Predicting smoking cessation with self-reported measures of nicotine dependence: FTQ, FTND, and HSI

Lynn T. Kozlowski*a3b, Carol Q. Porter, C. Tracy Orleansd, Marilyn A. Popeb, Todd Heathertonc

*210 East Health and Human Development, Program in Biobehavioral Health, Penn State University, University Park, PA 16802, USA
bAddiction Research Foundation, Ontario, Canada M5S 2S1
cHealth Services Research Center, University of North Carolina, Chapel Hill, NC, USA
dBehavioral Medicine, Fox Chase Cancer Center, Philadelphia, PA, USA
Psychology Department, Harvard University, Cambridge, MA 02138, USA

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Abstract

In two independent studies, we explored the usefulness of three self-report measures of tobacco dependence — the Fagerström Tolerance Questionnaire (FTQ), the Fagerström Test for Nicotine Dependence (FTND), and the Heavy Smoking Index (HSI). The FTND is a revised version of the FTQ. The HSI is identical to a two-question subset of the FTND. Study 1 involved 932 participants in a seven-session, five-week, group smoking cessation program, and it looked at the ability of these self-report tests to predict expired air carbon monoxide (i.e., heaviness of smoking) at beginning of treatment and cessation at end of treatment. Study 2 involved 1877 participants in a self-help smoking cessation program, and it looked at the prediction of cessation at 16-month follow up. All tests made statistically reliable predictions of smoking cessation, but generally accounted for little variance (about 1%). In Study 1, the test scores were associated positively with carbon monoxide levels. The shorter (six vs. eight questions), more reliable FTND is to be preferred to the FTQ; and the HSI (two questions) works as well as the FTND. Evidence is presented that suggests that samples of high-scoring smokers will not be well differentiated from the mid-range to the high-end of the scores.

Key words: Nicotine dependence; Smoking cessation; Nicotine addiction; Smoking; Tobacco use

1. Introduction

The Fagerström Tolerance Questionnaire (FTQ) has been widely used to assess heaviness of smoking and dependence on cigarettes (see Fagerström & Schneider, 1989, for a recent review); to our knowledge most major smoking cessation trials include some version of the FTQ. The original FTQ, however, was recognized increasingly as having deficiencies (Lichtenstein and Mermelstein, 1986; Pomerleau et al., 1989). Recently, Fagerström and colleagues (Heatherton et al. 1991) have proposed a revision of the FTQ that corrects some of the psychometric deficiencies of the earlier test and also reduces the number of questions from 8 to 6 without reducing reliability. This new test was validated as a predictor of indicators of biochemical exposure to tobacco smoke, but no data were then available on how well the revised test predicted smoking cessation. Here we compare the new version, the Fagerström Test for Nicotine Dependence (FTND) (6 questions), the FTQ (8 questions), and the Heavy Smoking Index (HSI) (based only on 2 questions — time to the first cigarette of the day and number of cigarettes per day [Heatherton et al., 1989]) as predictors of smoking cessation in two large, independent samples of adult males and females undergoing smoking treatment. This project allows us to judge (a) if the FTND is better than the FTQ in predicting smoking cessation for males and females and (b) if...
the HSI in only two questions can compete favorably with the longer tests. Especially in large-scale research like survey research a two-question test may have important practical advantages over tests three to four times larger.

2. Study 1

2.1. Methods

Subjects presented for treatment for smoking from the Ontario Lung Association. This was a low-cost ($50 to $75[CAN]), group program that held seven sessions over 5 weeks. The program included self-monitoring of smoking before quitting, stress management and relaxation lessons, and discussions of and social supports for smoking withdrawal problems. This program was offered throughout the Province. Questionnaires were administered at the first meeting of the group. Overall, 2183 participants supplied some data. Our sample for this report uses only the 932 subjects for whom expired air carbon monoxide had been tested at start of treatment and for whom information on gender and Fagerstrom questionnaires was available. (Not all sites had access to carbon monoxide testing equipment). Quit rates are based on self-reports of smoking cessation at the end-of-treatment (no cigarette in the past week = not smoking). No-shows were counted as smokers.

