Published in final edited form as:

Addiction. 2009 December ; 104(12): 2088–2099. doi:10.1111/j.1360-0443.2009.02732.x.

Predictors of smoking relapse by duration of abstinence: findings from the International Tobacco Control (ITC) Four Country Survey

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Abstract

Aim—To explore predictors of smoking relapse and how predictors vary according to duration of abstinence.

Design, setting and participants—A longitudinal survey of 1296 ex-smokers recruited as part of the International Tobacco Control (ITC) Four Country Survey (Australia, Canada, UK, and USA).

Measurements—Quitters were phone interviewed at varying durations of abstinence (from one day to approximately three years) and then followed-up approximately one year later. Theorised predictors of relapse (i.e., urges to smoke; outcome expectancies of smoking and quitting; and abstinence self-efficacy) and nicotine dependence were measured in the survey.

Findings—Relapse was associated with lower abstinence self-efficacy and a higher frequency of urges to smoke, but only after the first month or so of quitting. Both of these measures mediated relationships between perceived benefits of smoking and relapse. Perceived costs of smoking and benefits of quitting were unrelated to relapse.

Conclusions—Challenging perceived benefits of smoking may be an effective way to increase abstinence self-efficacy and reduce frequency of urges to smoke (particularly after the initial weeks of quitting), in order to subsequently reduce relapse risk.

Keywords

smoking; tobacco; cessation; relapse

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Conflict of interest declaration: None

Introduction

Most smokers would like to quit (1) and the majority have tried to do so (2, 3), but most of those who try end up relapsing. (4-7). Relapse occurs most often during the initial days of quitting (6); however, longitudinal studies have shown that a substantial proportion of quitters who remain abstinent early in the quit attempt, actually go on to relapse after being quit for months or even years (5, 8-10). Despite the prevalence of late relapse there is limited understanding of its precipitates and whether it differs from early relapse.

In a companion paper (13), we showed that smoking related beliefs and experiences change systematically after quitting. Measures of most variables studied (e.g., frequency of urges to smoke, abstinence self-efficacy) changed relatively rapidly during the first few weeks of quitting before beginning to asymptote; however, the rate of asymptoting varied from a rapid, logarithmic, function to a slower, square-root function of time. Differing rates of change means that the influences of these beliefs are likely to change and it is possible that this is related to the power of these factors to influence relapse at different points in time.

Real time data and retrospective accounts of relapse have found that cravings and urges to smoke are often cited as precipitates of early relapse (12, 14, 15). Similarly, perceived benefits of smoking predict relapse early in quit attempts (16, 17); however, it is unclear what role they play in long-term relapse. Low self-efficacy has proven to be a reliable predictor of early relapse (5, 11, 18-20). One study found an interactive relationship between self-efficacy and time (11): high self-efficacy predicted success among those quit for less than a week or those experiencing at least daily strong urges to smoke, but predicted relapse among participants who had been quit for more than a week and who reported less than daily strong urges to smoke. The authors suggested that overconfidence might play a significant role in late relapse. Other research has found that higher levels of behavioural change process predicted relapse, but only during the first month of quitting (5). Research into post-quitting weight gain has shown that during the initial weeks of quitting gains predict abstinence, whereas gains later in the quitting process predict relapse (12).

Using longitudinal data from the International Tobacco Control (ITC) Four Country Survey, our aim was to explore the rate at which quitters relapsed over time, and how smoking related beliefs (i.e., abstinence self-efficacy, benefits of smoking/costs of quitting, benefits of quitting/costs of smoking) and experiences (i.e., frequency of urges to smoke) precipitate relapse over time.

Given that these factors are unlikely to trigger relapse independently of one another, we also explored possible interactive processes by which predictors precipitate relapse. In line with Bandura's social cognitive theory (21) and previous research findings (17) we hypothesised:

- 1) that perceived benefits of smoking would only threaten sustained abstinence when self-efficacy was low; and
- 2) that self-efficacy would only protect against relapse when the task of quitting was deemed to be more difficult (i.e., in this study, having high perceived benefits of smoking).

