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A Comparison of Three Smokeless Tobacco Dependence Measures

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Abstract

Smokeless tobacco (ST) use is associated with tobacco dependence and long-term adverse health consequences. Clinical and research tools that can accurately assess ST dependence are needed to improve research and treatment of ST users. Measures of ST dependence have been developed to address this need. We used data from a study evaluating the effectiveness of bupropion sustained release for the treatment of ST use (N=225) to compare the Fagerström Tolerance Questionnaire for Smokeless Tobacco (FTQ-ST) users, the Severson Smokeless Tobacco Dependency Scale (SSTDS), and the Glover-Nilsson Smokeless Tobacco Behavioral Questionnaire (GN-STBQ). We observed that despite the intention of the scale: (1) all scales were significantly correlated with ST cans consumed per week; (2) the FTQ-ST was significantly correlated with serum nicotine and cotinine concentrations and craving; (3) the GN-STBQ and SSTDS were significantly associated with both craving and withdrawal; and (4) none of the scales were significantly associated with ST abstinence. When all of the scales were entered simultaneously in a multivariable analysis, the SSTDS was the only scale independently associated with withdrawal and craving. As when used with cigarette smokers, the FTQ-ST appeared to measure the construct of physical dependence. The GN-STBQ and SSTDS, designed to measure broader constructs of dependence, were found to predict both withdrawal and craving which may be advantageous in clinical settings. The GN-STBQ and the FTQ-ST did not contribute significantly to the prediction of withdrawal and craving beyond what was accomplished using the SSTDS. The use of the scales is discussed in terms of clinical usefulness and how each scale might assess differing aspects of tobacco dependence.

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Contributors

J.O. Ebbert, E.D. Glover, D.R. Schroeder, and H.H. Severson designed the study and wrote the protocol. J.O. Ebbert and B.G. Danaher conducted the literature searches and provided summaries of previous research studies. D.R. Schroeder conducted the statistical analysis. J.O. Ebbert and H.H. Severson wrote the first draft of the manuscript and all authors contributed to and have approved the final manuscript.

Conflict of Interest

All authors declare that they have no conflicts of interest.

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Keywords

smokeless tobacco; tobacco use disorder; nicotine; dependence measure

1. Introduction

Smokeless tobacco (ST) is tobacco consumed orally but not burned. A variety of types of ST are consumed throughout the world. In the United States (US), the principal types of ST are chewing tobacco (cut tobacco leaves) and snuff (moist ground tobacco). In Sweden, “snus” (finely ground moist tobacco) is used. In India, commonly used ST products contain tobacco leaves mixed with ingredients such as areca nut and lime (Critchley & Unal, 2003).

In 2009, 8.6 million individuals (3.4%) in the US aged 12 or older were current (past month) users of ST (Substance Abuse and Mental Health Services Administration, 2010). The rate of past month ST use among 12 to 17 year olds increased from 2.0% in 2002 to 2.3% in 2009, representing an additional 600,000 youths (Substance Abuse and Mental Health Services Administration, 2010). ST consumed in the US has been associated with significant adverse health consequences such as oral cancer (Stockwell & Lyman, 1986) and cancer of the kidney (Goodman, Morgenstern, & Wynder, 1986; Muscat, Hoffmann, & Wynder, 1995), pancreas (Muscat, Stellman, Hoffmann, & Wynder, 1997), and digestive system (Henley, Thun, Connell, & Calle, 2005). ST use is also associated with death from coronary heart disease and stroke (Henley, et al., 2005).

In the US, ST products are being targeted to smokers with the presumed purpose of “supporting” smoking quit attempts motivated by personal health concerns about cigarette smoking, clean indoor air policies, and increased cigarette excise taxes (Campaign for Tobacco Free Kids, 2006). At the same time, ST is also increasingly being proposed as a harm reduction strategy for cigarette smokers (McNeill, 2004; NIH State-of-the-Science Panel, 2006). The impact of these market changes underscores the importance of developing valid and reliable measures of ST dependence.

