

Attrition in Smoking Cessation Intervention Studies: A Systematic Review

Emily Belita, Souraya Sidani

Withdrawal of participants from intervention studies has dire methodological and clinical consequences. Attrition rates in smoking cessation studies have been found to be particularly high. Identifying factors that contribute to attrition may inform strategies to address the problem and prevent its consequences. This systematic review had 2 objectives: to report attrition rates, and to identify factors that influence attrition of adult smokers participating in smoking cessation intervention studies. Inclusion criteria were (1) published between 1980 and 2015; (2) experimental or quasi-experimental design; (3) pharmacological, educational, or behavioural intervention; (4) target population of adult smokers; (5) examination of attrition rate; and (6) exploration of factors associated with attrition and/or of reasons given by participants for withdrawing. These criteria were met by 10 studies. Attrition rates ranged from 10.8% to 77%. A small number of demographic, clinical, behavioural, health, health-related beliefs, and logistical factors were related to attrition. The report of high attrition rates underlines the importance of incorporating strategies to minimize attrition in smoking cessation studies. Strategies to reduce attrition are proposed.

Keywords: attrition, withdrawal, dropout, smoking cessation, interventions, systematic review

Résumé

Revue systématique du taux d'abandon dans les études d'intervention sur la cessation du tabagisme

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Le retrait de participants à des études d'intervention a des conséquences fâcheuses sur les plans méthodologique et clinique. Le taux d'abandon observé dans les études sur la cessation du tabagisme est particulièrement élevé. Cerner les facteurs qui contribuent à l'abandon peut contribuer à mieux éclairer les stratégies déployées pour résoudre ce problème et prévenir ses conséquences. Cette revue systématique visait deux objectifs : prendre acte des taux d'abandon et déterminer les facteurs influençant la décision de fumeurs adultes de se retirer d'une étude d'intervention sur la cessation du tabagisme à laquelle ils participent. Les critères de sélection des études étaient : 1) la publication entre 1980 et 2015, 2) l'emploi d'un modèle expérimental ou quasi expérimental, 3) les études portant sur des interventions pharmacologiques, d'éducation ou comportementales, 4) une population cible consistant en des adultes fumeurs, 5) un examen du taux d'abandon et 6) l'étude des facteurs associés à l'abandon ou des raisons données par les participants pour expliquer leur retrait de l'étude. Dix études répondaient à ces critères. Le taux d'abandon dans ces études se situait entre 10,8 % et 77 %. Un petit nombre de facteurs démographiques, cliniques, com-portementaux et logistiques ainsi que de facteurs liés à la santé et aux croyances relatives à la santé ont pu être associés aux abandons. L'indication de taux élevés d'abandon souligne l'importance d'intégrer aux études des stratégies visant à minimiser les départs des participants aux études sur la cessation du tabagisme. De telles stratégies sont proposées dans le cadre de la présente revue systématique.

Mots-clés : abandon, retrait, départ, cessation du tabagisme, interventions, revue systématique

Introduction

Attrition or withdrawal of participants from smoking cessation intervention studies has dire methodological and clinical consequences. It poses a major threat to statistical conclusion and internal and external validity of the findings. Attrition results in a sample size that is smaller than is necessary on the basis of power analysis. With a small sample size, the statistical power to detect significant intervention effects is reduced and the chance of type II error is increased (Shadish, Cook, & Campbell, 2002). This may lead to the abandonment of a potentially useful intervention. Attrition compromises the representativeness of the sample when individuals who withdraw from the study and those who complete it differ on sociodemographic (e.g., gender) and clinical (e.g., nicotine dependence) characteristics that can influence the response to the intervention; the generalizability of the findings is limited to the subgroups of the target population with the same characteristics as those observed for participants who completed the study. Attrition can also produce a situation in which the number and sociodemographic and clinical characteristics of participants assigned to the intervention and the comparison groups differ (i.e., differential attrition). This happens when a large number of participants with a particular profile assigned to one group withdraw from the study, so that the two groups are no longer comparable on baseline characteristics; these group differences have the potential to confound the effects of the intervention (Sidani, 2015; Valentine & McHugh, 2007).

