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Dependence and motivation to stop smoking as predictors of success of a quit attempt among smokers seeking help to quit

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HIGHLIGHTS

- The 'Fagerstrom', and its component scores, predicted abstinence in the short and long-term.
- Motivation towards quitting smoking did not predict abstinence.
- At 12 mths the 'Fagerstrom' and non-Heaviness of Smoking Index items were equally strong predictors.

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ABSTRACT

Introduction: It is not known how well motivation to stop smoking predicts abstinence in a clinical sample relative to the most widely used measure of cigarette dependence.
Methods: A secondary analysis was conducted from a trial with 864 smokers making quit attempt. Fagerström Test of Cigarette Dependence (FTCD), Heaviness of Smoking Index (HSI), and motivation to stop smoking (composite of determination to quit and importance of quitting) were measured at baseline. Continuous smoking abstinence, validated by expired-air carbon monoxide, was assessed at 4 weeks, 6 months and 12 months post-quit date. FTCD, HSI, non-HSI items in FTCD, and motivation were assessed as predictors of abstinence.
Results: In multiple-logistic regressions, controlling for age, gender and medication use, lower scores for FTCD, HSI and non-HSI all significantly predicted abstinence at all follow-ups, while motivation did not predict abstinence at any time. Likelihood ratio tests showed that the FTCD contributed most to the model at 4 weeks and 6 months; at 12 months FTCD and non-HSI equally contributed most to the model. At 4 weeks and 6 months, predictions were improved by combining HSI and non-HSI components, compared with using these components alone.
Conclusions: Cigarette dependence, measured by the FTCD, or by its HSI or non-HSI components, predicts both short-term and medium-term outcomes of attempts to stop smoking in treatment-seeking smokers involved in a clinical trial, whereas strength of motivation to stop predicts neither. Both the HSI and non-HSI components may be considered as briefer alternatives to the full FTCD.

1. Introduction

Data from population samples show that motivation to stop smoking predicts incidence of quit attempts but does not generally predict the success of those attempts; whereas cigarette dependence does not consistently predict quit attempts but does predict relapse to smoking following those attempts (Vangeli, Stapleton, Smit, Borland, & West, 2011). This issue is central to our understanding of factors that promote or inhibit different parts of the quitting process and has implications for targeting interventions that promote and aid quit attempts (West, 2009).

Clinical samples (i.e., smokers who proactively seek stop-smoking treatment in a stop smoking clinic) are also important to study because, compared with population studies, they generally provide an opportunity for measuring motivation and dependence immediately prior to the quit attempt, include greater rigour of measurement of outcome, and permit better control of the conditions under which quitting occurs. A range of factors might contribute to differences between studies, including the measures used, the samples, and the duration of abstinence. As regards dependence, studies from clinical samples, with smokers

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who are motivated to quit, have tended to show more mixed results compared with population studies, with dependence predicting quit success in some studies (Breslau & Johnson, 2000; Courvoisier & Etter, 2010; Ferguson et al., 2003; Japuntich, Leventhal, Piper, et al., 2011; Kozlowski, Porter, Orleans, Pope, & Heatherton, 1994) and other studies failing to observe this effect (Etter, 2005; Frikart, Etienne, Cornuz, & Zellweger, 2003; Piper, Piasecki, Federman, et al., 2004; Piper, McCarthy, & Baker, 2006). Dependence could be a more consistent predictor of abstinence in population studies, compared with clinical studies, because population samples tend to have a wider range of dependence.

For motivation, clinical studies have recruited a mixed sample of smokers wanting to quit and those not interested in quitting and have shown that motivation predicts success (Cox, Wick, Nazir, et al., 2011; Sciamanna, Hoch, Duke, Fogle, & Ford, 2000); however, in these studies, the results are confounded by combining, in the analysis, smokers who have and have not made a quit attempt. We could identify only two clinical studies in which the entire sample were treatment-seeking smokers, attempting to quit smoking, and motivation (assessed as determination to quit) predicted the success of quit attempts up to 12 months of abstinence in one study (Bauld, Ferguson, McEwen, & Hiscock, 2012) but not in the other study (Ferguson, Bauld, Chesterman, & Judge, 2005). However, these studies recruited smokers from routine smoking cessation clinics in the English National Health Service and it is not clear whether all the participants actually tried to quit (i.e., made it to their quit date), and that could influence the findings.