Next we explored the mediating mechanisms through which predictors precipitated relapse. In line with Marlatt and Gordon's model of relapse prevention (22), Dijkstra and Borland (17) found that the relationship between perceived benefits of smoking and relapse was mediated by cravings, but not self-efficacy. Given that greater perceived benefits of smoking are likely to make the task of quitting seem more difficult, it is surprising that the authors did not find a causal pathway in which greater perceived benefits of smoking also exert their influence on relapse by decreasing self-efficacy. We sought to test these mediating models of relapse individually and as part of a multiple mediation model.

In the current paper we also explore two models of relapse: a fixed threshold model and a relative threshold model. If relapse occurs when smoking related beliefs and experiences are above given fixed thresholds then the probability of relapse should decline over time as these measures fall further below the threshold. As the predictors asymptote, all other things being equal, rates of relapse should stabilise at very low levels. By contrast, the relative threshold model of relapse predicts that the probability of relapse will continue to vary over time because the thresholds at which smoking related belief and experiences precipitate relapse are relative and, therefore, also vary over time (i.e., the threshold would become progressively lower, and thus rates of relapse would be higher than predicted by a fixed threshold model).

Method

The ITC-4 Survey is an annual longitudinal survey of smokers that was established to evaluate the psychosocial and behavioural impact of tobacco control policies (23). Participants who choose to quit smoking are retained in the cohort, thus providing the opportunity to study predictors of relapse over time.

Participants

Participants in the current study were 1296 adults from the first five waves of the ITC-4 Survey, recruited as smokers who were then subsequently quit on at least one wave and who reported smoking status at the subsequent wave. Participants' beliefs and reported experiences taken from the first four waves of data were used to predict relapse in waves two through five (2003-2006). All predictors, except sociodemographics, time to first cigarette, and cigarette consumption, were assessed while participants were quit. Fifty-seven percent of participants were female and the mean age was 43.64 years ($SD=14.16$). Overall, 30% were from Australia, 27% from the UK, 26% from Canada, and 18% from the USA. Before quitting, 39% smoked 1-10 cigarettes per day, 42% 11-20, and 15% more than 20. Mean heaviness of smoking index (HSI), the combination of cigarettes smoked per day and time to first cigarette (range 0-6), was 2.18 ($SD=1.58$). At baseline (while still smoking), most participants had smokers among their five closest friends (24% none; 19% one; 22% two; 16% three; 20% four or five).

Participants who were quit at more than one wave (and reported more than one wave of follow-up data) contributed multiple response sets: 896 contributed one set; 296 two sets; and 104 three sets (no participants completed all four sets of data). There were 1800 sets of responses across the five waves from the 1296 respondents. Number of days quit across all

five waves ranged from one to 1121, with a median of 151 and an interquartile range of 341.5 (146 were surveyed during the first week post quitting, 239 were surveyed 1 week – 1 month, 655 were surveyed 1-6 months, 291 were surveyed 6 months - 1 year, 326 were surveyed 1-2 years, and 143 were surveyed >2 years). Nicotine replacement therapy was used by 8% of participants at the time of being interviewed.

Measures

The demographic and baseline (while smoking) measures used are described above. Smoking status outcome at each wave was determined by asking participants if they were still quit, and if so, whether they had stayed quit since the last survey date. Participants who were back smoking and those who were currently quit but reported that they had not stayed quit since the last survey were considered to have relapsed. Participants who reported smoking at least once a month were considered to be still smokers.

Proposed predictors of relapse (presented in **Error! Reference source not found.**) were drawn from established psychosocial models of health behaviour (refer to Fong et al (23)) and have been used in past research exploring predictors of quitting (24). Responses to each item were recorded on four- or five-point Likert scales (for more details of each measure see Herd et al. (13)).

