first cigarette?
Within 5 minutes
6 to 30 minutes
31 to 60 minutes
After 60 minutes

***Please enter the date you plan to quit smoking:
[Calendar to appear]**

5. Are you planning to quit smoking...
within the next month*
within the next 6 months
sometime in the future, more than 6 months from now
I am not planning to quit

6. In the last 12 months, did you stop smoking for at least 24 hours?
No

Yes → How many times did you stop for 24 hours?

7. In the last 12 months, what is the longest period of time you have quit and remained smoke-free?
 day(s) OR weeks OR months

8. In the past 12 months, have you used any of the following (check all that apply)
nicotine gum
nicotine patch
nicotine inhaler
nicotine lozenge

9. How confident are you that you can quit smoking altogether?
1 2 3 4 5 6 7 8 9 10
not confident | somewhat confident | very confident

10. How confident are you that you can stay smoke-free?

1 2 3 4 5 6 7 8 9 10

not confident | somewhat confident | very confident

11. How many of your close friends smoke cigarettes:

All of them

Most of them

About half of them

A few of them

None of them

I have no close friends

12 Do you have at least one person that you can count on to help you quit or remain smoke-free?

Yes

No

13. Where are you exposed to second hand smoke (other people smoking)? (Check all that apply)

Not exposed

At social events

At home

In the car

At work

Other: Please Specify:

The next few questions ask about your health and use of various substances

14. How many caffeinated beverages (e.g. coffee, tea, cola) do you drink per day?

None

1-2

3-5

More than 5

15. In the past month, how often did you consume alcohol?

not at all

1-3 times

once a week

more than once a week

every day

16. In the past month, how often did you use marijuana?

not at all

1-3 times

once a week

more than once a week

every day

17. In the past month, how often did you use shisha/waterpipe?

- not at all
- 1-3 times
- once a week
- more than once a week
- every day

18. In the past month, how often did you use e-cigarettes?

- not at all
- 1-3 times
- once a week
- more than once a week
- every day

These final questions ask about your beliefs and experiences about nicotine patches and gum

21. The following statements concern nicotine patches and gum. Check whether you agree with each statement. Reply even if you have never used the patch or gum. If you have no opinion, answer don't know.

	strongly disagree	disagree	neither disagree nor agree	agree	strongly agree	don't know
These products help people to feel less irritable when they quit smoking						
These products help people to feel less depressed when they quit smoking						
These products help people to cope with the craving for cigarettes						
These products help people to feel less anxious when they quit smoking						
It is reassuring to know that these products are available						
Knowing that these products exist encourages people to try to quit smoking						
These products help people to resist the need to smoke in situations where smoking is NOT possible (or tempting)						
I am concerned about the side effects of these products						
I am wary (worried) about these products						

There is a risk of becoming dependent on these products						
I do NOT need these products in order to quit smoking						

22. Have you participated in another study where you received free nicotine patches or gum?

Yes

No

23. What nicotine product do you want mailed to your house?

8 weeks of Habitrol Nicotine Patches (multiple strengths)

8 weeks of Thrive Nicotine Gum-mint flavour (2mg)

Pop-up for Nicotine Gum:
 For success with the gum, you need to use the gum every time you have a craving for 8-weeks. Stopping sooner decreases likelihood of success.

Pop-up for Nicotine Patches:
 For success with the patch, you need to apply a new one every day for 8 weeks. Stopping sooner decreases likelihood of success.

24. Do you intend to use all your nicotine patches / gum every day in the first four weeks of quitting smoking?

Yes

No

Don't know/Refuse

25. How likely is it that you will use all your nicotine patches / gum every day in the first 4 weeks of quitting smoking?

12345

Highly likely somewhat likely highly un-likely

Please select the answer that best describes you.