The present study aimed to add to the evidence base on associations between motivation to quit, cigarette dependence and success of quit attempts by employing a large clinical sample, making a definite quit attempt, and with data on both short- and medium-term follow-up with half the sample receiving no medication in support of the attempt. It provided a robust test of the relative predictive power of these measures through applying a strict criterion for abstinence, involving no self-reported smoking from the quit date onwards, with biochemical verification at 1, 2, 3 and 4 weeks and at 6 months and 12 months after the target quit date. Use of a strict abstinence criterion (e.g., lapse-free abstinence from the quit date) is important as weaker outcome measures (e.g., point prevalence — typically defined as not smoking on the day of follow-up or for a specified number of days before a follow-up) are contaminated by some 'successes' being only transient arising after failure of the initial quit attempt (West, Hajek, Stead, & Stapleton, 2005).

The most commonly used self-report measure of cigarette dependence is the Fagerström Test for Cigarette Dependence (FTCD, previously known as the Fagerström Test for Nicotine Dependence) (Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991; Fagerstrom, 2012) which has been found to predict success at stopping smoking in some studies (Breslau & Johnson, 2000; Courvoisier & Etter, 2010; Ferguson et al., 2003; Japuntich et al., 2011; Kozlowski et al., 1994), although other studies have found no relationship with quitting success (Etter, 2005; Frikart et al., 2003; Piper et al., 2004). Measures based on self-rated dependence or Diagnostic and Statistical Manual of Mental Disorders (DSM) criteria typically fail to predict quitting outcomes (Piper et al., 2006; DiFranza, Ursprung, Lauzon, et al., 2010; Piper, McCarthy, Bolt, et al., 2008). A scale composed of two items from the FTCD, time to first cigarette of the day and number of cigarettes usually smoked per day (i.e., Heaviness of Smoking Index (HSI)), (Heatherton, Kozlowski, Frecker, Rickert, & Robinson, 1989) has been shown to predict failure of quit attempts at least as well as the full scale, whether in population studies (Courvoisier & Etter, 2010; Fidler, Shahab, & West, 2011) or in clinical studies with treatment seeking smokers who are motivated to quit (Kozlowski et al., 1994; Baker, Piper, McCarthy, et al., 2007; Burling & Burling, 2003; Fagerstrom, Russ, Yu, Yunis, & Foulds, 2012). Overall, as these studies found no evidence of superiority of the FTCD over the HSI for predicting abstinence, they have encouraged use of the HSI as a more economical substitute for the FTCD. However, these studies used a point-prevalence measure of abstinence which, as argued above, has limitations. It would be useful to collect more data from clinical samples to determine whether the non-HSI parts of the FTCD predict outcome over and above the HSI.

As regards use of multiple follow-up points, it might be expected that cigarette dependence would be more successful in predicting short-term than medium or long-term relapse to smoking. This is because relapse after the initial period of cigarette withdrawal symptoms might be more of a random event, arising from a range of environmental and social triggers. This is also consistent with the proposal that the FTCD is predominantly a measure of physical dependence (DiFranza et al., 2013; Moolchan, Radzius, Epstein, et al., 2002).

Thus, this study addressed the following questions: (i) How well do motivation to stop smoking and cigarette dependence measured just prior to a quit attempt in a clinical sample of treatment-seeking smokers predict short-term (i.e., at 4 weeks) and medium-term (i.e., at 6 or 12 months) abstinence? (ii) How do the HSI and non-HSI parts of the FTCD compare as predictors of short- and medium-term abstinence?

2. Methods

2.1. Design and interventions

This study involved secondary data analysis from a double-blind placebo-controlled trial of glucose tablets for smoking cessation (West et al., 2010) Information on demographic characteristics and smoking patterns was gathered by means of a postal questionnaire completed at one to four weeks before the quit date. All participants attended the clinic 1 week prior to their target quit date, on their quit date, then weekly up to 4 weeks after their quit date, totalling six sessions over 5 weeks. At each session, they received 60 min of group-based behavioural support (Stead & Lancaster, 2012). Participants were randomised to receive either glucose tablets or sorbitol tablets (placebo), supplied up to 6 weeks after the quit date. In addition, within the both groups, participants were randomised to receive either stop smoking medication (nicotine replacement therapy (NRT) and/or bupropion) or no medication, which were prescribed up to 8 weeks post-quit. Participants were followed up 1, 2, 3, 4, 26, and 52 weeks post-quit date.