Statistical analysis

Results in the corresponding trends paper (13) found that the majority of proposed predictors of relapse changed according to a logarithmic or square-root function. Therefore, for duration of abstinence in the current study, we used the transformation that best fitted each of the dependent variables in the previous paper; a log transformation of days quit was used for proposed predictors that changed over time according to a log function and a square root transformation was used for those that changed according to a square root function. All analyses were conducted using STATA 10 (and significant findings are indicated by p-values of 0.05, 0.01, and 0.001).

Logistic regression analysis was used to explore relationships between demographic variables (i.e., sex, age, country, HSI, and nicotine replacement therapy) and relapse at the following wave approximately one year later, after adjusting for log transformed duration of abstinence. Wald tests were used to determine the overall significance of each categorical demographic variable. Hierarchical logistic regression analysis was used to examine the relationships between proposed predictors of relapse and relapse at the subsequent wave, after adjusting for demographic variables and appropriately transformed duration of abstinence. Interactions between proposed predictors and duration of abstinence were entered in the final step to determine if the relationships between these variables and relapse varied according to duration of abstinence. Due to missing data for HSI at recruitment and nicotine replacement therapy, we conducted analyses with and without these variables. Results including these variables are only reported if they were substantially different from the pattern of results obtained before they were added. The `postgr3` command for STATA (25, 26), was used to graph the adjusted predicted probability of relapse according to the

logistic regression estimation models. The `postgr3` command holds covariates entered in the logistic regression models constant at their mean.

Some responses in the current analysis were repeated measures and, therefore, cannot be considered independent from one another. Therefore, generalised estimating equation models (GEE) were also fitted to the data (27). An exchangeable within-subject correlation structure was used, as this allowed for unequal spacing in duration of abstinence between observations. An unstructured correlation structure was initially tried, but did not always allow the data to converge. All of the results from GEE modelling supported the results obtained from logistic regression analysis and, therefore, are not reported in the results.

Hypothesised moderating effects were explored by adding an interaction term between independent variables to the model after both variables had already been entered. Mediation analysis with a dichotomous dependent variable was carried out according to the methods described by MacKinnon and Dwyer (28) and multiple mediators were tested simultaneously according to the methods described by Kenny et al. (29). Once again, all analyses adjusted for demographic measures and duration of abstinence.

Results

Overall, 37% (n=668) of participants quit at one wave relapsed before the subsequent wave, with the remaining 63% (n=1132) remaining abstinent. Not surprisingly, relapse by the subsequent wave was more prevalent early in the quit attempt (Table 1). Sex, age, country, and use of nicotine replacement therapy did not predict relapse after adjusting for duration of abstinence. The HSI also did not predict relapse. However, among the small sample surveyed during the first month of quitting (n=289), during which nicotine dependence would be expected to be most likely to influence quitting success, relapse was marginally (albeit non-significant) higher among heavier smokers (11-20 cigarettes, OR=1.02, 95% CI=0.59-1.78; 21-30 cigarettes, OR=1.58, 95% CI=0.65-3.83; 31+ cigarettes, OR=1.41, 95% CI=0.27-7.46).

Results in Table 2 show that for every one point increase in log days quit, the odds of relapse decreased by a factor of 0.17.

After controlling for demographics and duration of abstinence, the number of smokers among participants' five closest friends significantly predicted relapse; for each friend who smoked, the odds of relapse increased by 1.12 (95% CI=1.04-1.20, $p<0.01$). There was a significant interaction between number of friends who smoked and duration of abstinence (OR=1.16, 95% CI=1.04-1.29, $p<0.01$) suggesting that a higher proportion of friends who smoke was only associated with an increased risk of relapse after approximately a month post quitting. **Error! Reference source not found.** shows the probability of relapse at each measured time point as a function of reported number of smoker friends at baseline.