26. Where do you live?

- with my parents
- with my "own" family (partner and/or kids)
- with roommates
- alone

26. Marital status:

- Single, never married
- Married
- Living common-law
- Widowed
- Divorced
- Separated

27. How many children do you have? (if you have no children, put 0)

28. How many children do you have living with you? (if you have no children, put 0)

29. Schooling:

- not currently in school
- attending college
- attending university
- attending trade school/ adult education/ private college

30. Which school do you attend? (appears only if they checked college, university, trade school)
[drop down list provided, includes an other category]

31. Highest level of education:

- Some elementary or some high school
- High school
- Some college or some university
- College diploma
- University or a post-graduate degree
- Refused

32. Current employment status:

- Student
- Full Time
- Part Time
- Self Employed
- Unemployed
- Disability
- Homemaker
- Working without pay
- Retired
- Refused

Unknown

Please enter your contact information so we can mail your patches or gum to you:

First Name:

Last Name:

Home Address:

City:

Postal Code: (format: L3L-3L3)

Province:

Please enter your email address:

Please re-enter your email address for verification:

PLEASE NOTE You will receive our 8-week and 6-month surveys to this email address.

Please enter your telephone number(s) where we can contact you:

Home: (Telephone number format: [area code]-[3-digits]-[4-digits])

Cell: same

PLEASE NOTE We will only phone you to complete the 8-week and 6-month survey if you haven't done the survey online.

Order confirmation:

Congratulations! You have successfully enrolled in the study and your patches or gum will be mailed to you within the next 7 days. Your PIN is: #####. Please hold onto this verification if you have any questions about your data.

An email will be sent, shortly, to the email address you provided with confirmation of your address. If your address is incorrect, please reply with corrections.

Click the links for: [Frequently Asked Questions](#) or [Quit Tips](#).

To re-read the full, detailed information page about this study, [click here](#).

To contact the researchers, email Dr. Kelli-an Lawrance at klawrance@brocku.ca.

To contact the Brock University Research Ethics Officer, call 905-688-5550 x. 3035

This study is funded by the Ontario Ministry of Health and Long Term Care. Participation in it should in no way be taken as a form of medical consultation or substitute for consultation with a health professional.

Appendix B: Intervention Check Questionnaire

This section of the survey asks about your experiences with the nicotine patch or gum.

NOTE: Participants will respond to questions about EITHER patch OR gum

1. About 8 weeks ago you ordered nicotine products from us. What nicotine product did you get in the mail?

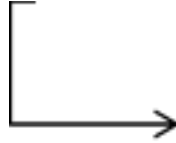
nicotine patch → Did you use at least some of the nicotine patches you received?

no



yes → Think of the first day you began using the patch. From that first day onward, how did you wear the patch?

I wore a patch *every day*



I wore a patch almost every day

I wore a patch, but not every day

What answer BEST describes how you used the patch?



At first I wore it irregularly, then switched to wearing it every day

I wore it when I felt like it would help me

I wore it when it was convenient

I wore it a couple of times, then stopped

Are you still using the patch?

no → For how many weeks did you use the patch?

yes → For how many weeks have you been using the patch?

Directions for using the patch are printed on the package, and included in the info that came with your shipment. Did you read either of these directions?

no

yes → **How closely did you follow the directions?**

I followed them exactly

I mostly followed the directions

I did not follow the directions

What made you stop using the nicotine patch?

Check all that apply

I'm still using the patch

I quit; so I didn't need to wear it anymore

I decided not to stop smoking; so I didn't need to wear it anymore

I experienced side effects

I felt like it wasn't helping me

I ran out of patches

I worried that I *might* get side effects from wearing it much longer

other _____

Page Break" nicotine gum → **Did you use at least some of the nicotine gum you received?**

no

yes → **Think of the first day you started using the nicotine gum. From that first day onward, how did you use the gum?**

I used nicotine gum *every time* I had a craving

I used some gum almost *every time* I had a craving

I used some gum, but not *every time* I had a craving

Are you still using the gum?

no → For how many weeks did you use nicotine gum?

yes → For how many weeks have you been using nicotine gum?

Directions for using the gum are printed on the package, and included in the info that came with your shipment. Did you read either of these directions?

no

yes → **How closely did you follow the directions?**

I followed them exactly

I mostly followed the directions

I did not follow the directions

What made you stop using the nicotine gum?