2.2. Participants

Smokers wanting help with stopping smoking were recruited through general practitioner referral, word of mouth, and advertising. They were excluded if under 18, diabetic, currently smoking < ten cigarettes a day, unable to read and write English, or if they reported a current psychiatric condition. Written informed consent was obtained. Nine-hundred-twenty-eight participants were recruited over a 19 month period between November 2006 and May 2008. The eligibility criteria were clearly outlined in the invitation letter and it was not necessary to exclude anyone who expressed interest in taking part. As the study was investigating the prediction of success of quit attempts, only the 891 (96%) who made a quit attempt were included. Twenty-seven participants with missing FTCD scores were excluded from the analysis. The characteristics of those included were very similar to the excluded 27. Eight-hundred-sixty-four (93.1%) participants were included in the analysis.

2.3. Measures

Prior to the quit attempt, demographics, motivation to quit and cigarette dependence were assessed. Demographics, including age, gender and occupation were assessed by the postal questionnaire.

2.3.1. Motivation to quit

Determination to quit was measured twice: by the postal questionnaire prior to the quit date and at the quit date session: "How determined are you to give up smoking at this attempt?" (not all that determined = 1, quite determined = 2, very determined = 3, greatly determined = 4, extremely determined = 5) (West & Willis, 1998). Importance of quitting was measured once by postal questionnaire: "How important is it to you to give up smoking altogether at this attempt?" (not all that important = 1, quite important = 2, very important = 3, desperately important = 4) (adapted from Miller & Rollnick, 1991) Following the analysis it was decided to combine the measures of motivation to produce a single composite score (see first paragraph of Results).

2.3.2. Cigarette dependence

Cigarette dependence was assessed by the postal questionnaire, prior to the quit date, using the FTCD (scored 0–10) (Heatherton et al., 1991; Fagerstrom, 2012) which consists of six items: daily cigarette consumption scored 10 or less = 0, 11–20 = 1, 21–30 = 2, 31 or more = 3; time to first cigarette of the day (31+ min = 0, 6–30 min = 2, 0–5 min = 3); difficulty not smoking in no-smoking areas (No = 0, Yes = 1); which cigarette would most hate to give up scored ('first of the morning' = 1, others = 0); smoke more frequently in first hours after waking (No = 0, Yes = 1); smoke when ill in bed (No = 0, Yes = 1). Higher scores FTCD scores indicate greater cigarette dependence. The first two FTCD items make up the Heaviness of Smoking Index (HSI, scored 0 to 6) (Heatherton et al., 1989).

Use of stop smoking medications (NRT or bupropion) was assessed. Smoking abstinence was defined as continuous, self-reported lapse free abstinence from the target quit date to 4 weeks, 6 months and 12 months confirmed at each follow-up (i.e., at weeks 1, 2, 3, 4, 26 and 52 weeks post-quit date) by expired-air CO < 10 ppm. As is conventional, participants lost to follow-up were considered to have relapsed (West et al., 2005).

2.4. Analysis

Descriptive statistics were produced for the participant and treatment characteristics, both for the whole sample and according to median splits on FTCD and motivation to quit. Chi-squared and t-tests were used to compare the sample characteristics according to these splits. The reliability (internal consistency) of the dependence and motivation measures were assessed using Cronbach's alpha. Using logistic regression, bivariate associations were examined between dependence/motivation measures and smoking abstinence (abstinent = 1, non-abstinent = 0) at 4 weeks, 6 months and 12 months.

The primary analyses involved multiple-logistic regressions with smoking abstinence at 4 weeks, 6 months and 12 months as dependent measures. It was decided a priori to first fit a basic model with five covariates as independent variables: age, gender (female = 1, male = 0), occupation (1 = professional managerial, 0 = other occupation, as an indicator of socio-economic status), medication use (NRT or bupropion = 1, no medication = 0), and whether receiving glucose (code 1) or placebo (code 0) tablets as they are potentially important prognostic factors for smoking cessation. Those receiving glucose versus placebo tablets did not differ on rates of smoking abstinence at any time; therefore, assignment to glucose or placebo was not ultimately controlled for.