For scoring of the FTQ, FTND, and HSI see Heatherton et al., 1991. The non-HSI score was calculated as what was left from the FTND score when HSI was subtracted. Expired air carbon monoxide (CO) was measured using various types of measurement systems (mainly equipment built by Analygas Systems Ltd, Toronto, Ontario). It should be considered a crude indicator of CO levels, given that we have no information on the calibration of the equipment or the compliance with intended sampling procedures (a 15 s breath hold).

2.2. Analyses (for both Study 1 and 2)

Given the range of scores and the relatively large sample sizes, the linear probability model was judged to be as good as, if not preferable to logistic regression (Berk, 1983). Multiple regression, correlations, and analyses of variance (Sex X Dependence Score) [categorized at the extreme scores to avoid small sample problems] were calculated; dependent variables were CO in ppm or quitting = yes (0) or no (1). (Logistic regression analyses were also run and do support fully the findings of the correlational analyses, but will not be reported). Multivariate models were also run with age and education as predictors. Given that the magnitude of the effect for the self-reported measures was stable across models, the univariate model is presented for ease of exposition. Analyses of variance were also done, with post-hoc comparison using Fisher’s protected t values, to explore the pattern of the relationships between dependence scores and quitting.

2.2. Subjects

They were married or living as married (66%), and well-educated (61% high school or beyond, 20% college or beyond). They averaged 40 years of age (S.D. = 11.3). The mean number of cigarettes smoked per day was 27 (S.D. = 12.2). There were 602 females and 330 males.

2.3. Results and discussion

Table 1 shows the mean scores for the various self-report dependence measures as a function of gender.

2.3.1. Correlational analyses

The multivariate models showed the same patterns as the univariate models and had slight influences on the coefficients for the dependence scores. Our report, therefore, focuses on the univariate analyses to simplify the presentation. Table 2 shows the correlations between the dependence scores and end-of-treatment smoking cessation. For males, only the HSI was a reliable predictor of smoking cessation. For females, each variable was a statistically significant predictor to about the same degree, with FTQ and FTND being numerically better predictors (0.01% larger $r^2$) than HSI alone. For males and females together, HSI, FTND, and FTQ are about equally good at predicting smoking cessation.

For males, a stepwise regression model with HSI and non-HSI as predictors enters HSI first ($\beta = -0.14$, $r^2 = 0.02$, $P < 0.05$), then non-HSI ($\beta = +0.13$, change in $r^2 = 0.013$, $P < 0.05$). Note that for males non-HSI has a significant positive relationship (the higher the
non-HSI score, the higher the percent quitting). For females, both HSI and non-HSI enter the equation with β of −0.13 and −0.12, respectively (P values < 0.05). This pattern of results indicates that the non-HSI questions were working differently in males and females.

The correlations for FTQ, FTND, and non-HSI scores as predictors of quitting were reliably larger for females than for males (P values < 0.05); the correlations for HSI did not differ reliably between males and females.

The correlations with CO show no evidence of a sex difference and replicate our earlier findings on different samples (Heatherton et al., 1991). For both males and females, FTQ, FTND, HSI, and non-HSI predict carbon monoxide levels at baseline. These CO measures were indicators of heaviness of smoking before treatment; they are not biochemical validators of abstinence. Our data on smoking cessation are based entirely on self-report.

### 2.3.2. ANOVA

The FTQ and FTND plots are very similar. Since we think that an equivalent 6-item scale is to be preferred to an 8-item scale, we focus our attention on the FTND. The HSI is also examined in detail as a possible option to the FTND.