Attrition may also prolong the study and increase its costs (Butler et al., 2013). Researchers attempt to enrol more individuals in the study to make up for those who withdraw and put in extra efforts to follow up with participants to prevent attrition. These strategies require extensive human and financial resources (Marcellus, 2004), which may not be available. Further, their effectiveness in minimizing attrition is not well established.

High attrition rates in smoking cessation intervention studies, classified as either pre-inclusion or post-inclusion, have been reported (Curtin, Brown, & Sales, 2000). Pre-inclusion attrition takes place when participants withdraw after screening for eligibility and fail to begin any aspect of the intervention (Ahluwalia et al., 2002; MacPherson, Stipelman, Duplinsky, Brown, & Lejeuz, 2008). Thus, these participants do not receive the treatments (i.e., intervention under evaluation or comparison treatment) offered in the study. Post-inclusion attrition occurs any time after the intervention is provided. Attrition rates have been reported as ranging from 30% to 50% pre-inclusion and 10% to 50% post-inclusion (Curtin et al., 2000). Regardless of when it takes place throughout the

study, attrition poses the same methodological dilemmas for researchers. Thus, examining predictors of any type of attrition is warranted, to establish general attrition prevention strategies that could also transcend smoking cessation intervention studies.

This descriptive systematic review was designed to generate a list of factors underlying attrition in smoking cessation intervention studies. The specific objectives were to (1) report attrition rates, and (2) identify factors that influence the attrition of adult smokers in intervention evaluation studies. Investigating factors that contribute to attrition can help to identify specific groups of individuals, with distinctive characteristics, that are most at risk for dropout and/or contextual factors that impede continued participation in the study. Exploration of factors that influence attrition in smoking cessation intervention studies is important for devising strategies that are relevant and appropriate and that successfully address attrition.

Method

This descriptive review focused on studies that evaluated the effectiveness of smoking cessation interventions. Data were extracted on the type of treatments under evaluation, the reported attrition rate, and factors that contributed to participants' withdrawal from the study.

Selection Criteria

Studies were included in the systematic review if they met the following criteria: (1) published between 1980 and 2015, to ensure relevance of the settings and interventions to the current context of smoking cessation; (2) experimental (or randomized clinical trial) or quasi-experimental (cluster randomized trial or cohort study) design, which are considered appropriate for the evaluation of interventions; (3) pharmacological, educational, or behavioural smoking cessation intervention; (4) targeting adult smokers (18 or older); (5) reporting the rate of attrition, defined as the number of participants who withdrew at any point during the study, or relevant data that allow calculation of the attrition rate; and (6) exploring factors associated with attrition and/or reasons given by participants for their withdrawal.

Search Strategy

The search for relevant studies included the following databases: Medline, CINAHL, PsycINFO, Health Star, and Cochrane. The databases covered literature pertaining to different disciplines (i.e., medicine, nursing, health psychology, health education) engaged in smoking cessation treatment. The keywords were as follows: smoking, smoking cessation, smokers,

drop-out, non-participation, attrition, intervention, nonparticipants, and research studies. The reference lists included in the study reports were searched for additional sources. The search was limited to the English language.

Data Extraction

Data were extracted on study characteristics, intervention characteristics, attrition rate, and factors influencing attrition. Study characteristics entailed target population (as delineated by the inclusion criteria) and overall design (as described in the study report). Intervention characteristics were related to the type of treatment offered; these were obtained from the description of the intervention and the comparison protocols. The attrition rate was extracted if reported. Otherwise the number of participants who withdrew or the number who completed the study was recorded. This number allowed for computation of the attrition rate when it was not explicitly reported. Data on factors influencing attrition encompassed (1) the list of factors hypothesized to affect attrition and assessed with relevant quantitative measures, and (2) the factors that were found to be significantly or not significantly associated with attrition. Reasons for withdrawal, as given by participants, were also extracted. Data from journal articles were extracted individually by three researchers; these had high interrater reliability ($\geq 80\%$).