In the next model FTCD score was added to the basic model. The likelihood ratio test was used to assess whether the FTCD improved the basic model (i.e., significantly increased the prediction of smoking abstinence). The latter analysis was repeated, without the FTCD, adding motivation, HSI, and non-HSI separately to the basic model. We then tested whether adding motivation improves the models for FTCD, HSI or non-HSI. Finally, we assessed whether adding non-HSI improves the model for HSI, and vice versa. In all the regression models, we tested the interaction terms for age, gender and use of medication with the predictors, and the interaction term for motivation score with FTCD, HSI, and non-HSI using likelihood ratio tests. For the significant predictors, we used the likelihood ratio test to assess whether covariates moderate the results significantly. To assess the effect of the assumption that those lost to follow-up had relapsed, all the analyses were repeated when only including those who were followed-up and confirmed as abstinent. The analysis was conducted using SPSS version 21 and Stata version 12.

3. Results

The sample characteristics are presented in Table 1. The numbers lost to follow-up and presumed to be smoking were: four participants at four weeks, 66 at six months, and 17 at 12 months. When only including those who were followed-up all the following results were very similar. The Cronbach's alpha for the dependence scores were: FTCD 0.61, HSI 0.54, non-HSI 0.46. The two measures of 'determination to quit' were significantly correlated (Pearson's $r = 0.493$, $p < 0.001$) and we combined them in order to increase the reliability of the measure and to give it every possible chance to predict outcome. Very similar results were obtained when using either of the determination ratings individually. As the 'importance of quitting' item was significantly correlated with the combined determination item ($r = 0.513$, $p < 0.001$) and the Cronbach's alpha for the three items (i.e., two determination items and importance item) was acceptable (0.71), in order to arrive at the most accurate measure available to us, we combined the items in a single measure of motivation to quit (range of scores: 3 to 14). All the findings were very similar whether we used the combined motivation measures or if we used determination and importance separately. The mean (SD, actual range of scores) dependence and motivation scores were: FTCD 5.8 (2.3, 0–10), HSI 3.7 (1.5, 0–6), non-HSI 2.1 (1.2, 0–4), motivation 12.0 (2.0, 6–14).

Table 2. shows the unadjusted (i.e., bivariate) and adjusted odds ratios for the dependence and motivation scores at the three follow-up points. When adding occupation as a covariate there was minimal change in any of the results for the regressions. As there were 40 cases missing for occupation, in order to preserve the sample size, occupation was excluded from the findings presented in Table 2. Table 2. also presents the findings for the likelihood ratio tests, which assessed whether the basic model is improved by adding any of the dependence variables or the motivation variable. At four weeks, in the adjusted regressions, lower scores for FTCD, HSI and non-HSI all significantly predicted abstinence at $p < 0.001$. The likelihood ratio test indicated that the basic model was improved most by adding FTCD ($\chi^2 = 30.27$), followed by HSI then non-HSI ($\chi^2 = 24.03, 19.29$, respectively); however, all three dependence variables were highly significant with the likelihood ratio test (all $p < 0.001$). At 4 weeks, having already added HSI to the basic model, adding non-HSI significantly further improved the model ($\chi^2 = 6.28$, $p = 0.012$). Similarly, adding HSI to the adjusted model for non-HSI significantly improved the model at four weeks ($\chi^2 = 11.02$, $p < 0.001$).

At six months, the adjusted regressions showed that, as for 4 weeks, each of the dependence variables significantly predicted abstinence at $p < 0.001$ (see Table 2.). According to the likelihood ratio test, FTCD once again contributed most to the basic model ($\chi^2 = 18.98$), followed by non-HSI ($\chi^2 = 15.13$) and HSI ($\chi^2 = 12.72$), with all three reaching a significance of $p < 0.001$. Having added HSI to the basic model, adding non-HSI further improved the model ($\chi^2 = 6.60$, $p = 0.010$). Likewise, adding HSI to the adjusted model for non-HSI improved the model at 6 months ($\chi^2 = 4.19$, $p = 0.041$), though to a lesser extent than at 4 weeks.

At 12 months, in the adjusted model, abstinence was significantly predicted by each of the dependence variables (see Table 2). The basic model was improved to a greater extent by adding FTCD and non-HSI ($\chi^2 = 12.19, 13.23$, respectively), than when adding HSI ($\chi^2 = 5.96$).