Check all that apply

- I'm still using the gum
- I quit; so I didn't need to use it anymore
- I decided not to stop smoking; so I didn't need to use it anymore
- I experienced side effects
- I felt like it wasn't helping me
- I ran out of gum
- I worried that I *might* get side effects from using it much longer
- other _____

The next few questions ask about your use of tobacco and other quit smoking services

2. In the *past 30 days*, have you smoked a cigarette, even a puff?

- No
- Yes

3. In the *past 7 days*, have you been completely smoke-free, without even a single puff?

no → In the past week, how many cigarettes did you smoke? |__|__|__|

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

- Within 5 minutes
- 6 to 30 minutes
- 31 to 60 minutes
- After 60 minutes

Since you received the nicotine patch or gum, did you quit smoking for at least one day?

- no
- yes → **How many days did you stay completely smoke-free without even a single puff** |__|__| days

How confident are you that you can quit smoking altogether?

1 2345678910
not confident somewhat confident very confident

How important is it for you to be quitting smoking?

1 2345678910
not important somewhat important very important

Are you planning to quit smoking...

- within the next month
- within the next 6 months
- sometime in the future, more than 6 months from now
- I am not planning to quit

Do you have some nicotine patches or gum leftover?

- no
- yes → **Do you plan to use them for your next quit attempt?**
 - yes
 - no

What do you think caused you to start smoking again?

_____ (*open field*)

- yes → **How many days has it been since you last smoked even a puff of a cigarette?**
It's been |__|__| days since I last smoked

How confident are you that you can stay smoke-free?

1 2345678910

not confident somewhat confident very confident

How important is it for you to be quitting smoking?

12345678910

not important somewhat important very important

How helpful was the nicotine patch or gum in helping you to quit?

12345

not helpful somewhat helpful very helpful

How satisfied are you with the way the patch or gum worked for you?

12345

not satisfied somewhat satisfied very satisfied

How sure are you that you can resist the temptation to smoke?

12345

not sure somewhat sure very sure

How important is it to you to stay completely off cigarettes?

12345

not important somewhat important very important

4. Since ordering your nicotine product and joining this study, have you done any of the following to help you with your quitting:

(Check all that apply)

- I read the booklet I received with my patch/gum
- I visited a "Leave The Pack Behind" display booth
- I entered the "would rather" contest to reduce/quit smoking
- I got treatment at a stop smoking clinic
- I spoke to a family physician
- I spoke to a pharmacist
- I spoke to a different health professional
- I bought more nicotine patches / gum / inhaler / lozenge
- I used e-cigarettes (electronic cigarettes) instead of regular cigarettes
- I called Smokers' Helpline
- I seriously asked a friend or loved one to help me quit
- Other: _____

5. In the past 30 days, have you used any other tobacco product e.g., cigars, cigarillos, shisha, chewing tobacco, or snus?

- No
- Yes

These next few questions ask about your beliefs and experiences about nicotine patches and gum

6. Check whether you agree with each statement. If you have no opinion, answer don't know.

	strongly disagree	disagree	neither disagree nor agree	agree	strongly agree	don't know
These products help people to feel less irritable when they quit smoking						
These products help people to feel less depressed when they quit smoking						
These products help people to cope with the craving for cigarettes						
These products help people to feel less anxious when they quit smoking						
It is reassuring to know that these products are available						
Knowing that these products exist encourages people to try to quit smoking						
These products help people to resist the need to smoke in situations where smoking is NOT possible (or tempting)						
I am concerned about the side effects of these products						
I am wary (worried) about these products						
There is a risk of becoming dependent on these products						
I do NOT need these products in order to quit smoking						

These final questions ask about your health and use of various substances

7. How many caffeinated beverages (e.g. coffee, tea, cola) do you drink per day?

- None
- 1-2
- 3-5
- More than 5

8. In the past month, how often did you consume alcohol?

- not at all
- 1-3 times
- once a week
- more than once a week
- every day

9. In the past month, how often did you use marijuana?

- not at all
- 1-3 times
- once a week
- more than once a week
- every day

10. In the past month, how often did you use shisha/waterpipe?

- not at all
- 1-3 times
- once a week
- more than once a week
- every day

11. In the past month, how often did you use e-cigarettes?

- not at all
- 1-3 times
- once a week
- more than once a week
- every day

Appendix C: 6-Month Follow-up Questionnaire

Four months ago, you completed a LTPB survey about your experience with the nicotine patch or gum. Thank you for logging on to do the final survey. Please answer just a few more questions ask about your smoking and you'll be on your way.