Post-quit belief and experiences as predictors of relapse

Table 3 presents results from logistic regression analysis identifying predictors of relapse. A higher frequency of urges to smoke measured at waves two to four was significantly related

to an increased likelihood of relapse. A significant interaction between urges and duration of abstinence indicated that urges predicted relapse differently according to duration of abstinence (see Figure 2). This, and subsequent figures, show the probability of relapse (12 months later) for the measure taken at the time indicated. Given that the interaction appeared to cross over at approximately one month post quitting, we conducted separate logistic regression analyses for one month or less post quitting and more than one month post quitting. Results showed that urges during the first month of quitting were unrelated to relapse (OR=1.09, 95% CI=0.83-1.43, $p>0.05$); however, frequent urges reported after a month or more were associated with a greater likelihood of relapse at follow-up (OR=1.42, 95% CI=1.25-1.60, $p<0.001$). We tested to see if this may have been due to the use of nicotine replacement therapy early in the attempt, but found no effect.

Four of the five perceived benefits of smoking we measured predicted relapse, with only perceived weight control benefits of smoking being unrelated. Figure 3 shows that higher agreement with three perceived benefits was related to increased relapse independent of time. Higher frequency of thoughts about the enjoyment of smoking was also significantly related to an increased likelihood of relapse, but the effect varied by time quit (Figure 4). There was no effect during the first month of quitting (OR=0.96, 95% CI=0.79-1.16, $p>0.05$); however, after a month there was an increased likelihood of relapse with higher frequency of enjoyment thoughts (OR=1.23, 95% CI=1.12-1.36, $p<0.001$). For those quit for less than one month there were limited numbers of cases (as low as 256), so the results need to be treated with caution. The only perceived benefit of smoking to be independently predictive for this sub-sample was the belief that smoking is too enjoyable to give up for good.

We found that perceived costs of smoking and perceived benefits of quitting did not predict relapse (**Error! Reference source not found.**). There were also no significant interactions between each of these measures and duration of abstinence. Figure 5 shows that higher self-efficacy was associated with a lower probability of relapse.

Moderation of relapse

Moderating models of relapse were used to determine if perceived benefits of smoking only threatened sustained abstinence when self-efficacy was low. After adjusting for main effects, demographics, and duration of abstinence, the interactions between self-efficacy and each perceived benefit of smoking item was not significant, indicating no moderation effect. We also tested to see if self-efficacy was only important when urges were high by looking at its effects among those quit for more than one month and reporting less than daily strong urges. However, self-efficacy was still a strong predictor (OR=0.69, 95% CI=0.59-0.81).

Mediation of relapse

Mediating models of relapse explored whether frequency of urges to smoke and self-efficacy mediated the relationships between perceived benefits of smoking and relapse. Duration of abstinence, sex, age, and country were entered as covariates at each step. Given that frequency of urges to smoke only predicted relapse after the first month of quitting, we only explored whether it acted as a mediator after this point. Likewise, the mediation of

frequency of thoughts about the enjoyment of smoking was only explored after one month post quitting.

The relationships between relapse and the beliefs that smoking calms you down, that it is an important part of life, and that it is too enjoyable to give up for good, were all mediated by self-efficacy (**Error! Reference source not found.**). Frequency of thoughts about the enjoyment of smoking was only partially mediated by self-efficacy. For those quit for more than one month, the relationships between relapse and frequency of thoughts about the enjoyment of smoking, and the belief that smoking calms you down, were both mediated by frequency of urges to smoke. The belief that smoking is too enjoyable to give up for good was only partially mediated by urges. The relationship between relapse and the belief that smoking is an important part of life was not significant when data from the first month of quitting was excluded.

Given the overlapping mediation, we next explored whether the above effects were simultaneously mediated by urges and self-efficacy. Not surprisingly, frequency of urges and self-efficacy were negatively correlated ($r=-0.32$, $p<0.001$). Results confirmed that when both proposed mediators were added to the models predicting relapse, each perceived benefit of smoking no longer predicted relapse. Sobel tests found that the indirect effects of perceived benefits of smoking on relapse were carried by both urges and self-efficacy (see Figure 6). This figure does not show the relationship for the belief that smoking is an important part of life as it was not a significant predictor of relapse post one month quit.