Table 1
Participant characteristics according to median split for scores for FTCD and motivation (N = 864).[a]

Variable[b]	Total sample, N = 864	FTCD score ≤ 5 (n = 363)	FTCD score ≥ 6 (n = 501)	Motivation score ≤ 12 (n = 458)	Motivation score ≥ 13 (n = 406)
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Female	539 (62.4)	225 (62.0)	314 (62.7)	**268 (58.5)***	**271 (66.7)**
Professional/managerial occupation (N = 824[c])	239 (27.7)	**121[d] (34.6)****	**118[e] (24.9)**	**145[f] (33.1)****	**94[g] (24.4)**
Any use of smoking cessation medication	419 (48.5)	**158 (43.5)***	**261 (52.1)**	**197 (43.0)***	**222 (54.7)**
Abstinent from smoking up to 4 weeks	303 (35.1)	**157 (43.3)*****	**146 (29.1)**	151 (33.0)	152 (37.4)
Abstinent from smoking up to 6 months	122 (14.1)	**71 (19.6)*****	**51 (10.2)**	61 (13.3)	61 (15.0)
Abstinent from smoking up to 12 months	68 (7.9)	**44 (12.1)*****	**24 (4.8)**	34 (7.4)	34 (8.4)
	Mean (SD)	No. (%)	No. (%)	No. (%)	No. (%)
Age	44.2 (12.4)	**42.3 (12.5)*****	**45.6 (12.2)**	43.9 (12.7)	44.6 (12.2)

FTCD = Fagerström Test of Cigarette Dependence.
For each sample characteristic, significance (in bold) for difference between FTCD or motivation groups using chi-squared or t-tests: *p < 0.05, **p < 0.01***p < 0.001. Denominators: [d]350, [e]474, [f]438, [g]386.
[a] Sum of ratings of determination to quit and importance of quitting.
[b] Ethnic group not recorded.
[c] Missing data for 40 participants not declaring an occupation.

At 12 months, adding non-HSI improved the adjusted model for HSI ($\chi^2 = 8.13$, p = 0.004). While, adding HSI to the adjusted model for non-HSI did not improve this model ($\chi^2 = 0.86$, p = 0.353).

Motivation did not significantly predict abstinence, or improve the basic model, at any time point. Moreover, adding motivation did not significantly improve the adjusted model for any of the dependence variables at any time point (range for likelihood ratio tests: $\chi^2 = 0.01$ to 1.40). None of the interactions reached statistical significance. Likelihood ratio tests showed that the covariates significantly moderated the findings for: FTCD, HSI and non-HSI predicting abstinence at 4 weeks ($\chi^2 = 22.89$, p < 0.001, $\chi^2 = 23.13$, p < 0.001, $\chi^2 = 18.19$, p < 0.001, respectively) and for FTCD and HSI predicting abstinence at 6 months. The covariates did not significantly moderate the findings for non-HSI at 6 months or for any of the dependence variables at 12 months. There was no evidence of substantial multicollinearity among any of the independent variables in the multiple regressions.

4. Discussion

Cigarette dependence, whether measured by the FTCD, or by the HSI or non-HSI parts of the FTCD, significantly predicted both short-term and medium-term smoking abstinence. Motivation to stop did not predict abstinence at any time. For 4 week and six-month abstinence the FTCD contributed most to the model; while at 12 months the non-HSI and FTCD contributed most. Combining the two FTCD components improved the contribution at 4 weeks and six months but not at 12 months. The internal consistency of the FTCD and HSI and non-HSI parts of the FTCD was poor and slightly lower than that of the motivation scale.

The findings provide possibly the most robust evaluation of the relative power of measures of cigarette dependence and motivation to stop smoking in predicting the outcome of smoking cessation attempts. Use of continuous lapse-free validated abstinence and multiple follow-up

Table 2
Odds ratios and likelihood ratios for measures of tobacco dependence and motivation predicting smoking abstinence (N = 864).

Unadjusted bivariate associations (independent variables, per point increase)	Time of smoking abstinence assessment (dependent variable)		
	4 weeks	6 months	12 months
	OR (95% CIs)	OR (95% CIs)	OR (95% CIs)
FTCD	**0.86 (0.81–0.92) p < 0.001*****	**0.85 (0.78–0.92) p < 0.001*****	**0.83 (0.75–0.93) p = 0.001****
HSI	**0.82 (0.75–0.90) p < 0.001*****	**0.82 (0.73–0.93) p = 0.002****	**0.83 (0.71–0.97) p = 0.023***
Non-HSI items from FTCD	**0.79 (0.70–0.88) p < 0.001*****	**0.74 (0.63–0.86) p < 0.001*****	**0.68 (0.55–0.84) p < 0.001****
Motivation to quit	1.03 (0.96–1.11) p = 0.391	0.98 (0.89–1.08) p = 0.687	0.94 (0.83–1.06) p = 0.300