Data Abstraction

Information extracted from the selected studies was incorporated into a table to facilitate data abstraction and synthesis. When the attrition rate was not explicitly reported, it was computed as the percentage of participants who withdrew from the study out of those who consented. Data on the attrition rate were examined descriptively (i.e., range and mean). Data on influential factors were synthesized across studies to determine the frequency with which they were found to affect attrition and to describe the direction of their influence (inferred from the correlation or regression coefficients given in the reports).

Results

The search yielded 189 articles. Only 10 studies examined factors influencing attrition in smoking cessation intervention studies. Nine studies met the selection criteria; one study was excluded as the attrition rate was not explicitly reported and there were no data available to compute the attrition rate. The characteristics of the included studies, the treatment, the attrition rates, and the factors that were and were not associated with attrition are summarized in Table 1.

Study	Population	Type of Intervention	Attrition Rate	Non-significant Factors Influencing Attrition	Significant Factors Influencing Attrition
Ahluwalia et al. (2002)	N = 787 African-American smokers over 18 years of age	<p><i>Control</i> Standard (non-tailored) care: videotape and guide for smoking cessation</p> <p><i>Intervention</i> Culturally sensitive smoking cessation videotape and guide</p>	36%	<p><i>Demographic</i></p> <ul style="list-style-type: none"> • employment • income • marital status <p><i>Clinical</i></p> <ul style="list-style-type: none"> • number of quit attempts • age of first cigarette • smoking within 5 minutes of waking <p><i>Behavioural</i> Participation in physical activity and weight loss program</p> <p><i>Health status</i></p> <ul style="list-style-type: none"> • pre-existing medical conditions • self-reported good health • depression <p><i>Health beliefs</i> Health will improve if I quit smoking.</p> <p><i>Logistical</i> Travel time from home to clinic</p>	<p><i>Demographic</i></p> <ul style="list-style-type: none"> • age (younger) • sex (male) • education (lower) • literacy level (lower) • regular source of health care (less likely) • health insurance (less likely) • having own transportation (less likely) <p><i>Clinical</i> Smoking fewer and lower-tar cigarettes</p> <p><i>Behavioural</i></p> <ul style="list-style-type: none"> • alcohol use • intention to quit (low) <p><i>Logistical</i> Proactive recruitment</p> <p><i>Other</i></p> <ul style="list-style-type: none"> • physician advice to quit (less likely) • knowing someone whose health was impacted by tobacco (less likely)

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Study	Population	Type of Intervention	Attrition Rate	Non-significant Factors Influencing Attrition	Significant Factors Influencing Attrition
Curtin et al. (2000)	N = 358 Smokers with history of major depressive disorder	<i>Control</i> Standard smoking cessation treatment <i>Intervention</i> Standard smoking cessation treatment + cognitive-behavioural treatment for depression	28%	<i>Demographic</i> Age <i>Clinical</i> <ul style="list-style-type: none"> • minutes after waking until first cigarette • daily number of cigarettes • duration of smoking • current and past participation in psychotherapy <i>Behavioural</i> Current and past use of alcohol and non-prescription drugs	<i>Demographic</i> Gender (female) <i>Clinical</i> Smoking cigarettes with high nicotine levels <i>Health status</i> Taking psychiatric medication
MacPherson et al. (2008)	N= 53 Smokers with symptoms of depression	<i>Control</i> Standard smoking cessation treatment <i>Intervention</i> Standard cessation intervention + group behavioural activation (i.e., activity monitoring and conscious exposure to positive life experiences)	40%	<i>Demographic</i> <ul style="list-style-type: none"> • age • gender • ethnicity • employment status • education • income <i>Clinical</i> <ul style="list-style-type: none"> • duration of smoking • nicotine dependence • daily number of cigarettes • number of quit attempts • motivation for quitting 	<i>Behavioural</i> Engagement in avoidance behaviours in response to affective and physical stress

