The Quitting Rollercoaster: How Recent Quitting History Affects Future Cessation Outcomes (Data From the International Tobacco Control 4-Country Cohort Study)

Timea R. Partos PhD[1], **Ron Borland** PhD[1], **Hua-Hie Yong** PhD[1], **Andrew Hyland** PhD[2], **K. Michael Cummings** PhD[3]

[1]*Cancer Council Victoria, Carlton, Australia;* [2]*Department of Health Behavior, Roswell Park Cancer Institute, Buffalo, NY 14263;* [3]*Hollings Cancer Centre, Medical University of South Carolina, Charleston, SC 29425*

Corresponding Author: Ron Borland, Cancer Council Victoria, 100 Drummond Street, Carlton, Victoria 3053, Australia. Telephone: +61 (0)3 9635 5185; Fax: +61 (0)3 9635 5440; E-mail: Ron.Borland@cancervic.org.au

ABSTRACT

Introduction: Most smokers have a history of unsuccessful quit attempts. This study used data from 7 waves (2002–2009) of the International Tobacco Control 4-country cohort study to examine the role of smokers' quitting history (e.g., recency, length, and number of previous quit attempts) on their subsequent likelihood of making a quit attempt and achieving at least 6 months of sustained abstinence.

Methods: Generalized estimating equations were used, allowing for estimation of relationships between variables across repeated observations while controlling for correlations from multiple responses by the same individual (29,682 observations from 13,417 individuals).

Results: The likelihood of a future quit attempt increased independently with recency and number of prior attempts. By contrast, the likelihood of achieving sustained abstinence of at least 6 months was reduced for smokers with a failed quit attempt within the last year (15.1% vs. 27.1% for those without, $p < .001$). Two or more failed attempts (vs. only one) in the previous year were also associated with a lower likelihood of achieving sustained abstinence (*OR*: 0.57, 95% *CI*: 0.38–0.85). Effects persisted after controlling for levels of addiction, self-efficacy to quit, and use of stop-smoking medications.

Conclusions: There appears to be a subset of smokers who repeatedly attempt but fail to remain abstinent from tobacco. Understanding why repeated attempts might be less successful in the long term is an important research priority because it implies a need to tailor treatment approaches for those who are motivated to quit but persistently relapse back to smoking.

INTRODUCTION

At least 94% of smokers have tried to quit before, with around two of five smokers making an average two quit attempts every year (Borland, Partos, Yong, Cummings, & Hyland, 2012). Only around 10% of these, however, succeed in staying quit for at least 7 months or longer (Lee & Kahende, 2007). Reported strength of wanting to quit has been found to predict making subsequent quit attempts, but not long-term abstinence among smokers who try to quit (Borland et al., 2010). Borland et al. (2010) postulated that smokers who really want to quit but relapse to smoking are somehow more addicted than others. This suggests that a history of multiple failed quit attempts might index an aspect of addiction not captured by traditional measures like the Heaviness of Smoking Index (HSI; Heatherton, Kozlowski, Frecker, Rickert, & Robinson, 1989). Similarly, other aspects of smokers' quitting history, such as the length and number of past quit attempts, relate differently to making subsequent attempts versus achieving mid- to long-term sustained abstinence, and current published findings are not always in agreement (see Table 1). It is important to better understand the relationship between smokers' past and future quitting activity, to enable the development of more effective smoking cessation interventions tailored to the individual.

The published research seems to support the utility of assessing past quit attempts as a predictor of future quitting efforts, but it is less clear as to how past attempts relate to sustained abstinence. The mixed findings from previous work suggest the need for more detailed study to better understand what is going on. A learning-based model would suggest that smokers should learn from past quit failures and thus be better equipped to succeed in future, such that the chances of future success on any given attempt should improve with the number of past attempts. The reviewed findings presented in Table 1 are clearly inconsistent with such an explanation.

Table 1. Review of Published Literature Relating Past Quit History (Recency, Length, and Number of Past Attempts) to Future Cessation Outcomes (Making Quit Attempts and Achieving Sustained Abstinence)

