Do the results of the Fagerström Tolerance Scale predict successful abstinence from smoking?
April 20, 2017

The Fagerström Test for Nicotine Dependence (FTND) is the modified version of the Fagerström Tolerance Questionnaire (FTQ), which was originally developed in 1978.[1] FTND has been employed as a tool to measure the level of nicotine dependence in patients who smoke cigarettes. The FTND is comprised of 6 questions addressing the time to the first cigarette of the day, the number of cigarettes smoked per day, difficulty in refraining from smoking in prohibited spaces, difficulty in giving up the first morning cigarette, whether a patient smokes even when very ill, and tendency to smoke more in the morning versus the remainder of the day. Possible scores range from 0 to 10; higher scores suggest a higher level of nicotine dependence. FTND scores may also correlate with biochemical measures of smoking behavior, such as salivary cotinine, nicotine levels, and expiratory carbon monoxide (CO) levels. However, it is unclear whether FTND scores definitively predict successful smoking cessation outcomes. The following literature evaluation was completed to assess whether the FTND can be used to predict successful abstinence from smoking.

The FTND has been shown to predict smoking cessation outcomes in some studies,[2-6] but not in others.[7-9] (See Appendix 1 for a summary of selected studies). A pooled analysis of 10 randomized, double-blind, placebo-controlled clinical trials of varenicline showed that higher baseline scores were associated with poorer abstinence outcomes.[2] Investigators analyzed FTND scores of 4,972 patients as continuous variables and found that an increase in FTND score by 1 unit lowered the odds of abstinence at the 24-week mark by 11% (odds ratio [OR]=0.89, 95% confidence interval [CI]=0.86-0.92, p<0.0001). This inverse relationship between the FTND and abstinence was observed in both the varenicline and placebo groups.

In another study, Iliceto et al focused on identifying factors that predicted smoking cessation outcomes in patients who underwent a specific smoking cessation program.[3] The study evaluated patients over a 10-year period; each patient was assessed at 12-, 26-, and 52-week follow-up appointments after initiation of the smoking cessation program. In total, Iliceto et al evaluated 1,282 patients and found that smokers with higher FTND scores (i.e., 5 or greater) were nearly twice as likely to continue smoking compared to those with scores less than 5 (OR=1.794, 95% CI=1.407-2.286, p=0.000). Similarly, Stolz et al showed that a higher FTND score was associated with a higher rate of failure in smoking cessation at 24 months post-intervention (OR=0.76, 95% CI=0.59-0.89, p=0.04).[4] Ussher et al found that cigarette dependence (measured by the FTND) predicted the outcome of quit attempts.[5] Lastly, Tanriverdi et al reported that subjects who quit had significantly lower FTND scores (mean 6.36 vs 6.73, p=0.022).[6]

There were also several studies demonstrating conflicting results.[7-9] A cross-sectional study involving 248 individuals who entered a smoking cessation program showed that there was no difference between quitters and non-quitters in terms of the means of the FTND scores (0.5, 95% CI=-0.0-1.1, p=0.65) at 6 months after the quit date.[8] However, the results of this study are limited by a small number of patients who were continuously abstinent at 6 months (n=79). Studies by Etter and Rohsenow et al also demonstrated a lack of predictive value of the FTND in determining success of smoking cessation.[7,9] These 2 studies analyzed the association between FTND score and short-term abstinence (7 days to 60 days after the quit date). Etter's investigation was an internet survey intended to compare the cigarette dependence scale (CDS) to the FTND.[7] Etter reviewed data for 802 smokers

and of the 231 smokers who quit, they found that the FTND did not predict smoking abstinence at 31 and 60 days from the initial assessment (OR=0.98, 95% CI=0.92-1.04, p=NS). The author suggested that there may be other pertinent psychosocial factors that affect smoking cessation that are independent of the degree of nicotine dependence. Rohsenow et al conducted a prospective study designed to compare the CDS to the FTND, evaluating patients with substance use disorder (SUD) in a residential treatment program.[9] Using data from 302 smokers, Rohsenow et al found that the FTND did not predict abstinence at 7, 14, and 30 days. However, the applicability of the results is limited to patients with substance use disorder (SUD) who are currently in treatment.

As noted, there have been conflicting results from studies assessing the predictive value of the FTND for smoking cessation outcomes.[2-9] It is important to state that the methods used in these studies varied considerably. The study designs were also disparate; for example, the pooled analysis by Fagerström involved randomized, double-blind, placebo-controlled trials, while other studies were cross-sectional or observational. Also, many of the studies used self-reports to confirm abstinence; this raises the potential concern for inaccurate abstinence rates. Therefore, interpretation and comparison of these studies should be done cautiously. Furthermore, the primary objective of many of these studies was not to measure the correlation of the FTND to abstinence. The likelihood of the FTND to predict abstinence was often a secondary endpoint of interest; there may have been other factors that may have affected the results. Also, each study investigated the association between the FTND and abstinence in specific populations, which limits the generalizability to the general smoking population. Lastly, it is important to keep in mind that the FTND was originally created to measure the level of nicotine dependence.[1] Its ability to measure nicotine dependence was successfully demonstrated by yielding strong correlation with biochemical markers of dependence.