Discussion

This study is one of the few to assess relapse in the general population, rather than as a part of a clinical cessation intervention. Our results showed that the rate of smoking relapse decreased over time consistent with previous studies (5, 6), dropping to around 5% after more than two years. The two main dynamic predictors of relapse appear to be self-efficacy, which protects against relapse, and frequency of urges to smoke, which promotes relapse, but only after being quit for around one month. Both these variables appear to mediate the predictive relationships between relapse and perceived benefits of smoking/barriers to quitting. The other important predictor we identified was number of friends who smoke, but again only from a month or so after quitting. Curiously, cigarette consumption prior to quitting, an indicator of dependence, was not a predictor of relapse. We also found no effect for perceived costs of smoking/benefits of quitting and one potential barrier to quitting, perceived weight control benefits of smoking. In the following paragraphs we attempt to integrate these findings with each other and with previous research.

We were surprised to find no effect for dependence given that this is known to be a strong predictor of smoking cessation (24), although the literature regarding relapse is scarce (12). This may suggest that high levels of addiction (at least as measured by the behavioural indices of the HSI) generally only predicts very early relapse, something we were underpowered to study. If these findings were to be replicated, then it would be good news for dependent smokers who might anticipate greater difficulty in staying quit for sustained periods, suggesting that if they survive the early days they are as likely to succeed as would

anyone else. That said, frequency of strong urges to smoke predicted relapse after one month, and this is clearly related to dependence (30). It may be that our behavioural measures of dependence are missing a vital element of dependence that becomes important post-cessation.

Number of friends who smoked was predictive of relapse, but only after a month or so. Early on those with more smoking friends seemed to do somewhat better. We suspect this is partly a function of those with many smoking friends taking this into account early on; however, the impact of friends being continual, means the ease of staying quit does not improve as it might for those who live in a more non-smoking environment. Any such effect could be magnified if quitters tended to avoid socialising with smoking friends in the early days of their attempt, but, understandably, did not sustain this over time.

Lower self-efficacy was a significant predictor of relapse independent of duration of abstinence and frequency of urges, consistent with much previous research (5, 19, 20). The only study to find time-dependent effects (11) looked at predictors short term (around three weeks), while our study considers them over a longer time period, suggesting that in the long term, at least, high self-efficacy for the maintenance of abstinence is critical.

Frequency of strong urges to smoke also predicted relapse, but only after the first month or so of quitting. Retrospective accounts of relapse suggest that urges to smoke precipitate relapse (15), as too, does real time data of initial smoking lapses among recent quitters (14). Our findings are consistent with this. However, they do suggest that the frequency of such urges may not be a problem early on in a quit attempt. Perhaps early in the quit attempt, quitters are prepared to deal with urges and this helps keep them focussed on the task; however, if urges persist then they may experience self-regulatory fatigue and become more susceptible to relapse (31). Although urges may not precipitate early relapse, we do not question the utility of learning how to cope with such urges.

Perceived benefits of smoking/barriers to quitting appear to only be associated with relapse to the extent that they lead to more urges to smoke and/or reduce self-efficacy for staying quit. The barriers we identified as being important were frequency of thoughts about the enjoyment of smoking, and agreement with the beliefs that smoking calms you down when stressed, that it is an important part of life, and that it is too enjoyable to give up for good. Two of these may be particularly important early in quit attempts; smoking being an important part of life (see Figure 3B), as it was not significant when analyses were restricted to those quit for more than one month, and that smoking is too enjoyable to give up for good, the only independent predictor during the first month. These beliefs might be expected to persist, so the fact that they decline and may lose influence is reassuring, as it suggests that they may lose potency with time, as well as becoming less prevalent (13). The belief that smoking calms you down when stressed or upset was one of the few predictors of relapse that was still persistent among many participants even years after quitting (13). Given that this belief was significantly associated with relapse, it may contribute to a substantial proportion of late relapse, particularly when stressful or upsetting experiences occur.