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Study	Population	Type of Intervention	Attrition Rate	Non-significant Factors Influencing Attrition	Significant Factors Influencing Attrition
MacPherson et al. (2008) <i>(continued)</i>				<p><i>Health status</i></p> <ul style="list-style-type: none"> • anxiety • depressed mood 	
Brouwer & Pomerleau (2000)	N = 143 Female smokers with self-reported weight concerns	<p><i>Control</i></p> <ul style="list-style-type: none"> • 6 weeks of nicotine replacement therapy • cessation counselling sessions • placebo <p><i>Intervention</i></p> <ul style="list-style-type: none"> • 6 weeks of nicotine replacement therapy • cessation counselling sessions • fluoxetine 	16%	<p><i>Demographic</i></p> <ul style="list-style-type: none"> • age • education • race <p><i>Clinical</i></p> <p>Daily number of cigarettes</p> <p><i>Behavioural</i></p> <ul style="list-style-type: none"> • use of smoking as weight control • restraint and disinhibition when eating <p><i>Health status</i></p> <ul style="list-style-type: none"> • depression • BMI 	<p><i>Clinical</i></p> <p>Nicotine dependence (higher)</p> <p><i>Behavioural</i></p> <p>Dieting severity (higher)</p>
Copeland et al. (2006)	N = 746 Female smokers with self-reported weight concerns	<i>Intervention 1</i> Individually tailored group session focused on smoking relapse prevention and cessation weight gain	36%	<p><i>Demographic</i></p> <ul style="list-style-type: none"> • age • race <p><i>Smoking/quit behaviours</i></p> <ul style="list-style-type: none"> • daily number of cigarettes • duration of smoking • number of quit attempts 	<p><i>Clinical</i></p> <p>Nicotine dependence (higher)</p> <p><i>Behavioural</i></p> <p>Eating restraint (low level)</p>
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Study	Population	Type of Intervention	Attrition Rate	Non-significant Factors Influencing Attrition	Significant Factors Influencing Attrition
Copeland et al. (2006) <i>(continued)</i>		<i>Intervention 2</i> Group session focused on smoking relapse prevention and cessation weight gain		<i>Other health behaviours</i> • disinhibition (losing control of eating) • perceived hunger	<i>Health status</i> Weight concern (higher)
Woods et al. (2002)	N = 120 African-American smokers	<i>Control</i> • 8 motivational interviews (phone or in-person) • culturally tailored cessation guidebook • placebo for 7 weeks <i>Intervention</i> • 8 motivational interviews (phone or in-person) • culturally tailored cessation guidebook • bupropion for 7 weeks	45%	<i>Demographic</i> • marital status • income • health insurance <i>Clinical</i> • daily number of cigarettes • depression • nicotine dependence • number of quit attempts <i>Social network</i> Having smokers in network <i>Logistical</i> Transportation	<i>Demographic</i> • age (younger) • employment (full-time) • education (low levels) • gender (male) <i>Health beliefs</i> • confidence in quitting (low) • motivation to quit (low)

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Study	Population	Type of Intervention	Attrition Rate	Non-significant Factors Influencing Attrition	Significant Factors Influencing Attrition
Leeman et al. (2006)	N = 246 Female smokers	<i>Intervention</i> Nicotine gum, brief behavioural counselling, exercise <i>Control</i> Nicotine gum, brief behavioural counselling, standard care	77%	<i>Clinical</i> • daily number of cigarettes • nicotine dependence • depression <i>Logistical</i> Group assignment	<i>Demographic</i> • living condition (with a child) • non-white • age (younger) • education (low) <i>Clinical</i> • length of quit attempt • confidence in quitting (high) <i>Health behaviours</i> • concerns about weight gain • guilt
Geraghty et al. (2012)	Two cohorts of smokers: n = 16,430, n = 1,000	<i>Intervention 1</i> Static online cessation guide <i>Intervention 2</i> Static online cessation guide + reminder e-mails <i>Intervention 3</i> Static online cessation guide + lessons on mood management	<i>Automated treatment</i> 48.1% <i>Live treatment</i> 10.8%	<i>Demographic</i> • age • sex • marital status • education <i>Clinical</i> • nicotine dependence • confidence in quitting • motivation to quit	Automated group <i>Demographic</i> • age (younger) • sex (male) • marital status (unmarried) <i>Clinical</i> • nicotine dependence (high) • education (low) • confidence in quitting (low) • motivation to quit (low) • delay before quit date