The assessment of ST dependence builds on decades of research on smoking dependence as both clinicians and researchers have sought to develop standardized measures of tobacco dependence. Measures have included items or scales to assess physical dependence, psychological dependence, and tobacco use patterns. The Diagnostic and Statistical Manual of Mental Disorders-IV (DSM-IV) measures core attributes of drug dependence, including cognitive behavior and physiologic components; the diagnosis is made based upon whether individuals meet three of seven criteria (American Psychiatric Association, 1994). The most widely adopted measure of tobacco dependence in clinical use and research has been the Fagerström Tolerance Questionnaire (FTQ) (Fagerström & Schneider, 1989). The FTQ measures physiologic and behavioral parameters of dependence. Items include cigarettes per day, time to first cigarette, frequency of inhalation, and questions relating to dependence behaviors (i.e., difficulty refraining from use). Among smokers, FTQ scores have been shown to significantly correlate with measures of carbon monoxide, nicotine, and cotinine, but the relation is less robust between FTQ scores and self-reported withdrawal symptoms (Fagerström & Schneider, 1989). The FTQ also displays relatively low internal consistency and reliability, and the item measuring time to first cigarette in the morning has been observed to correlate as well with other scales as the entire FTQ (Colby, Tiffany, Shiffman, & Niaura, 2000; Lichtenstein & Mermelstein, 1986; Shiffman, Waters, & Hickcox, 2004). The Fagerström Test for Nicotine Dependence (FTND) was developed to overcome limitations of the FTQ and excluded the questions on inhalation and nicotine content of cigarettes (Pomerleau, Carton, Lutzke, Flessland, & Pomerleau, 1994). However, the FTND

does not measure a single construct of physical dependence, it does not predict either withdrawal symptoms or smoking cessation, and it has low internal consistency (Etter, Duc, & Perneger, 1999; Heatherton, Kozlowski, Frecker, Rickert, & Robinson, 1989; Pomerleau, et al., 1994; Shiffman, et al., 2004). Other scales have been developed to address these limitations of the FTND. For example, measures developed to correspond more closely to the *DSM-IV* definitions of tobacco dependence include the 12-item and 5-item Cigarette Dependence Scales (CDS) (Etter, Le Houezec, & Perneger, 2003), and the 10-item Tobacco Dependence Screener (TDS) (Kawakami, Takatsuka, Inaba, & Shimizu, 1999). The 37-item Brief Wisconsin Inventory of Smoking Dependence Motives (BriefWISDM) assesses nicotine dependence in terms of distinct motivations for smoking (Smith, et al., 2010). The Glover-Nilsson Smoking Behavioral Questionnaire (GN-SBQ) focuses on behavioral patterns of cigarette use, such as “the rituals that surround smoking, the security smoking creates, or the relationship a smoker develops with a cigarette (Glover, et al., 2005).” The GN-SBQ is designed to be used in combination with a physical dependency scale in order to inform the tailoring of cessation treatment for the tobacco user.

The first scales to assess ST dependence were modified versions of the FTQ (Boyle, Jensen, Hatsukami, & Severson, 1995) and the FTND (Ebbert, Patten, & Schroeder, 2006). Fagerström Tolerance Questionnaire for Smokeless Tobacco (FTQ-ST) scores were positively correlated with serum cotinine and amount of tobacco used. However, poor concordance was found between the FTQ-ST and the diagnosis for nicotine dependence as measured by the Diagnostic Interview Schedule (DIS), a structured interview based on *DSM-IV* criteria (Robins, et al., 1999). More recent ST dependence scales have included items drawn from the literature on smoking motives, behavioral patterns, withdrawal symptoms, and expectations. For example, Glover and colleagues created a version of the GN-SBQ for ST users (GN-STBQ) intended to measure the level of behavioral dependence to be used in combination with a physical dependence scale (Glover, et al., 2005). Severson and colleagues created the Severson Smokeless Tobacco Dependency Scale (SSTDS) which includes items from the FTQ, items assessing behavioral patterns of ST use, and anticipated withdrawal symptoms (Severson, Akers, Andrews, & Boles, 2003).

We had the opportunity to compare three measures (FTQ-ST, GN-STBQ, and SSTDS) in predicting cessation outcomes and reported withdrawal symptoms for adults in a randomized-controlled trial of bupropion sustained-release (SR) tablets for ST users (Dale, et al., 2007). The FTQ-ST was seen as the standard measure that has had the most use in ST cessation studies. The other scales were included to assess whether their broader concepts and diverse items might enable them to provide a better measure of dependence. We hypothesized that ST users wanting to quit who have elevated dependence scores on the FTQ-ST and the SSTDS would have higher serum nicotine and cotinine concentrations, increased nicotine withdrawal, increased craving, and a lower likelihood of successfully quitting ST use.