FTND scores are associated with quitting (F[4,922] = 4.1, P < 0.01). There was no sex difference, but an interaction between sex and FTND (F[4,922] = 2.4, P = 0.05) (see Fig. 1). Inspection of Fig. 1 shows that the interaction is influenced by high scoring females being less likely to quit than high scoring males. HSI scores are associated with quitting (F[4,922] = 6.9, P < 0.001). Neither the sex difference nor the interaction term were statistically significant (P values > 0.05). Except for the discrepancy with respect to the interaction, the FTND and the HSI scores behaved similarly (see Figs. 1 and 2). Apparently, the non-HSI parts of the FTND are responsible for the interaction between sex and the FTND in

### Table 2

<table>
<thead>
<tr>
<th></th>
<th>FTQ</th>
<th>FTND</th>
<th>HSI</th>
<th>Non-HSI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Female</strong> (n = 602)</td>
<td>-0.22*</td>
<td>-0.21*</td>
<td>-0.18*</td>
<td>-0.17*</td>
</tr>
<tr>
<td><strong>Male</strong> (n = 330)</td>
<td>-0.06</td>
<td>-0.08</td>
<td>-0.14*</td>
<td>-0.04</td>
</tr>
<tr>
<td><strong>All (n = 932)</strong></td>
<td>-0.16*</td>
<td>-0.16*</td>
<td>-0.16*</td>
<td>-0.10*</td>
</tr>
</tbody>
</table>

*P ≤ 0.05.

### Table 3

<table>
<thead>
<tr>
<th></th>
<th>FTQ</th>
<th>FTND</th>
<th>HSI</th>
<th>Non-HSI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Female</strong> (n = 602)</td>
<td>0.27*</td>
<td>0.28*</td>
<td>0.25*</td>
<td>0.29*</td>
</tr>
<tr>
<td><strong>Male</strong> (n = 330)</td>
<td>0.20*</td>
<td>0.22*</td>
<td>0.20*</td>
<td>0.17*</td>
</tr>
<tr>
<td><strong>All (n = 932)</strong></td>
<td>0.25*</td>
<td>0.26*</td>
<td>0.24*</td>
<td>0.19*</td>
</tr>
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*P ≤ 0.05.
Fig. 3 shows the mean expired air carbon monoxide levels in ppm (±95% confidence intervals) for Study 1.

Table 4
Mean ± S.E.M. for the measures of nicotine dependence (range of scores is given in the column label) for Study 2

<table>
<thead>
<tr>
<th></th>
<th>FTQ (0–11)</th>
<th>FTND (0–10)</th>
<th>HSI (0–6)</th>
<th>Non-HSI (0–4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Female</strong> (n = 1207)</td>
<td>5.36 ± 0.07</td>
<td>5.30 ± 0.07</td>
<td>3.85 ± 0.05</td>
<td>1.45 ± 0.03</td>
</tr>
<tr>
<td><strong>Male</strong> (n = 668)</td>
<td>5.95 ± 0.07</td>
<td>5.50 ± 0.09</td>
<td>4.05 ± 0.06</td>
<td>1.45 ± 0.04</td>
</tr>
<tr>
<td><strong>All</strong> (n = 1875)</td>
<td>5.70 ± 0.05</td>
<td>5.37 ± 0.05</td>
<td>3.91 ± 0.04</td>
<td>1.45 ± 0.03</td>
</tr>
</tbody>
</table>

places where it is forbidden, e.g., in church, at the library, in the cinema, etc? And ‘Do you smoke if you are so ill that you are in bed most of the day?’

It should be noted that even though these self-report measures are statistically significant predictors of smoking cessation, the effects are small (the largest percentage of variance accounted for is 4.7).

Some might be concerned about the effects of limiting our sample to just those who were at settings with CO measurement. Analyses of the end-of-treatment effects in the entire available sample support the conclusions from the reduced set.

3. Study 2

This sample derives from research on self-help quitting interventions (Orleans et al., 1991). All subjects received the self-help guide, ‘Free and Clear’, presenting standard behavioral quitting techniques (e.g., nicotine fading, withdrawal coping tips, relapse prevention (slip recovery guidelines), and some received additional social support materials and/or brief telephone counseling). For the present paper, this sample was used to compare the ability of these various self-report measures of nicotine dependence to predict smoking status 16 months after having received self-help treatments.