Adjusted[a] multiple regressions	Time of smoking abstinence assessment (dependent variable)					
	4 weeks		6 months		12 months	
	OR (95% CIs)	LR[b] χ^2	OR (95% CIs)	LR[b] χ^2	OR (95% CIs)	LR[b] χ^2
FTCD	**0.84 (0.78–0.89) p < 0.001*****	**30.27 p < 0.001*****	**0.83 (0.76–0.90) p < 0.001*****	**18.98 p < 0.001*****	**0.83 (0.74–0.92) p < 0.001*****	**12.19 p < 0.001*****
HSI	**0.78 (0.71–0.86) p < 0.001*****	**24.03 p < 0.001*****	**0.79 (0.69–0.90) p < 0.001*****	**12.72 p < 0.001*****	**0.81 (0.69–0.96) p = 0.013***	**5.96 p = 0.015***
Non-HSI items from FTCD	**0.77 (0.68–0.87) p < 0.001*****	**19.29 p < 0.001*****	**0.73 (0.62–0.86) p < 0.001*****	**15.13 p < 0.001*****	**0.68 (0.55–0.84) p < 0.001****	**13.23 p < 0.001*****
Motivation to quit	1.02 (0.95–1.09) p = 0.673	0.18 p = 0.672	0.98 (0.89–1.08) p = 0.636	0.22 p = 0.638	0.95 (0.84–1.07) p = 0.398	0.70 p = 0.403

OR (95% CIs) = odds ratio (95% confidence intervals).
Results shown in bold are significant at: ***p < 0.001, **p < 0.01, *p < 0.05.
FTCD = Fagerström Test of Cigarette Dependence, HSI = Heaviness of Smoking Index, LR χ^2 = chi-squared value for likelihood ratio test.
[a] All regressions adjusted for the covariates of age, gender and use of medication.
[b] Likelihood ratio test to assess the extent to which adding each variable (i.e., FTCD, HSI, non-HSI, motivation) separately to the basic model (i.e., model with covariates only) affects the prediction of smoking abstinence.

points, and demonstration that the motivation score showed at least as good reliability and similar variation as the dependence measures, strengthen the conclusion that dependence but not baseline motivation to quit, within the ranges seen in a typical sample seeking treatment in a stop smoking clinic, is important in determining the success of quit attempts. This informs us about where interventions need to focus in helping quit attempts among those who seek treatment (e.g., in helping people avoid and manage urges to smoke, rather than in assessing and boosting motivation towards quitting among smokers attending prior to attempting to quit). However, this research does not address motivation over the course of the quit attempt. It may be that when motivation drops, during a quit attempt, that change predicts relapse. It must also be considered that motivation is likely to be more unstable over time than dependence. This would tend to militate against showing an association with cessation outcomes. It remains possible, or even likely, that motivation measured continuously after the quit attempt would provide insights into the lapse and relapse processes. However, it may also be noted that motivation has enough stability for it to predict quit attempts over a 6 month period (Kotz, Brown, & West, 2013). Alternatively, it may be that motivation is key for initiating a quit attempt, but dependence is important as regards abstinence. Also, smokers seeking treatment in other contexts, such as when seeing a physician, nurse or midwife, may have lower motivation to quit, when compared with the current sample, and increasing motivation among these individuals may be beneficial. Thus, the findings are not generalizable beyond those smokers who proactively seek stop-smoking treatment in a stop smoking clinic, and who have also volunteered to participate in a clinical trial.

The finding that the non-HSI part of the FTCD added predictive power over and above the HSI at all three follow-ups, and that it was the non-HSI parts, rather than HSI, that contributed most at 6 and 12 months, suggests that the non-HSI may be important. The full scale has only six items and the additional resources required to use it over and above the HSI are small; therefore, it would seem prudent to use the full scale, at least up to 6 months. It is not clear why the non-HSI items, relative to the HSI items, are more important as predictors of quit success as the duration of abstinence increases. As non-HSI performed similarly to the FTCD as 12 months, the non-HSI may provide a briefer alternative to FTCD at this time; however, this is the first study to observe such results for the non-HSI and replication is required.