The belief that smoking helps control weight was the only perceived benefit of smoking that was unrelated to relapse, and interestingly, also the only perceived benefit for which agreement increased over time (13). Given that agreement with this belief was likely to have increased in response to actual weight gain, the results suggest that weight gain alone was unlikely to have been a precipitate of relapse. Past research has found that baseline concerns about potential weight gain are unrelated to subsequent relapse (32-35). However, given that quitters increasingly gain weight the longer they are quit it is likely that concern with weight gain also increases over time. Future research would benefit from exploring the relationship between relapse, actual weight gain, and concerns about weight that has been gained.

Frequency of thoughts about the enjoyment of smoking was the one perceived benefit of smoking that became a stronger predictor with time. This highlights the importance of helping the quitter develop strategies for extinguishing craving-evoking cues in as many contexts as possible. Nostalgic beliefs about the value of smoking may be one particularly important set of cues for sustaining cravings and threatening self-efficacy. Our findings suggest a more dynamic model of the interrelationships between these factors and self-efficacy than that found by Dijkstra and Borland (17), in that it is not high self-efficacy itself that is critical in preventing barriers from precipitating relapse, but rather the capacity to maintain high self-efficacy in the context of strongly felt barriers to quitting that is critical.

Although perceived costs of smoking and benefits of quitting often precipitate a quit attempt (3, 24) and are often used in the media to encourage quitting, results in the current study found that agreeing with, or thinking more about, these issues did not increase the likelihood of successful abstinence after quitting. Similar research by Hyland and colleagues (24) also found that perceived costs of smoking (measured before quitting) were unrelated to relapse; however, larger expected benefits of quitting at baseline did predict relapse (unexpectedly). The health benefits of quitting are typically difficult to observe and were probably still largely in the future for most participants in this study, thus they may be largely insignificant in helping maintain abstinence. An alternative explanation is that some levels of such beliefs are universal and the variability in our measures was not meaningful. We do not question the utility of quitters understanding the health benefits of staying quit, indeed why would they bother if they thought there was no benefit, particularly those that see benefits from smoking? Instead, it might be that knowledge of the harms helps to maintain abstinence only if it is specifically accessed during periods of relapse vulnerability (something that was not measured in this study).

The finding that the probability of relapse reduces over time for all variables studied is notable. It supports a relative threshold model of relapse, in which the threshold at which determinants precipitate relapse varies over time. We might have expected that persistence or strong pro-smoking attitudes, frequent urges, and low self-efficacy might have been even more predictive of relapse over time. It is possible the effect is because the ratings are made relative to their current situation, rather than to an absolute, but even if this is so, it is reassuring. These findings complement those found in our companion paper (13) that showed changes in levels of beliefs over time. These changes should add to the reduced predictive value for relapse to further reduce overall relapse rates. It suggests that failure to successfully intervene to reduce the threat from these factors might not be a complete recipe

for relapse. However, it remains important to challenge these beliefs and experiences, because they remain predictors of relapse, which as we have seen, occurs at unacceptably high rates.

Caution needs to be exercised however in generalising too strongly from our results. To further explore the manner in which these potential determinants of relapse interact, research is required in which these variables are measured more frequently and closer to the smoking status outcome. Our mediation analysis was also limited by the predictor variables and mediators being measured at the same time. It would be particularly instructive to experimentally induce changes in perceived benefits of smoking and assess their impact on urges and self-efficacy, and then on relapse in order to confirm this mediational pathway.

The current study was limited by the varying intervals between our measures and when relapse occurred. It could have been only days after the survey, in which case the predictors were measured proximally, or it could have been up to a year. Given the potential gap between the survey and outcome measures, it is notable that we still found strong predictors of relapse. We acknowledge that we lacked sensitivity to detect the effects of variables that change considerably day to day. However, the variables that are most likely to change in this way, urges and frequency of thoughts, were identified as predictors, so we think it unlikely that we have missed other major predictors for this reason. However, we acknowledge that the strength of the association between the predictors we found and relapse is likely to be stronger than we estimate here. We also acknowledge that predictors of relapse may vary according to factors not measured here, and might vary for some population sub-groups (e.g., those with psychiatric or affective disorders, those from different subcultures), but it is equally possible that the determinants of relapse are relatively constant and all that would vary is the frequency of predictors of relapse and perhaps the rates at which they change with time.