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Study	Population	Type of Intervention	Attrition Rate	Non-significant Factors Influencing Attrition	Significant Factors Influencing Attrition
Geraghty et al. (2012) <i>(continued)</i>		<i>Intervention 4</i> Static online cessation guide + virtual group for peer support		<i>Logistical</i> <ul style="list-style-type: none"> • reminder e-mails • group that received mood lessons • week of study enrolment (enrolling later) 	<i>Logistical</i> <ul style="list-style-type: none"> • group that received reminder e-mails • group that received mood lessons • week of study enrolment (enrolling later) <i>Live group</i> <ul style="list-style-type: none"> • age (younger)
Nevid et al. (1996)	N = 93 Hispanic smokers: 48 men, 45 women	<i>Intervention</i> Multicomponent behavioural program <i>Control</i> Self-help	<i>Intervention</i> 18% <i>Control</i> 20%	<i>Demographic</i> <ul style="list-style-type: none"> • age • education • gender • origin and acculturation <i>Clinical</i> <ul style="list-style-type: none"> • daily number of cigarettes • duration of smoking • nicotine dependence • health 	<i>Demographic</i> <ul style="list-style-type: none"> • income (low) <i>Clinical</i> Confidence in quitting (high) <i>Health-related</i> <ul style="list-style-type: none"> • health (poor) • cardiovascular problems

Characteristics of Studies

The nine studies were conducted in the United States in the period 1996 to 2012. The target population, which differed across studies, included African Americans ($n = 2$ studies), Hispanics ($n = 2$), and smokers in the contemplation and preparation stage of quitting smoking ($n = 2$). Women were targeted in three studies, with weight concern being a focus in two of the three.

Sample sizes ranged from 53 to 17,430, with only two studies reporting a sample size under 100. In all studies, the treatment was offered in a community setting. With the exception of Geraghty, Torres, Leykin, Perez-Stable, and Munoz (2012), all studies consisted of a randomized clinical trial.

Characteristics of Interventions

The smoking cessation interventions comprised two or more components (Table 1), with behaviour modification being the most common ($n = 6$). In three studies, the intervention consisted of a combination of behavioural and pharmacological (e.g., nicotine replacement therapy) components. The mode of intervention delivery differed. It involved interactive individual ($n = 3$), both group and individual format ($n = 3$), or passive format. The interactions among smokers or between smokers and interventionists occurred through virtual or face-to-face contact. The passive format included a review of a videotape and guides (Ahluwalia et al., 2002) and Internet lessons on mood management (Geraghty et al., 2012). Studies that targeted African-American and Hispanic smokers provided culturally tailored interventions.

Attrition Rate

The overall attrition rates ranged from 10.8% to 77%. The rates exceeded 35% in six studies that targeted African-American smokers (Ahluwalia et al., 2002; Woods et al., 2002), smokers with symptoms of depression (MacPherson et al., 2008), and women in general (Leeman et al., 2006) as well as women with weight concerns (Copeland, Martin, Geiselman, Rash, & Kendzor, 2006). The intervention for these studies consisted of behavioural treatment only or a combination of behavioural and pharmacological treatment. The attrition rates that were less than 35% included women with weight concerns (Brouwer & Pomerleau, 2000), people with depressive symptoms (Curtin et al., 2000), and Hispanics (Nevid, Javier, & Moulton, 1996). The interventions in these studies consisted of combined behavioural and pharmacological treatment, behavioural treatment for smoking cessation and depression, and behavioural treatment for smoking cessation, respectively.