Source	Method	Control variables[a]	Recency of past attempts	Length of past attempts	Number of attempts
Making a quit attempt					
Hyland et al. (2006)	N = 6,260 smokers, followed-up after 6 months	Country, age, income, intention to quit, HSI, smoking frequency, opinion of smoking, worries about health, favorable attitudes to smoking	Any quit attempts in the past year (vs. none) predicted future attempts	Longest attempt ever of 6 months or more (vs. none) predicted future attempts	Not measured
van den Putte et al. (2009)	N = 3,411 smokers, followed-up after 4 months	Intention to quit, subjective norm, self-efficacy, quitting identity, smoking identity	More recent attempts (over lifespan) predicted future attempts	No significant association	More lifetime attempts reduced likelihood of future attempts
Zhou et al. (2009)	N = 2,431 smokers intending to quit within the next 3 months, followed-up every 3 months for up to 18 months	Sex, motivation to quit, intention to quit, number of smoke-free days in past 3 months, FTND score	Any lifetime attempts, and any attempts in the past 3 months (vs. none) predicted future attempts (more recent = stronger association)	Not measured	More lifetime attempts increased likelihood of future attempts
Hagimoto et al. (2009)	N = 1,358 smokers followed-up after 1 year	Cigarettes per day, wish to quit, intention to quit, doctor's advice to quit	Any lifetime quit attempts (vs. none) predicted future attempts	No significant association	Not measured
Achieving sustained abstinence					
Hyland et al. (2006)	N = 2,274 smokers who made quit attempts, followed-up after 6 months	HSI, smoking frequency, outcome expectancy	No significant association	Longest attempt ever ≤ 1 week (vs. none) reduced likelihood of 1 month abstinence	Not measured
Zhou et al. (2009)	N = 2,431 smokers intending to quit within the next 3 months, followed-up every 3 months for up to 18 months	Country, FTND score, other smokers, depression/anxiety symptoms, stop-smoking medication use, postquit sleep/appetite disturbance	Any previous lifetime quit attempts (vs. none) increased likelihood of relapse over the next 18 months among smokers who had tried to quit	Not measured	No significant association
Hagimoto et al. (2009)	N = 312 smokers who made quit attempts followed-up after 1 year	FTND score	Any lifetime quit attempts (vs. none) reduced likelihood of 1 week abstinence; no significant association with 6 months sustained abstinence	No significant association	Not measured
Farkas et al. (1996)	N = 2,066 smokers, followed-up after 2 years	Cigarettes per day, smoking frequency, prior episodes of quitting for at least 1 year	Not measured	Longest attempt ever ≥6 months (vs. <6 months) more likely to be quit (point prevalence)	Not measured
Lee & Kahende (2007)	N = 3,218 current smokers with a failed attempt in the past year, and N = 772 recent "successful" quitters (abstinent at least 7 months)	Age, education, marital status, race/ethnicity, ever used low-tar cigarettes, other smokers in home, nonsmoking policy at work	Not measured	Not measured	Current smokers reported more lifetime attempts than current successful quitters
Sendzik et al. (2011)	N = 551 smokers who made quit attempts, followed-up 6 months later	Planning of attempt, cigarettes per day, support person	Not measured	Not measured	No association with 1 week or 1 month sustained abstinence

Note. HSI = heaviness of smoking index; FTND = Fagerstrom Test for Nicotine Dependence.
[a] Only the control variables with significant associations with the outcome are listed, and details of variable definitions are not provided. Please consult the relevant references for further details of control variables.

As noted earlier, another possibility is that repeated failures reflect the difficulty of the task and that compared with those who succeed easily, those who try repeatedly and fail are more addicted, because of physiological responses to nicotine, or due to their dispositional capacity for self-regulation, or both. In other words, just as prior quit efforts predict future attempts to stop smoking, so might we expect to observe that past failed quit efforts predict future failed efforts to sustain abstinence. Such data would be consistent with using past failed quit attempts as a measure of chronic relapse and strength of nicotine addiction.

Alternatively, experiencing multiple failed quit attempts could result in demoralization (e.g., reduced self-efficacy; Yzer & van den Putte, 2006) and a reduced likelihood of future success, regardless of levels of addiction. Self-regulatory fatigue may also play a role (Muraven & Baumeister, 2000; Piasecki, Fiore, McCarthy, & Baker, 2002), with smokers who make multiple quit attempts experiencing cessation fatigue, which depletes their resources for self-control and decreases their likelihood of success on subsequent attempts, unless they allow time for recovery.

Whatever the underlying mechanisms, it is clear that smokers' past quitting experiences impact their future cessation outcomes and that these relationships need to be better understood so that health care professionals can incorporate quitting histories into tailored advice for future cessation attempts. This study uses data from the International Tobacco Control 4-country cohort survey (ITC-4) to prospectively explore the relative importance of recency, length, and number of past attempts for making quit attempts and achieving periods of sustained abstinence. The ITC study allows use of a very large dataset from a broadly representative sample of smokers.

METHODS

Participants

Participants were selected from the ITC-4, which is a longitudinal study of representative samples of smokers aged 18 years or older from Canada, the United States, the United Kingdom, and Australia. Standardized telephone interviews were conducted annually, and smokers were followed-up where possible. Each year (survey "wave") new smokers were also recruited to maintain a sample size of around 8,000 participants per wave. Further details of survey methodology have been documented elsewhere (Thompson et al., 2006). Seven waves of data, spanning from 2002 to 2009, were available for analysis, giving a total of six consecutive baseline-outcome "wave pairs." Multiple wave pairs of data were analyzed concurrently using generalized estimating equations (GEEs) (see below) with the predictors measured at a baseline wave (wave t) predicting outcomes measured at the next wave, the outcome wave (wave $t + 1$). Thus, it was possible for participants to provide data for multiple wave pairs. Participants were eligible at each wave pair if they were smoking at the baseline wave and provided valid data for all predictors, control variables, and outcome measures. Notably, for sustained abstinence, sometimes this had to be confirmed at wave $t + 2$.