At this time, the use of the FTND as a predictive tool of successful smoking cessation is not recommended due to conflicting results from published studies.[2-9] Nevertheless, the components of the FTND may be useful to clinicians in identifying behavioral patterns that should be addressed in order to achieve smoking abstinence.

References:

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Appendix I: Studies evaluating predictive utility of the FTND in smoking cessation.

Study	Objective(s)	Methods	Selected Results	Author Conclusions
Etter (2005)[7]	To compare the psychometric properties of the CDS-12, FTND, CDS-5, and HSI	- An internet survey was conducted from December 2002 to September 2003 in French - Total of 802 smokers responded to both initial and follow up surveys during the 31-60 days of follow-up - Quitters were identified through self-reported abstinence - Logistic regression model was used to assess the association between FTND score and abstinence	- Survey responders resided in France (59%), Switzerland (14%), Canada (12%), Belgium (8%), and other countries (7%) - A total of 760 participants provided complete data on all corresponding variables and 32% (245 out of 760) of them quit during the follow-up period - The FTND did not predict smoking abstinence at follow-up (OR=0.98, 95% CI=0.92-1.04, p=NS)	- FTND has low predictive value for successful abstinence - Smoking cessation may be dependent on other psychological/social factors that are independent of nicotine dependence - Limitations: abstinence was self-reported (may contribute to low reliability), utilized the internet to pool participants
Fagerström et al (2012)[2]	To investigate the relationship between the FTND and smoking abstinence rates	- Eligible participants were pooled from 10 randomized, double-blind, placebo-controlled Phase 2-4 studies of varenicline - The clinical trials were conducted in North America, Asia, Latin America, Africa, Middle East, and Europe - Inclusion criteria identified adults motivated to quit and who smoke ≥10 cigarettes per day - Excluded: those with specified psychiatric conditions, use of medications that may interfere with varenicline therapy - Participants completed the FTND at baseline and were followed up for 6 or 12 months from the initiation - Continuous abstinence was defined as self-reported abstinence and an exhaled CO of ≤10 ppm - Logistics regression model used to assess relationship between the FTND and abstinence	- 4,972 individuals had baseline FTND scores and were included in the analysis (varenicline group=2,752; placebo group=2,220) - Logistic regression analysis showed that every unit increase in the baseline FTND was associated with 11% decrease in abstinence at week 24 (OR=0.89, 95% CI=0.86-0.92, p<0.0001) - The association of higher FTND score with lower rate of abstinence was observed in both varenicline and placebo groups	- Baseline FTND scores can predict smoking cessation outcome, regardless of treatment modality - Individuals with higher scores are less likely than those with lower scores to achieve complete abstinence - Limitations: retrospective study design, differences in the distribution of FTND scores amongst the included clinical trials

Study	Objective(s)	Methods	Selected Results	Author Conclusions
Iliceto et al (2013)[3]	To identify factors that predict smoking cessation following a 6-week group program	- Included were 1,282 smokers that completed smoking cessation program in Italy from January 2001 to November 2011 - Abstinence was self-reported at 12-, 26-, and 52-weeks - Multivariate forward stepwise conditional logistic analysis was utilized to assess predictability of variables, including FTND score	- Smokers with higher FTND scores (≥ 5) were twice as likely to smoke than those with low-to-moderate scores (< 5) (OR=1.794, 95% CI=1.407-2.286, p=0.000)	- FTND is a significant predictor of successful smoking cessation in patients who undergo treatment - Limitation: abstinence was self-reported, which may not be completely reliable
Nerin et al (2004)[8]	To identify predictors of successful outcome in smoking cessation at 6-month follow-up	- Cross-sectional descriptive study of 248 individuals - Included were smokers aged ≥18 years who underwent smoking cessation program in Spain between 2002 and 2003 - Abstinence was self-reported and confirmed with CO oximetry reading of <10 ppm at 1-week, 3- and 6-months - Multivariate logistic regression model tested the following variables at 6-month follow up: success at 3 months, age, and FTND score	- 79 out of 248 individuals (31.9%) were still abstinent at 6-months follow-up - FTND mean score difference between quitters and non-quitters did not differ significantly (mean difference=0.5, 95% CI=-0.0-1.1, p=0.065)	- Success at 3 months was the only variable predictive of continuous abstinence at 6-months - FTND did not have a predictive value in determining success of smoking cessation at 6-months of follow-up - Limitations: small sample size, discrepancy between self-reported abstinence and CO oximetry results
Rohsenow et al (2013)[9]	To investigate the predictive validity of the CDS and FTND in patient population being treated for SUD	- The study was a prospectively designed secondary analysis - Included 305 smokers in the US who were being treated for SUD - Abstinence was assessed at 7-, 14-, and 30-days using expired CO (≤ 6 ppm) - Each participant was started on NRT and received weekly counseling for smoking cessation - Logistic model regression was used to assess the predictability of CDS and FTND for abstinence, as well as for TTF and CPD	- The FTND did not predict abstinence at any of the time points following therapy - 7-day abstinence (OR=0.95, 95% CI=0.83-1.09, p=NS) - 14-day abstinence (OR=0.96, 95% CI=0.84-1.10, p=NS) - 30-day abstinence (OR=0.92, 95% CI=0.75-1.13, p=NS) - TTF (in minutes) predicted abstinence at 7- and 14-days - 7-day abstinence (OR=2.01, 95% CI=1.07-3.78, p=0.03) - 14-day abstinence (OR=2.41, 95% CI=1.30-4.49,p=0.005)	- The FTND does not have value in predicting successful outcomes of smoking cessation in patients being treated for SUD - Limitations: data interpretation limited to smokers in treatment for SUD and level of motivation to quit was not same across participants, rate of abstinence was low (9% at 30-day mark)