Factors Influencing Attrition

A variety of factors have been investigated as potentially contributing to attrition. The factors can be meaningfully categorized as demographic, clinical, behavioural, health status, health beliefs, and logistics. Demographics and clinical characteristics were the most frequently examined in the reviewed studies.

The demographic characteristics commonly investigated included age ($n = 9$), gender ($n = 6$), education ($n = 7$), income ($n = 4$), ethnicity ($n = 4$), employment status ($n = 3$), and marital status ($n = 2$). As shown in Table 1, the influence of these factors on attrition was inconsistent across studies. Age was significantly associated with attrition in five studies. The results of four studies indicate that younger participants are more likely than older ones to drop out. Gender was not related to attrition in two studies (Macpherson et al., 2008; Nevid et al., 1996); however, more women were reported to withdraw in one study and more men were observed to drop out prior to intervention in three studies. Education was found to influence attrition in three of the seven studies that explored this factor; participants with lower education levels were more likely to withdraw. Only one study found a significant relationship between employment status and attrition, with participants employed full-time withdrawing prior to study completion. Three of the four studies examining income found no significant relationship between income and attrition, whereas the fourth reported a higher risk of withdrawal for participants with low income. Three (of four) studies identified a non-significant relationship between ethnicity and attrition, whereas one found that non-whites were more likely to drop out early in the study. Marital status consistently showed no association with attrition.

The most frequently (i.e., more than two studies) examined clinical factors were those related to smoking behaviours: daily number of cigarettes smoked ($n = 8$), duration of smoking ($n = 5$), number of quit attempts ($n = 4$), nicotine dependence ($n = 6$), self-confidence in quitting smoking ($n = 3$), and motivation to quit ($n = 2$). The results consistently showed that duration of smoking and number of quit attempts were not associated with attrition. The daily number of cigarettes smoked was not related to attrition ($n = 7$). Level of nicotine dependence influenced attrition in three (of six) studies: participants with high levels of nicotine dependence tended to withdraw more than those with low levels. High levels of self-confidence in quitting showed a significant relationship with attrition ($n = 2$). One study found that motivation to quit was not related to attrition, but another study found that participants with low motivation were more likely to drop out.

The influence of additional clinical factors on attrition was investigated in a few studies. Taking a medication (for a variety of conditions other than smoking) showed both a significant and a non-significant relationship with attrition in the same study, depending on the type of medication (psychiatric and non-prescription, respectively); specifically, smokers on psychiatric medication tended to withdraw ($n = 1$). Receiving psychotherapy did not influence attrition ($n = 1$). Participants reporting heavy drinking were more likely to withdraw ($n = 1$).

A few behavioural factors were examined. Engagement in physical activity, attempting to lose weight, alcohol use, and dieting/eating behaviours did not affect participant withdrawal. In contrast, severe dieting ($n = 2$), behavioural response to stress ($n = 1$), and engagement in avoidance behaviours in response to emotional and physical stress ($n = 1$) did influence attrition.

Factors related to health status that were examined included general health perception ($n = 2$), pre-existing conditions ($n = 2$), anxiety ($n = 1$), and depression ($n = 4$). One study found a significant relationship between perceived poorer health and report of cardiovascular problems with attrition. Anxiety was found to have a non-significant relationship with attrition, whereas depression was associated with attrition in one study. Only one study investigated the influence of health-related beliefs on attrition. Belief in the benefits of quitting smoking was not related to withdrawal.

Three studies evaluated logistical factors related to time it took participants to travel to the clinic ($n = 1$ study), driving to the clinic ($n = 1$), recruitment strategy ($n = 1$), and reminder e-mails throughout the study ($n = 1$). The two latter factors were associated with attrition. The use of a proactive recruitment strategy in which study staff recruited clients from hospital clinics and a hospital lobby and the use of reminder e-mails increased the odds of attrition.