Measures

Baseline Quit History Predictors (Measured at Wave t)
We determined recency of participants' last quit attempt by asking "How long ago did your most recent quit attempt end?"

Responses were stratified (see Table 3). These data were available for all waves of the survey (29,682 observations from 13,417 individuals, with 44.9% contributing only 1 wave pair of data, 23.6% contributing 2, 13.0% contributing 3, 8.1% contributing 4, 4.4% contributing 5, and 5.9% contributing to all 6 wave pairs of data).

The length of participants' most recent unsuccessful quit attempt was determined by asking "How long were you quit for, on your most recent quit attempt?" We determined the number of quit attempts participants had made since their last survey by asking "How many times have you tried to quit smoking since (last survey date [wave $t − 1$])?" For those participants who reported two or more attempts, we combined the number of attempts with whether or not the last attempt had been the longest, assessed by asking: "Since (last survey date [wave $t − 1$]) have you quit for longer than (length of last quit attempt at wave t)?" This gave four categories: (a) no quit attempts in the last year, (b) one attempt only, (c) two or more—last was longest, and (d) two or more—last was not longest. This information on length and number of attempts was only available from Wave 5 onwards (6,127 observations from 4,105 individuals, with 50.7% contributing only one wave pair of data and 49.3% contributing two).

Outcome Measures (Measured at Wave t + 1)

1. Quit attempts made between the baseline (wave t) and outcome (wave $t + 1$) waves were assessed with the question "Have you made any attempts to stop smoking since we last talked with you, that is, since (last survey date [wave t])?"
2. Among the participants who reported making quit attempts, we determined whether they had achieved sustained abstinence for at least 6 months since baseline (between wave t and wave $t + 1$). First we asked "What is the longest time that you stayed smoke-free since (last survey date [wave t])?" For anyone who did not meet the 6-month criteria but was currently still quit, we used data from the next wave (i.e., wave $t + 2$) to determine the length of abstinence of the target attempt. Such cases, if lost to follow-up were excluded from this analysis. At the Wave 7 outcome, all participants currently quit for under 6 months were excluded as follow up data from Wave 8 were not available. Missing data for sustained abstinence ranged between 2.0% and 6.9% from wave to wave. Participants who quit and remained abstinent for multiple waves were only included in the initial wave pair where they first quit.
3. We computed an "overall outcome" variable by recalculating the percentage of participants who achieved sustained abstinence for at least 6 months among all smokers, not just those who made quit attempts.

Baseline Control Variables (Measured at Wave t)
Sociodemographic variables we included were country of residence, sex, age, ethnic minority status, marital status, education, and annual household income. Education and income were both categorized into tertiles (low, moderate, and high) according to the appropriate criteria within each country. Participants who declined to tell us their income were treated as a separate valid category. We also included participants' cohort (the wave in which they were first recruited into the ITC-4) and the interval (in months) between each baseline and outcome wave. Participants' baseline smoking frequency (daily vs. weekly or monthly) and their HSI score (Heatherton et al., 1989) derived

from the number of cigarettes smoked per day and the minutes before smoking the first cigarette upon waking, served as indicators of addiction. Finally, perceived self-efficacy to quit was determined by asking "If you decided to give up smoking in the next 6 months, how sure are you that you would succeed (not at all/slightly/moderately/very/or extremely sure)?"

Outcome Control Variables (Measured at Wave t + 1)
Participants who reported making a quit attempt between the baseline and outcome wave were asked about their method of quitting ("stopping cold turkey" or "cutting down") and their use of stop-smoking medications (SSMs) ("SSMs not used," "SSMs used but not to quit," and "SSMs used to quit"). For the analyses investigating achievement of 6 months sustained abstinence only among those who tried, we included these two control measures that applied to the interval between the baseline and outcome waves.

Analyses

We used GEEs (Liang & Zeger, 1986) with binomial variations, logit link functions, and an unstructured correlation matrix for analysis. GEE is essentially a logistic regression model that allows for the estimation of relationships between variables across repeated observations, while controlling for the correlations between responses from participants who contributed data to more than one wave pair. First, we explored the association between quit recency, the longest attempt ever made, and the three cessation outcome measures, controlling for all baseline and outcome control variables, including models with interaction terms as appropriate. We then repeated these analyses, but excluded anyone who reported never having tried to quit in their life. These analyses were conducted on the large seven-wave sample. Next, we ran some analyses for the reduced two-wave sample, for which we had further information about the length and number of past quit attempts, pertaining only to the past year. Participants included in these analyses were those who had made at least one quit attempt within the year preceding the baseline wave (wave *t*).