Overall, the results confirm a considerable level of relapse even among those who have been abstinent for a year or longer. The model of relapse that emerges from this is that perceived benefits of smoking play a key role in effecting the frequency of urges to smoke and lowering self-efficacy, which then subsequently co-determine relapse. Rather than reminding ex-smokers about the costs of smoking or benefits of quitting to encourage sustained abstinence, it may be more beneficial to provide persuasive information or experiences that challenge perceived benefits of smoking, to the extent that this is possible. However, there is only limited evidence that such a strategy works to reduce alcohol consumption (36), so caution is required. Our findings also suggest that there may be a need to adopt somewhat different strategies for preventing relapse early in the quit attempt to later on. Early on, coping with challenges would appear to be important, while by a month or so, it is important to have fewer smoking urges and bolstered self-efficacy.

Acknowledgements

The first author was supported by an Australian Postgraduate Award. This research was funded by grants from the National Cancer Institute of the United States (R01 CA 100362), the Roswell Park Transdisciplinary Tobacco Use Research Center (P50 CA111236), Robert Wood Johnson Foundation (045734), Canadian Institutes of Health Research (57897 and 79551), National Health and Medical Research Council of Australia (265903 and 450110), Cancer Research UK (C312/A3726), and Canadian Tobacco Control Research Initiative (014578), with additional

support from the Centre for Behavioural Research and Program Evaluation, National Cancer Institute of Canada/Canadian Cancer Society.

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Figure 1.

The interaction between duration of abstinence and number of smokers among five closest friends as a predictor of relapse.

Figure 2.

The interaction between duration of abstinence and frequency of urges to smoke as a predictor of relapse.

Figure 3.
Duration of abstinence and perceived benefits of smoking as predictors of relapse.

Figure 4.

The interaction between duration of abstinence and frequency of thoughts about the enjoyment of smoking as a predictor of relapse.

Figure 5.

Duration of abstinence and abstinence self-efficacy as predictors of relapse.

Sobel test results:

1. Urges $Z=3.302$, $p<0.001$; ASE $Z=4.48$, $p<0.001$ 2. Urges $Z=3.53$, $p<0.001$; ASE $Z=4.38$, $p<0.001$
3. Urges $Z=3.00$, $p<0.01$; ASE $Z=4.96$, $p<0.001$

Figure 6.

The indirect effect of perceived benefits of smoking on relapse through frequency of urges to smoke and abstinence self-efficacy.

Table 1

Smoking status at the subsequent wave by duration of abstinence at the preceding wave.

Smoking status at follow-up wave	Duration of abstinence at preceding wave					
	1-7 days	8-30	31-182	183-365	366-730	>730
Relapsed	114 (78%)	154 (64%)	274 (42%)	65 (22%)	54 (17%)	7 (5%)
Continued abstinence	32 (22%)	85(36%)	381 (58%)	226 (78%)	272 (83%)	136 (95%)

Table 2

Results of logistic regression modelling identifying significant predictors of relapse by the subsequent wave: demographics and duration of abstinence (log transformed) (n=1678).

Variables		Wald test	Odds ratio	95% CI	p
Days quit (log transformed)			0.17	0.13-0.21	<0.001
NRT	Not using	2.56	1		
	Using		1.44	0.92-2.26	0.11
HSI			1.00	0.92-1.07	0.90
Sex	Female	0.52	1		
	Male		0.92	0.73-1.16	0.47
Age	18-24 years	6.71	1		
	25-39 years		0.73	0.48-1.11	0.14
	40-54 years		0.69	0.45-1.05	0.08
	55+ years		0.56	0.36-0.88	<0.05
Country	Australia	2.62	1		
	Canada		0.87	0.65-1.18	0.38
	United Kingdom		0.89	0.65-1.21	0.45
	United States		0.75	0.53-1.07	0.11

All Wald tests were not significant

NRT=nicotine replacement therapy use measured at each wave. HSI=Heaviness of smoking index at recruitment.