Two studies explored participants' reasons for withdrawing (Nevid et al., 1996; Woods et al., 2002). The themes emerging from the qualitative data analysis of the reasons included concerns about medications (e.g., nicotine replacement), low readiness to quit, significant other not believing in the effectiveness of smoking cessation, scheduling conflicts, transportation access, forgotten appointments, unavailability of child care, relocation, and loss of interest in the intervention.

Discussion

This systematic review set out to synthesize empirical evidence on the rates of and factors that influence attrition in smoking cessation intervention research. Despite extensive search efforts, only nine studies met the

selection criteria and were included in the review. This small number of studies suggests limited attention to attrition in this field and highlights the need to investigate the extent of and factors contributing to withdrawal from smoking cessation trials, in order to enhance the validity and clinical utility of the conclusions (Sidani, 2015).

The results of this review indicate that attrition rates range from 10.8% to 77%, which differs slightly from the range (10% to 50%) reported by Curtin et al. (2000). The difference may be related to a variety of factors, such as the type of smoking cessation interventions under evaluation and the characteristics of the population targeted in the selected studies. Pharmacological treatments were not investigated by Curtin et al. (2000). However, these treatments were provided to smokers in four studies included in this review and could have contributed to participant withdrawal that is associated with the experience of side or adverse effects. Concern about the medication was one reason reported by participants for dropping out of the trial (Woods et al., 2002); this should be further examined as a factor affecting attrition in future research. The populations targeted in the study by Curtin et al. (2000) included the general public and smokers diagnosed with depressive disorders. In contrast, the present review selected intervention studies targeting different groups of smokers, including smokers of African or Hispanic heritage, women expressing weight concerns associated with quitting, and smokers with depressive symptomology. The attrition rates for the last group (28% to 40%) are comparable to those reported by Curtin et al. (2000). However, higher attrition rates were found in studies with African Americans (45%), Hispanics (48%), and women (77%). The extent to which variability in attrition rates is related to differences in the type of intervention and/or characteristics of the target population cannot be confirmed and requires further investigation.

The influence on attrition of a wide range of demographic, clinical, behavioural, health-related, and logistical factors was examined in all nine studies included in the review. However, the set of factors that were explored differed across studies, so that only a small number of studies investigated the same factor. Further, the number of studies showing statistically significant associations between specific factors and attrition was low (not exceeding four), compared to the number of studies reporting non-significant associations. The limited evidence suggests that participants' age (4 of 9 studies), gender (4 of 6), education (3 of 7), and nicotine dependence (3 of 6) are related to attrition in smoking cessation intervention studies.

Younger age was consistently associated with attrition, as reported in other research on attrition (Geraghty et al., 2012). What exactly leads younger smokers to withdraw is not well understood. The following

explanations have been proposed. Younger smokers, even if they wish to quit, may have life (e.g., employment or familial) responsibilities that interfere with their full participation in the intervention (Woods et al., 2002). Strategies could be incorporated to make it convenient for younger smokers to participate in a trial, and therefore to minimize attrition. These include (1) flexibility in the time and location of research activities (e.g., screening, data collection) and delivery of the intervention (e.g., evenings, weekends), as well as the method of data collection (e.g., online); and (2) provision of child care when participants are involved in on-site activities (Butler et al., 2013; Warner et al., 2013).