RESULTS

The baseline characteristics of the smokers at each wave are provided in Table 2, demonstrating that it is a diverse sample. Table 3 presents the baseline distributions across the four quit history variables. Between 14% and 19% of participants reported never having tried to quit in the past and around one-third reported their last quit attempt within the last year, whereas around one-fifth said they last tried more than 5 years ago. Among those who reported at least one quit attempt within the past year, about half lasted a week or less on their most recent attempt, with around one-fifth abstaining for over a month. Among those trying, there were roughly equal proportions of participants reporting only one versus two or more failed quit attempts in the past year, and among those with two or more, 74.8% reported that their most recent attempt had not been their longest.

Among the participants who reported making a quit attempt between baseline and outcome, the use of SSMs increased over time from around 34% between Waves 1 and 2 to around 52% between Waves 6 and 7, with 39% of participants reporting they had used SSMs specifically for the purpose of quitting on their most recent quit attempt. Although the majority of participants quit cold turkey, there was a slight increase in cutting down to quit in Wave 6 (41% compared with 30%–33% in previous waves). It is also notable that the recency of past quit attempts was negatively associated with HSI scores ($r = -.15$, $p < .0001$).

Considering recency of last attempt and length of longest attempt in the larger sample (see Table 4), a greater likelihood of subsequent quit attempts was monotonically associated with more recent previous attempts and with longer past attempts independently, with those reporting never having tried least likely to subsequently try. The results for sustained abstinence among those making attempts were quite different. In this analysis, recency was associated with less-sustained abstinence, at least out to around 2–3 years where it plateaued and rates exceeded those for never trying (nonsignificantly). By contrast, having made any quit attempt that lasted less than 6 months, particularly less than 1 month, was associated with a reduced likelihood of sustained abstinence compared with longer attempts or reporting never having tried. Again these two effects were largely independent (bottom part of Table 4). For overall outcomes, the likelihood of being quit was unrelated to recency within the previous year, but declined beyond that, and was more likely the longer the previous longest attempt. These effects were essentially unchanged when we controlled for both demographic and smoking-related covariates, including HSI and self-efficacy.

We now turn to an analysis of the last two sets of data where we have more detail on the pattern of quitting activity within the previous year (see Table 5). Smokers with any attempts in the past year were more likely to make attempts, but less likely to achieve sustained abstinence, but overall were more likely to end up quit (i.e., sustained abstinence among all smokers at baseline). Among only those with a history of quit attempts in the year prior to baseline, those with a history of two or more were much more likely to make another quit attempt between baseline and outcome, and those with the more recent attempts were also more likely, although this latter effect disappeared in the multivariate analyses. The effect of length of the recent attempt was not statistically significant. Among those reporting two or more attempts, however, those whose last attempt was the longest were more likely to make attempts. Smokers with two or more attempts were less likely to achieve sustained abstinence, regardless of length, but neither recency nor length was related. For the overall outcome, there were no significant predictors.

We explored the possibility that addiction (indexed by HSI scores with 0–3 being low and 4–6 being high), use of SSMs since the baseline wave (no or yes), and method of quitting (stopping suddenly or cutting down) might be acting as effect modifiers for our quit history variables. We computed a series of interactions (HSI × recency, HSI × length, HSI × number, SSM × recency, SSM × length, SSM × number, quit method × recency, quit method × length, and quit method × number) and included these in the concurrent model predicting sustained abstinence. Full results may be obtained on request from the corresponding author. None of these interaction effects were statistically significant.

Table 2. Wave-by-Wave Sample Characteristics at Baseline (Wave *t*) for Smokers in the Large Seven-Wave Sample