3.1. Method

Detailed information on this sample has already been published (Orleans et al., 1991). Subjects were predominantly white (94%), married or living as married (69%), employed full-time (61%), and well-educated
rettes smoked per day was 26 (S.D. = 11). Long-term (16-month) quit rates were based on self-reports of cigarette abstinence (no cigarette in the past week = not smoking). Self-reports were cotinine verified for a subset of quitters on an 8-month follow-up with a 2% false report rate. A 'bogus pipeline' technique was in place at the 16-month follow-up. Subjects were reminded that abstinence might be biochemically checked before they were asked about smoking rates.

3.2. Results and discussion

Table 4 shows the mean scores for the various dependence measures. Note the similarity of the scores for Study 1 and Study 2.

3.2.1. Correlations

Table 5 shows the correlations between the dependence scores and cigarette abstinence at 16-month follow-up for males and females. In the sample as a whole, FTQ, FTND, and HSI show a very similar association with quitting smoking, with the non-HSI score being slightly less good a predictor ($r^2$ difference of only 0.006). There were no significant differences between males and females for any of the correlations.

3.2.2. ANOVA

Fig. 4 shows the relationship between FTND score and 16-month quitting for males and females. The only statistically significant effect is for FTND ($F_{9,1865} = 6.45, P < 0.001$).

Fig. 5 shows the same relationship for HSI and quitting: a main effect was found for HSI score ($F_{9,1861} = 6.05, P < 0.001$).

The overall pattern of results is very similar for the HSI and the FTND (and the FTQ, not shown). It is interesting that the quitting difference from the mid-point of these dependence scales to the high end of the scores is not great. This argues that, if these measures are used on a sample of mainly very heavy smokers, they would be unlikely to usefully predict quitting.

4. General discussion

Note that the shape of the curve relating cessation and FTND is very similar across these two studies, except for females in Study 1, where the highest FTND scores showed less and less likelihood of smoking cessation. With longer follow-up and with biochemical validation, the pattern in Study 1 may well have ended up very similar to Study 2. This would happen if a higher percentage of females with moderate to high FTND scores returned to smoking. In Study 1, the highest FTND females may simply have been sooner to return to smoking.
Similarly, with the exception of the Study 1 females, all patterns in the figures relating scores to quitting show little ability of any of the scales to discriminate differential levels of quitting as scores go from moderate to high. This is in contrast with the increase in CO scores in Fig. 3 as one goes from the moderate score to the high score on the FTND. The same pattern is found for the HSI and CO scores. This suggests that the FTND and the HSI are more finely related to heaviness of smoking, and it emphasizes, as argued in Heatherton et al. (1991), that predicting the chances of quitting smoking should be distinguished from the prediction of how heavily one smokes.

Finally, our research shows that the FTQ, FTND, and HSI are similarly able to predict smoking cessation to a small degree. Pomerleau et al. (1993) have demonstrated recently that the FTQ and FTND show high test-retest reliability (from +0.78 to +0.88). FTQ scores have been shown elsewhere to predict who is most likely to benefit from 4 mg rather than 2 mg nicotine-containing gum (Nicorette®) (Fagerström and Schneider, 1989). Our study does not further the exploration of how dependence scales might be used to guide the prescribing of nicotine replacement therapies, and our results might have been different if nicotine replacement therapies had been a common part of treatment.

The longer FTQ clearly could be abandoned, but the research using it should not be viewed as substantially different from that with the newer FTND. The HSI (Heatherton et al., 1989) was developed before the FTND (Heatherton et al., 1991), and the FTND is something of an amalgam of the HSI and the FTQ. The non-HSI components of the FTND were associated with a gender difference in Study 1. Study 2, with a much larger sample, and a longer follow-up, must be given greater weight, and it did not show a similar gender difference. This discrepancy also points to possible value in study differences between short-term (end-of-treatment) and long-term cessation. Overall, we found no evidence of greater superiority of the FTND, and, therefore, encourage the use of the two-question HSI as a practical, economical substitute. The clinical utility of these dependence scales, especially for samples involving mainly heavy smokers, is limited.

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6. References