Three studies found that men are likely to withdraw from smoking cessation intervention studies, whereas one study reported that women are likely to drop out. The reasons underlying men's attrition could not be explicitly identified in the literature. It is possible that men's employment hindered their continued involvement. Alternatively, participating men may not have been ready to quit smoking (due to social stereotyping) or may not have perceived the intervention as acceptable. The high attrition rate among women may be related to competing priorities, including familial responsibilities (Leeman et al., 2006). Flexibility in treatment and research activities and provision of child care are two possible strategies to address these barriers. Taking account of participants' perceptions and their preferences for smoking cessation interventions is another strategy to minimize attrition. Participants' perception of the treatment offered in a study is emerging as a factor influencing enrolment and attrition in intervention research. Favourable views of and preferences for treatment have been identified as deterrents to participation in randomized clinical trials and reasons for withdrawing from such trials (Lang, 2005). In particular, those who perceive the intervention as unacceptable may decline to enrol and those who do not receive the intervention of choice may drop out (Sidani, 2015; TenHave, Coyne, Salzer, & Katz, 2003).

Smokers with a low level of education were also likely to withdraw. This may be attributable to a low literacy level, which could affect one's understanding of the research requirements and/or the treatment recommendations. Ahluwalia et al. (2002) and Borrelli et al. (2002) report that low literacy levels are associated with poor adherence to treatment and medical appointments, and consequently with low smoking cessation rates. To address this barrier, Geraghty et al. (2012) suggest that smoking cessation interventions be modified to fit participants' literacy levels; for instance, oral (video/audio) instead of written intervention materials or resources could be provided to smokers with low literacy levels. Additional strategies include clearly communicating expectations related to participants' involvement in research activities, maintaining regular

contact with participants, and expressing appreciation for participants' involvement in the study both orally and non-orally (Sidani, 2015).

Smokers with high levels of nicotine dependence were consistently found to drop out of cessation studies. Yet this subgroup of smokers is most in need of treatment. Their high attrition rate is due to greater difficulty quitting (Borrelli et al., 2002; Leeman et al., 2006) and the perception that cessation interventions are ineffective. Strategies to reduce attrition in this subgroup of smokers include (1) design and implementation of tailored cessation interventions that consist of assessing participants' level of nicotine dependence and providing quit strategies that correspond with that level (Geraghty et al., 2012); for instance, those with high dependence may be given a multi-component intervention consisting of motivational interviewing to set reasonable goals and achievable plans of action, group therapy so that one might learn from peers' practical tips for successfully managing craving, and additional encouragement from the therapist; and (2) exploration of preferences for cessation interventions and offering the intervention of choice (Bower et al., 2014), as described above.

It is worth noting that the majority of factors investigated in the reviewed studies as potentially affecting attrition were characteristics of individual smokers. Exploration of additional logistical factors, such as those that emerged from one study with a qualitative component (Woods et al., 2002), is warranted. These factors, including transportation and child-care issues, are often mentioned as the reasons for non-enrolment and/or attrition in intervention research (Harris & Dyson, 2001). Further, attention should be paid to factors embedded in the context of research as potentially affecting attrition (Marcellus, 2004). Examples of contextual factors are characteristics of the research personnel, in particular their communication or interactional style, and characteristics of the study protocol, such as recruitment strategies and flexibility of scheduling. Preliminary evidence from the reviewed studies supports the influence of some contextual factors. For example, proactive recruitment strategies were found to increase the odds of attrition (Ahluwalia et al., 2002) and scheduling conflicts were identified as barriers to continued participation (Woods et al., 2002). As well, participants who received frequent e-mail reminders were more likely to drop out, possibly due to the phenomenon of e-mail fatigue resulting in e-mails being ignored (Geraghty et al., 2012). Last, methods of treatment assignment that account for participants' preferences should be investigated. Providing the treatment of choice has been found to reduce attrition in intervention research (Swift, Callahan, & Vollmer, 2011).

Conclusion

Attrition is reported to be high in smoking cessation intervention studies. This may present a threat to statistical conclusion and external and internal validity, and consequently limit the clinical applicability of potentially useful interventions. A small number of participant characteristics were found to influence attrition. The findings of this systematic review highlight the importance of incorporating strategies to minimize attrition throughout various phases of a study. The effectiveness of these strategies in addressing attrition should be investigated in future research.

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Acknowledgements

This work was partially supported by funding from the Canadian Lung Association.

Declaration of interests: None to declare.

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