	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5[a]	Wave 6[a]
N individuals	6,230	4,958	4,803	4,378	4,584	4,729
Country (%)						
United States	19.6	20.6	21.9	23.8	23.1	23.8
Canada	24.8	26.4	25.2	25.8	25.0	25.7
United Kingdom	27.6	25.7	25.9	25.1	24.9	23.5
Australia	28.1	27.2	27.0	25.4	27.0	27.1
Age (%)						
18–24	11.2	9.0	6.7	5.0	4.3	3.2
25–39	31.8	29.0	26.1	24.3	22.1	20.3
40–54	36.1	38.9	40.6	41.6	42.0	42.1
55 or older	21.0	23.1	26.6	29.1	31.6	34.3
Sex (%)						
Female	55.6	56.3	57.2	58.0	57.6	57.3
Male	44.4	43.8	42.8	42.1	42.4	42.7
Education (%)						
Low	55.7	53.5	52.3	51.3	52.6	51.7
Moderate	31.2	33.4	31.8	31.7	30.7	31.1
High	13.1	13.1	15.8	17.0	16.7	17.2
Income (%)						
Low	29.8	29.4	29.0	30.2	30.2	29.3
Moderate	34.5	35.2	35.5	34.5	33.6	32.9
High	28.9	28.7	28.9	29.2	30.0	31.0
Not disclosed	6.8	6.7	6.6	6.1	6.2	
Ethnic minority status (%)						
Nonminority group	88.7	89.8	91.0	90.9	90.6	90.9
Minority group	11.3	10.2	9.0	9.1	9.4	9.1
Marital status (%)						
Married	41.7	43.9	45.3	44.8	43.4	44.3
Separated	5.4	5.3	5.5	5.7	6.1	5.4
Divorced	12.1	12.9	13.2	14.8	15.9	16.4
Widowed	5.0	5.2	5.7	5.8	5.9	6.0
De facto	10.2	9.5	9.2	9.0	9.6	9.3
Single	25.5	23.1	21.1	19.9	19.1	18.5
Cohort (%)						
Wave 1 (2002)	100.0	78.8	54.7	40.7	28.9	21.3
Wave 2 (2003)	NA	21.2	13.0	9.3	6.3	4.5
Wave 3 (2004)	NA	NA	32.4	21.6	14.2	10.3
Wave 4 (2005)	NA	NA	NA	28.4	16.7	10.9
Wave 5 (2006)	NA	NA	NA	NA	33.9	21.4
Wave 6 (2007)	NA	NA	NA	NA	NA	31.7
Interwave interval in months (*SD*)	6.7 (0.6)	12.8 (1.0)	15.0 (2.0)	11.8 (1.0)	11.0 (1.3)	12.9 (1.6)
Heaviness of smoking index (%)						
0	14.5	14.9	12.9	12.4	10.9	10.4
1	10.9	11.6	11.0	10.2	10.9	10.7
2	16.8	17.7	17.9	19.1	18.6	18.6
3	28.8	27.0	28.7	28.4	29.6	29.0
4	17.0	17.6	17.8	18.5	18.0	18.6
5	8.9	7.9	8.3	8.0	8.9	9.3
6	3.2	3.4	3.4	3.4	3.1	3.5
Baseline smoking frequency (%)						
Daily	91.7	92.7	93.5	95.9	95.5	95.6
Weekly or monthly	8.3	7.3	6.5	4.1	4.5	4.4
Self-efficacy (%)						
Not at all sure	28.8	31.2	32.4	32.0	32.6	34.0
Slightly sure	17.5	17.6	17.9	18.0	19.8	19.0
Moderately sure	33.1	33.1	31.3	31.2	29.1	28.7
Very sure	12.3	11.0	11.6	12.2	12.1	11.6
Extremely sure	8.3	7.1	6.9	6.5	6.4	6.8

Note. [a]These percentages were very similar to the percentages for the reduced two-wave sample, with no value differing by more than ±5%.

Table 3. Wave-by-Wave Quit History Predictor Variables at Baseline (Wave *t*)

	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5	Wave 6
Full seven-wave sample (data available for all six wave pairs)						
N individuals	6,230	4,958	4,803	4,378	4,584	4,729
Time since last quit attempt ended (%)						
Within last month	5.9	11.3	8.7	9.5	8.9	8.5
32–181 days ago	13.3	13.8	13.9	13.0	13.4	13.3
182 days to 1 year ago	22.4	12.5	12.0	12.0	12.5	12.7
More than 1–2 years ago	11.9	14.3	13.9	12.9	13.8	12.3
More than 2–3 years ago	5.8	8.3	9.3	7.5	7.8	8.2
More than 3–5 years ago	6.9	7.0	9.5	11.6	9.5	9.6
More than 5 years ago	14.9	17.1	17.3	19.2	20.1	21.5
No previous quit attempts	18.9	15.8	15.4	14.3	14.1	14.0
Longest quit attempt ever made (%)						
More than 6 months	28.5	28.1	29.3	29.5	29.6	29.8
More than 1–6 months	23.3	25.3	25.6	26.4	25.9	26.0
More than 1 week to 1 month	13.6	14.4	14.6	14.9	15.5	14.6
Up to 1 week	15.8	16.5	15.2	14.9	15.35	15.7
No quit attempts ever made	18.9	15.8	15.4	14.3	14.1	14.0
Reduced sample (data only available for last 2 wave pairs)						
N individuals	–	–	–	–	2,960	3,167
Length of the last quit attempt (%)						
None in the last year	–	–	–	–	68.8	68.1
Up to 7 days	–	–	–	–	15.5	16.0
8–31 days	–	–	–	–	9.9	9.4
32 days or longer	–	–	–	–	5.9	6.5
Number of quit attempts (%)						
None in the last year	–	–	–	–	68.8	68.1
1 attempt only	–	–	–	–	14.9	16.8
2 or more attempts	–	–	–	–	16.3	15.1
2+, last was longest	–	–	–	–	28.8	21.5
2+, last was not longest	–	–	–	–	71.2	78.5