The study had limitations. Fewer low dependency smokers were included than might be found in the general smoking population (mean FTCD score in this study: 5.8; mean FTCD score for the general smoking population: 3–4) (Fagerstrom & Furberg, 2008). Dependence levels may also be slightly higher than in treatment seeking smokers in general, where those smoking less than 10 cigarettes would not be excluded, although as a rule smokers seeking treatment are highly dependent as less dependent smokers are able to quit unaided. Consequently, the variation in FTCD scores in this analysis may be restricted and the findings may be slightly different if more low dependency smokers were included. Secondly, as with most clinical data, these findings are based on smokers who are attending multiple clinic visits and they may not readily extrapolate to smokers attending fewer visits. Moreover, participants were willing to enrol for a prolonged clinical trial and thus were highly motivated at the outset; however, they were also motivated to quit; therefore further fine distinctions in level of motivation, related to joining a trial, would be unlikely to have a major impact. Smoking abstinence was validated by the standard measure of expired CO; however, the rigour of the validation could have been improved by also assessing cotinine levels (Etzel, 1990).

There are potential limitations concerning the validity of the motivation measure. Assessing the validity of a motivation measure in this context is subject to conceptual issues with regard to finding a criterion against which to assess it. Given the hypothesis that baseline motivation is not likely to be a good predictor of sustained abstinence, we cannot easily use abstinence as a criterion of pre-quit motivation. We are not aware of any other readily available behavioural criteria in a study of this kind. Another way of comparing the psychometric properties of the measures is their internal reliability. In that regard, the motivation measure and the FTCD performed similarly and in fact the FTCD has been criticised for weak psychometric properties (Heatherton et al., 1991; Payne, Smith, McCracken, McSherry, & Antony, 1994; Pomerleau, Carton, Lutzke, Flessland, & Pomerleau, 1994; Sledjeski et al., 2007). Nevertheless, it remains possible that conclusions relating to the differential predictive ability of dependence and motivation measures may be due to differences in the validity of the two measures. Moreover, motivation measures such as those related to determination and importance are reflective of the initial 'desire' to quit and may not predict quit success because they do not tap into the ability to work through the challenges of quitting, particularly in terms of the mental energy required for the inhibitory-control of smoking behaviour (West, 2009). Measures are needed which assess more behavioural aspects of motivation, such as self-control. This is a difficult proposition as motivation is an internal construct and may not be easily amenable to behavioural assessment.

It is also noteworthy that the mean motivation score of 12 was high (maximum score = 14), with a standard deviation of just 2, raising the potential for a ceiling effect. High motivation can be expected in smokers who enlist for multisession treatment and who volunteer for a clinical trial, and the heterogeneity in motivation to quit may have limited the potential to predict abstinence. However, it could also be argued that the potential 'ceiling effect' reinforces rather than weakens the finding. It suggests that people who pro-actively seek help in stopping smoking are, not surprisingly, well-motivated to quit and that the reason they cannot quit unaided is that they are dependent rather than that they do not want to quit. Thus, it is useful to know that once people have got to the point of making a quit attempt in a stop smoking clinic, a measure of motivation is not predictive of success while a measure of dependence is. The same motivation measure may predict stop-smoking outcome in a general population of smokers, where levels of motivation are likely to vary more widely. Similar limited variation, however, was also present in measures of dependence. As with any motivation measure of this type, there is also the risk of social desirability leading to reports of inflated motivation scores, although this is likely to have been lessened by the questionnaire being postal rather than being administered face-to-face.

In conclusion, in highly dependent treatment-seeking smokers making a quit attempt in a clinical trial, cigarette dependence is a significant predictor of both short-term and medium-term abstinence, while motivation, assessed through pre-quit ratings of 'determination to quit' and 'importance of quitting', is not. Besides the full FTCD, the HSI and non-HSI components of the FTCD are also both strong predictors of abstinence. Predictive ability is generally improved by combining the HSI and non-HSI, compared with using these components alone, suggesting that the FTCD is the best predictor.

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Contributors

RW and PH designed and conducted the original randomised controlled trial. This secondary data analysis was planned by MU, RW and GK. MU and GK conducted the analysis. MU led the drafting of the manuscript and all authors approved the final manuscript.

Conflict of interest

Professors West and Hajek undertake research and consultancy for companies that develop and manufacture smoking cessation medications. The remaining authors declare no conflict of interest.

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