Table 3

Results of logistic regression modelling identifying predictors of relapse.

Main effect model			Interaction model				
Independent Variables			N	OR	95% CI	OR	95% CI
Urges to smoke	Frequency of strong urges to smoke		1727	0.65 [*]	0.45-0.93	*** 1.45	1.22-1.72
Perceived benefits of smoking	Perceived weight control benefits of smoking		1785	1.06	0.97-1.16		
	Enjoy smoking too much to give it up for good		1764	*** 1.26	1.11-1.42		
	Smoking is an important part of your life [†]		1792	* 1.14	1.01-1.28		
	Smoking calms you down when you are stressed		1782	* 1.10	1.004-1.212		
	Thoughts about the enjoyment of smoking		1796	* 0.72	0.54-0.96	*** 1.29	1.12-1.48
Perceived costs of smoking	Thoughts about the harms of smoking to you and others [†]		1788	1.06	0.96-1.16		
	Thoughts about the money spent on smoking [†]		1797	1.00	0.93-1.09		
Perceived benefits of quitting	Perceived health and other benefits of not smoking		1723	0.98	0.88-1.10		
	Perceived risk of heart disease in future vs. non-smoker		1502	0.93	0.84-1.04		
	Perceived quality of life since quitting		1679	1.08	0.95-1.23		
Abstinence self-efficacy	How sure are you that you can stay quit?		1786	*** 0.62	0.56-0.70		

***p<0.01

All analyses adjusted for sex, age, country, and duration of abstinence.

Note: For each independent variable, results from one of two different models are presented: a main effects model or an interaction model. The interaction model is only shown when the interaction between the independent variable and duration of abstinence was significant.

* p<0.05

*** p<0.001.

[†] In line with previous findings (13), duration of abstinence for these measures was transformed by square-root rather than log.

Table 4

The mediation of perceived benefits of smoking on relapse by frequency of urges to smoke and abstinence self-efficacy.

Predictors	Outcomes (Standardized regression coefficients and SE)			Sobel test (z)
	ASE	Relapse	Mediated relapse	
Thoughts about the enjoyment of smoking [†]	*** -0.10 (0.01)	*** 0.14 (0.03)	*** 0.10 (0.03)	*** 4.72
ASE			*** -0.21 (0.03)	
Smoking calms me down when stressed	*** -0.09 (0.01)	* 0.07 (0.03)	0.02 (0.03)	*** 5.40
ASE			*** -0.26 (0.03)	
Smoking is an important part of life	*** -0.10 (0.01)	* 0.06 (0.03)	0.02 (0.03)	*** 5.46
ASE			*** -0.26 (0.03)	
I enjoy smoking too much to quit for good	*** -0.15 (0.01)	*** 0.11 (0.03)	0.04 (0.03)	*** 6.48
ASE			*** -0.26 (0.03)	
	Urges	Relapse	Mediated relapse	
Thoughts about the enjoyment of smoking [†]	*** 0.23 (0.01)	*** 0.14 (0.04)	0.06 (0.04)	*** 4.06
Urges			0.16 (0.04)	
Smoking calms me down when stressed [†]	*** 0.10 (0.01)	* 0.08 (0.04)	0.05 (0.04)	*** 4.25
Urges			0.18 (0.04)	
I enjoy smoking too much to quit for good [†]	*** 0.07 (0.01)	** 0.11 (0.03)	0.08 (0.03)	*** 3.45
Urges			0.17 (0.03)	

Urges: Frequency of urges to smoke. ASE: Abstinence self-efficacy.

Note: Demographic variables and duration of abstinence were entered as covariates at each step in the mediation analysis. Regression coefficients have been standardized according to the methods described by MacKinnon & Dywer (28).

*
p < 0.05

**
p < 0.01

† Analysis did not include data from the first month of quitting.

p < 0.001.

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