CONCLUSIONS

Having ever made a quit attempt, especially within the previous year, was a strong predictor of making subsequent quit attempts, and the likelihood of subsequent attempts decreased monotonically with time since last quit attempt, to be least common for those reporting no previous attempts. These effects persisted after controlling for sociodemographics, addiction, and self-efficacy. These findings are consistent with the literature (Hyland et al., 2006; Zhou, Nonnemaker, Sherrill, Gilsenan, Coste, & West, 2009). Further, compared with smokers with just one attempt in the past year, those with two or more were even more likely to try again. It seems that, instead of being demoralized or deterred by failed quit attempts, the more smokers have tried to quit in the past, the more they are likely to try again in the future; that is, past behavior predicts future behavior.

Quitting history has a more complex association with sustained abstinence. Compared with never having tried before, a failed quit attempt in the last year or two was associated with significantly reduced likelihood of achieving sustained abstinence, even when adjusting for measures of nicotine addiction, self-efficacy, method of quitting (cutting down or cold turkey), and use of SSMs. This was accentuated for those making multiple attempts in the previous year. More distant quit attempts appear to have little association with sustained abstinence. Our

findings are consistent with prior work such as Hagimoto et al. (2009), and Zhou et al. (2009) also noted that the impact of a failed quit attempt diminished the longer ago it had occurred. Overall, not having tried for more than a year or two and a shorter longest ever attempt were associated with reduced likelihood of overall success.

Taken together, our findings suggest that there are a segment of smokers who repeatedly attempt and fail to succeed in remaining abstinent from tobacco. Experiencing a recent (within the past year) failed quit attempt, or worse multiple such experiences, was associated with a reduced likelihood of achieving at least 6 months sustained abstinence on the next attempt. We are not sure whether the effect is a causal one or whether recent quitting reflects some aspect of the smoker.

It is possible that recent failures mainly reflect high levels of addiction (defined broadly as reduced capacity to change). However, the observed inverse relationship between quit history and sustained abstinence persisted even after stratifying by level of nicotine addiction (as measured by the HSI) and reported use of SSMs. If addiction is a cause, it would need to be some unmeasured aspect of the strength of nicotine addiction, plausible, as heaviness of smoking may be less predictive of relapse beyond the first weeks of cessation (Herd, Borland, & Hyland, 2009), or some aspect of the strength of self-control mechanisms, or a combination of both.

Table 4. Generalized Estimating Logistic Regressions for Quit History Variables (at Wave *t*) Predicting Cessation Outcomes (at Wave *t* + 1) for the Full Seven-Wave Sample

	Quit attempt		Sustained abstinence (among attempters)		Overall outcome (sustained abstinence)	
N observations/*N* individuals	29,682/13,417		9,794/6,519		28,493/12,819	
Total percent achieving the outcome	37.0		21.1		7.3	
Percentage of participants achieving each of the cessation outcomes						
Time since last quit attempt ended (%)						
Within last month	67.3		16.0		10.5	
32–181 days ago	60.7		16.9		9.8	
182 days to 1 year ago	49.0		18.6		8.6	
More than 1–2 years ago	36.2		22.4		7.5	
More than 2–3 years ago	31.8		26.2		7.7	
More than 3–ago	27.5		27.9		7.0	
Over 5 years ago	19.9		29.2		5.3	
No previous quit attempts	17.0		27.7		4.2	
Longest quit attempt ever made (%)						
More than 6 months	43.1		27.7		11.1	
More than 1–6 months	42.8		20.4		8.2	
More than 1 week to 1 month	40.1		13.5		5.1	
Up to 1 week	33.1		12.5		3.9	
No quit attempts ever made	17.0		27.7		4.2	
Odds ratios (OR) and 95% confidence intervals (CI) for concurrent generalized estimating equations (never quit excluded)						
N observations/*N* individuals	25,051/11,357		9,104/6,007		23,961/10,817	
	OR	95% CI	*OR*	95% CI	*OR*	95% CI
Time since last quit attempt ended						
Within last month	Ref	$p < .00001$	Ref	$p < .00001$	Ref	$p < .00001$
32–181 days ago	0.79	0.71–0.87	1.13	0.95–1.35	0.98	0.83–1.17
182 days to 1 year ago	0.55	0.50–0.61	1.39	1.16–1.67	0.98	0.82–1.17
More than 1–2 years ago	0.32	0.29–0.35	1.58	1.30–1.92	0.77	0.64–0.93
More than 2–3 years ago	0.28	0.25–0.32	1.91	1.52–2.41	0.77	0.63–0.95
More than 3–5 years ago	0.25	0.22–0.28	2.16	1.72–2.72	0.74	0.60–0.91
More than 5 years ago	0.16	0.14–0.18	2.25	1.83–2.76	0.54	0.44–0.65
Longest quit attempt ever made						
More than 6 months	Ref	$p < .00001$	Ref	$p < .00001$	Ref	$p < .00001$
More than 1–6 months	0.88	0.82–0.95	0.74	0.65–0.85	0.71	0.63–0.80
More than 1 week to 1 month	0.80	0.73–0.87	0.49	0.41–0.59	0.45	0.39–0.53
Up to 1 week	0.67	0.61–0.73	0.48	0.40–0.58	0.40	0.34–0.48