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Stolz et al (2014)[4]	- Primary objective: To assess rate of abstinence at 24 months
	- Secondary endpoint: To identify predictors of long-term abstinence
		- Investigator-initiated and investigator-driven, open, multi-center, cohort prospective study
		  - Total of 703 smokers (out of 17,000 employees at 3 different health care companies) were included in the final data for analysis
		  - Study was conducted from May 2005 to January 2009 in Switzerland
		- Each smoker received counseling, choice of bupropion and/or NRT for smoking cessation
		- Abstinence rates at 12 and 24 months were collected by self-reported abstinence, confirmed by exhaled CO of ≤ 6 ppm
		- Multivariable logistic regression was used for analysis
		  - Total of 14 variables, including FTND scores, were analyzed to assess potential association(s) with abstinence
			- Abstinence rates at 12 and 24 months were 38.8% and 37%, respectively
			- Higher FTND score (6 vs. 3 points) was associated with lower rates of abstinence 24 months post-intervention (OR=0.76, 95% CI=0.59-0.89, p=0.04)
				- The severity of nicotine dependence, as assessed by the FTND, correlated with the risk of failure of abstinence at 24 months following intervention
				- Limitation: limited generalizability to smokers who work in health care companies

Tanriverdi et al (2015)[6]	- To analyze demographic data of those that present to smoking cessation clinic
	- Compare success rates among 3 treatment options
	- Determine factors that affect smoking cessation rates
		- A retrospective study of 749 participants who presented to the smoking cessation unit between January and November 2012 (Turkey)
		- Patients were offered NRT, bupropion, or varenicline to aid in smoking cessation
		- Abstinence was assessed at the end of therapy, at week 12, and follow-up was made between 3 to 12 months after quit date
		  - Self-reporting measures were used to identify abstinent individuals
		- A score of ≥5on FTND was classified as high level of nicotine dependence
		- Student's t-test was used to compare difference in FTND scores between quitters and non-quitters
			- Mean FTND score was significantly higher in non-quitters compared to quitters
			  - FTND scores: 6.73±2.03 vs 6.36 ±2.1 (p=0.022)
			- Note: number of cigarettes per day alone did not significantly differ between quitters and non-quitters
			  - 23.20±8.78 (quitters) vs 23.79±8.74 (non-quitters) (p=0.37)
				- FTND carries an instrumental value in predicting smoking cessation
				- Limitations: retrospective study, unequal distribution of participants between treatment options chosen for smoking cessation

Study	Objective(s)	Methods	Selected Results	Author Conclusions
Ussher et al (2016)[5]	Assessed motivation to quit smoking and nicotine dependence as potential predictors for abstinence at 4 weeks, 6-, and 12 months	- Secondary data analysis from a double-blind placebo-controlled trial evaluating glucose tablets for smoking cessation - 864 participants were included in the analysis - Participants were recruited from November 2006 to May 2008 in the UK - Abstinence was defined as continuous, self-reported abstinence at 4 weeks, 6 and 12 months (confirmed with expired CO < 10 ppm) - Adjusted multiple regression model used to assess FTND as a predicting variable for abstinence	- Smokers with higher FTND scores were more likely to have relapsed compared to those with lower scores - At week 4: OR=0.84, 95% CI=0.78-0.89, p<0.001 - At 6 months: OR=0.83, 95% CI=0.76-0.90, p<0.001 - At 12 months: OR=0.83, 95% CI=0.74-0.92, p<0.001	- Nicotine dependence, as measured with FTND, is a significant predictor of both short-term and medium-term abstinence in highly dependent smokers - Limitations: results are limitedly generalizable to smokers motivated enough to participate in a smoking cessation program; study population included a lower percentage of smokers with low nicotine dependency

CDS=cigarette dependence scale; CI=confidence interval; CO=carbon monoxide; CPD=cigarettes used per day; FTND= Fagerström test for nicotine dependence; HSI=heaviness of smoking index; NRT=nicotine replacement therapy; NS=not significant; OR=odds ratio; ppm=parts per million; SUD=substance use disorder; TTF=time to first cigarette in the morning; UK=United Kingdom; US=United States