1. In the *past 30 days*, have you smoked a cigarette, even a puff?

- No
- Yes

2. In the *past 7 days*, have you been completely smoke-free, without even a single puff?

- no → In the past week, how many cigarettes did you smoke? |__|__|__|

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

- Within 5 minutes
- 6 to 30 minutes
- 31 to 60 minutes
- after 60 minutes

Since you received the nicotine patch or gum, did you quit smoking for at least one day?

- no
- yes → How many days did you stay completely smoke-free without even a single puff |__|__| days

How confident are you that you can quit smoking altogether?

1 2345678910

not confident | somewhat confident | very confident

How important is it for you to be quitting smoking?

1 2345678910

not important | somewhat important | very important

Are you planning to quit smoking...

- within the next month
- within the next 6 months
- sometime in the future, more than 6 months from now
- I am not planning to quit

Do you have some nicotine patches or gum leftover?

- no
- yes → Do you plan to use them for your next quit attempt?
 - yes
 - no

What do you think caused you to start smoking again? _____ (*open field*)

yes → **How many days has it been since you last smoked even a puff of a cigarette?**
It's been |__|__| days since I last smoked

How confident are you that you can stay smoke-free?

1 2345678910

not confident | somewhat confident | very confident

How important is it for you to be quitting smoking?

12345678910

not important | somewhat important | very important

How helpful was the nicotine patch or gum in helping you to quit?

12345

not helpful | somewhat helpful | very helpful

How satisfied are you with the way the patch or gum worked for you?

12345

not satisfied | somewhat satisfied | very satisfied

How sure are you that you can resist the temptation to smoke?

12345

not sure | somewhat sure | very sure

How important is it to you to stay completely off cigarettes?

12345

not important | somewhat important | very important

3. Since the last survey (4-months ago), did you buy any additional nicotine product to help you quit smoking?

yes → **what did you buy:**

nicotine gum

nicotine patch

nicotine lozenge

other, please specify: _____

How many days did you use it for? _____ # days

no

These next few questions ask about your health and use of various substances

4. How many caffeinated beverages (e.g. coffee, tea, cola) do you drink per day?

- None
- 1-2
- 3-5
- More than 5

5. In the past month, how often did you consume alcohol?

- not at all
- 1-3 times
- once a week
- more than once a week
- every day

6. In the past month, how often did you use marijuana?

- not at all
- 1-3 times
- once a week
- more than once a week
- every day

7. In the past month, how often did you use shisha/waterpipe?

- not at all
- 1-3 times
- once a week
- more than once a week
- every day

8. In the past month, how often did you use e-cigarettes?

- not at all
- 1-3 times
- once a week
- more than once a week
- every day

These final questions ask about your beliefs and experiences about different ways to quit smoking

9. The following statements concern nicotine patches and gum. Check whether you agree with each statement. If you have no opinion, answer don't know.

	strongly disagree	disagree	neither disagree nor agree	agree	strongly agree	don't know
These products help people to feel less irritable when they quit smoking						
These products help people to feel less depressed when they quit smoking						
These products help people to cope with the craving for cigarettes						
These products help people to feel less anxious when they quit smoking						
It is reassuring to know that these products are available						
Knowing that these products exist encourages people to try to quit smoking						
These products help people to resist the need to smoke in situations where smoking is NOT possible (or tempting)						
I am concerned about the side effects of these products						
I am wary (worried) about these products						
There is a risk of becoming dependent on these products						
I do NOT need these products in order to quit smoking						

THANK YOU SCREEN (after a participant submits answers)

Thank you for participating in the study.

You have automatically been entered into the prize draw for a 1-in-100 chance to win \$200 worth of gift cards to the retailers of your choice. You will be notified by e-mail if you have won the prize.