Note. Sustained abstinence is for at least 6 months; overall outcome = sustained abstinence among all smokers. All analyses are adjusted for age, sex, education, income, ethnic minority status, marital status, cohort, interwave interval, Heaviness of Smoking Index, baseline smoking frequency, and self-efficacy. Analysis predicting the sustained abstinence outcome among those who tried is also adjusted for use of stop-smoking medications since baseline and method of quitting (cut down or cold turkey) followed on the last quit attempt at the outcome wave (wave *t* + 1). The full table of results including associations with the control variables may be obtained on request from the corresponding author. Significance (*p*) values next to the reference category represent the overall effect across categories.

The results are also consistent with a resource-depletion model where prior attempts result in cessation fatigue (e.g., Muraven & Baumeister, 2000; Piasecki et al., 2002), but are less plausibly related to demoralization from past failures as the effect persisted when controlling for self-efficacy. The fact that multiple recent attempts were especially detrimental lends credence to the resource depletion model. The ways that cessation fatigue could compromise a smoker's ability to remain abstinent warrant further exploration, as it is unlikely to be a primarily conscious experience given that failed quit attempts certainly did not deter smokers from trying again. Symptoms of anxious arousal and reports of more negative experiences such as withdrawal, weight gain, and irritability during quit attempts have been associated with a history of more past quit attempts (Zvolensky, Johnson, Leyro, Hogan, & Tursi, 2009). Such symptoms may be caused by cessation fatigue; however, it is also possible that the subgroup of smokers who typically make multiple attempts are also more prone to experience these symptoms and therefore are less likely to succeed when they try.

A third possibility that cannot be ruled out is that those who tried and failed in the past year are a group who have adopted self-defeating strategies and are caught in a vicious cycle of failure. Those who tried recently are also more likely to have

Table 5. Generalized Estimating Logistic Regressions for Quit History Variables (at Wave *t*) Predicting Cessation Outcomes (at Wave *t* + 1) for the Reduced Two-Wave Sample

	Quit attempt	Sustained abstinence (among attempters)	Overall outcome (sustained abstinence)
Cessation outcomes by whether or not a quit attempt was made in the past year			
N observations/*N* individuals	6,127/4,105	1,888/1,616	5,845/3,952
Total percent achieving the outcome	35.4	20.4	6.6
Made any quit attempts last year?	*p* < .00001	*p* < .00001	*p* < .00005
No	23.2% (ref)	27.1% (ref)	5.6% (ref)
Yes	61.8%*	15.1%*	8.9%*
Percentage achieving each cessation outcome (among only those with an attempt in the past year)			
N observations/*N* individuals	1,930/1,556	1,049/868	1,785/1,455
Total percent achieving the outcome	61.8	15.1	8.9
Time since last quit attempt ended	*p* < .0001	*p* = .34	*p* = .96
Within last month	67.2% (ref)	14.4% (ref)	9.3% (ref)
32–181 days ago	63.6%	14.5%	8.8%
182 days to 1 year ago	51.8%*	17.5%	8.5%
Length of the last quit attempt	*p* = .71	*p* = .16	*p* = .23
Up to 7 days	62.4% (ref)	12.8% (ref)	7.7% (ref)
8–31 days	62.1%	15.7%	9.3%
32 days or longer	59.8%	20.5%	11.3%
Number of quit attempts	*p* < .00001	*p* < .005	*p* = .18
One attempt only	52.6% (ref)	19.6% (ref)	9.6% (ref)
Two or more attempts	70.1%*	11.8%**	8.1%
	p < .05	*p* = .58	*p* = .18
2+, last was longest	76.5% (ref)	14.5% (ref)	10.8% (ref)
2+, last was not longest	69.3%***	10.8%	7.2%

	Concurrent generating estimating equations (among only those with an attempt in the past year)					
	OR	95% CI	OR	95% CI	OR	95% CI
Time since last quit attempt ended						
Within last month	Ref	*p* =.14	Ref	*p* =.93	Ref	*p* =.85
32 to 181 days ago	0.94	0.74–1.19	0.94	0.59–1.48	0.89	0.59–1.36
182 days to 1 year ago	0.76	0.58–1.01	1.02	0.60–1.74	0.89	0.55–1.45
Length of the last quit attempt						
Up to 7 days	Ref	*p* = .32	Ref	*p* = .53	Ref	*p* = .34
8–31 days	1.07	0.86–1.35	1.23	0.79–1.91	1.22	0.81–1.83
32 days or longer	1.24	0.94–1.63	1.29	0.78–2.12	1.40	0.88–2.21
Number of quit attempts						
One attempt only	Ref	*p* < .00001	Ref	*p* < .01	Ref	*p* = .30
Two or more attempts	2.14	1.72–2.65	0.57	0.38–0.85	0.82	0.57–1.19

Note. OR = odds ratio, CI = confidence intervals. Sustained abstinence is for at least 6 months; overall outcome = sustained abstinence among all smokers. All analyses are adjusted for age, sex, education, income, ethnic minority status, marital status, cohort, interwave interval, Heaviness of Smoking Index, baseline smoking frequency, and self-efficacy. Analysis predicting the outcome among those who tried is also adjusted for use of stop-smoking medications since baseline and method of quitting (cut down or cold turkey) followed on the last quit attempt at the outcome wave (wave *t* + 1). The full table of results including associations with the control variables may be obtained on request from the corresponding author. Significance (*p*) values next to the reference category represent the overall effect across categories. **p* < .001, **p < .01, ***p < .05 (referring to upper panels, generalized estimating equations analyses conducted individually on each quit history variable).

tried in the year previous to that, consistent with such an explanation. These smokers may be repeatedly using suboptimal or inadequate quitting methods. Again research to explore possible mechanisms is important, and health care practitioners would be well advised to consider smokers' previous quitting strategies before providing cessation advice.

With the current data, it is not possible to empirically differentiate alternative mechanism for maintaining smoking and precipitating relapse and how past failure might either contribute or signal likely difficulties. Regardless of which explanation is correct, our findings suggest that clinically there is a value

in assessing recent quit efforts, as those who have recently quit and failed are likely to need greater assistance to succeed in the future, we are just not sure what that assistance should be.

Current trends in tobacco control are to motivate smokers to make quit attempts and to quit now instead of delaying (e.g., the "Never give up giving up" campaign in Australia: an example advert may be viewed at http://www.quit.org.au/media/article.aspx?ContentID=never-give-up&ContainerID=media-centre). Smokers in countries with a long history of tobacco control also experience overwhelming societal pressure to quit, with increasing prevalence of public smoking bans and

negative public opinion of smokers. The present findings do have implications for tobacco control strategies that focus on simply increasing the rate of quit attempts (Zhu, Lee, Zhuang, Gamst, & Wolfson, 2012), especially if they are based on the assumption that it will not affect the success rate. These findings suggest that where smokers are encouraged to make multiple attempts within the last year, success rates might drop although not to the point where all the population-level benefit is lost. In light of the present findings, it is worth reexamining the utility of such messages, keeping in mind that increasing quit attempts is still a key objective in tobacco control. Should we consider recommending to smokers who have a history of many unsuccessful quit attempts within the past year that they may be better off taking a break to recover before trying again? Alternatively, should we be identifying such highly motivated individuals as needing extra help because they are either more addicted or are adopting inadequate quitting strategies in their attempts? Unfortunately, at present we do not know enough to make a clear recommendation either way.

It must be stressed that we are by no means suggesting that making quit attempts is detrimental or should be discouraged. Even unsuccessful quit attempts can have residual beneficial effects, such as a temporary reduction in cigarette consumption (Knoke, Anderson, & Burns, 2006; Yong, Borland, Hyland, & Siahpush, 2008) and improved lung function (Murray, Anthonisen, Connett, Wise, Lindgren, Greene, & Nides, 1998). Although those who have tried to quit and failed have lower rates of success on subsequent quit attempts, they still have some likelihood of achieving cessation, which would not be possible if they had not tried to quit again. It is unclear from these data whether waiting to make an attempt with a higher success rate or making multiple attempts with somewhat lower success rates is optimal from a public health viewpoint.

What our findings highlight is that there is a cost to just focussing on quit attempts. These findings, however interpreted, have major implications for modelling the impact of strategies that have their impact by increasing quit attempts. We can no longer assume that increasing quit attempts will translate into a commensurate increase in quit success. Rather, the benefits will need to be discounted to the extent that the increase in quitting activity is among those already trying rather than those who have tried less frequently, if at all, in the past. Although we await further research, we feel it is not premature to advise practitioners in smoking cessation services to identify smokers with multiple past unsuccessful quit attempts and to try to determine whether the strategies they have used in the past are the optimal ones for that individual.

ETHICS CLEARANCE

All waves of the study have received ethical approval from the relevant institutional review board or research ethics committee at The Cancer Council Victoria (Australia), Roswell Park Cancer Institute (USA), University of Waterloo (Canada), and University of Strathclyde (UK).

DECLARATION OF INTERESTS

KMC has consulted with various manufacturers of stop-smoking medications in the past and currently serves as a paid expert witness in litigation against cigarette manufacturers. The remaining authors declare that they have no competing interests.

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