2. Methods

Our analysis is based upon data from participants recruited for a multicenter, double-blind, placebo-controlled, randomized-controlled trial conducted to assess the efficacy and safety of bupropion SR for tobacco abstinence among ST users (Dale, et al., 2007). The study was conducted by Mayo Clinic (Rochester, MN) and the West Virginia University School of Medicine (Morgantown, WV). The institutional review board of each study site approved the study protocol prior to recruitment and participant enrollment.

2.1. Participants

Participants were recruited from the local community and were eligible for enrollment if they were: (a) at least 18 years old; (b) identified ST (chewing tobacco or snuff) as their primary tobacco product; (c) had used ST for at least the past year; and (d) were willing to quit. Exclusion criteria included any of the following: (a) presence of major current depression; (b) current active alcoholism or recent substance abuse other than tobacco; (c) use of antipsychotics or antidepressants; (d) use of any other behavioral or pharmacologic intervention for tobacco treatment in the past 30 days; (e) use of any investigational drug in the past 30 days; (f) report of unstable angina or myocardial infarction in the past 3 months; (g) any contraindication to the use of bupropion SR; (h) diagnosed cancer in the previous year; or (i) previous use of bupropion SR for tobacco cessation.

A total of 225 study participants were randomly assigned in a double-blind fashion to bupropion SR 150 mg by mouth twice per day (N=113) or identical-appearing placebo for 12 weeks (N=112). All participants were male. The mean age was 38.1 years (range 19 to 72 years), and the mean duration of regular ST use was 19.0 years (range 2 to 60 years). In addition to ST use, 91 participants (40%) reported “ever” cigarette smoking (>100 cigarettes in a lifetime) with a median duration of cigarette abstinence of 8 years, and 3 participants reported current cigarette smoking at baseline (2 in the bupropion SR condition and 1 in the placebo control condition). Participants were assessed at the end of treatment (12 weeks) and at both 24 and 52 weeks.

2.2. Procedures

Prospective participants participated in an initial telephone screening to determine eligibility. If eligible, chewers were invited to attend a clinic visit during which time chewers provided their informed consent, were randomized to condition, completed baseline questionnaires that included the three dependence measures compared in this study, and provided a blood sample used to assess for the serum tobacco alkaloids nicotine and cotinine (Moyer, et al., 2002). All measures were collected prior to the dispensing of medication. All participants received an oral examination and a behavioral intervention. ST abstinence and all tobacco abstinence were determined at each weekly visit starting with week 2 by participant self report and biochemically confirmed using urinary cotinine. A more detailed description of these procedures has been published previously (Dale, et al., 2007).

2.3. Dependent variables

The primary endpoint was the biochemically-confirmed, 7-day point-prevalence tobacco abstinence rate at end of treatment (12 weeks postrandomization), defined as the self-reported tobacco abstinence in that last 7 days confirmed by a urine cotinine of <50 ng/mL. Similar biochemically-validated, point-prevalence tobacco use outcomes were obtained at 6 and 12 months. Baseline assessments were obtained for serum nicotine concentration, serum cotinine concentration, and self-reported cans of ST used per week.

Participants were asked to keep a daily diary to assess nicotine withdrawal symptoms and tobacco craving. Withdrawal symptoms were measured with the Minnesota Nicotine Withdrawal Scale (MNWS) (Hughes & Hatsukami, 1998) assessing depression, insomnia, irritability/frustration/anger, anxiety, difficulty concentrating, restlessness, and increased appetite. We changed the item for tobacco craving from “desire to smoke” to “desire to use tobacco.” Symptoms were rated on a 5-point Likert scale ranging from 0 (not present) to 4 (severe). Daily diaries were distributed weekly starting at the baseline visit and returned at each weekly study visit through week 12.

2.4. Dependence measures

2.4.1. Fagerström Tolerance Questionnaire for Smokeless Tobacco (FTQ-ST)

—A 9-item and 10-item version of the FTQ-ST have been previously described (Boyle, et al., 1995). Assuming that higher nicotine exposure reflected greater nicotine dependence, the association of scores on these scales with the concentration of salivary cotinine (criterion variable) has been assessed. The scales correlated 0.33 ($p < .01$) and 0.47 ($p < .0001$) with cotinine concentrations for the 9-item and 10-item scale, respectively. We selected the 10-item FTQ-ST scale for use in the current study. The total score for the FTQ-ST is calculated as the sum of the 10 items with possible scores ranging from 4 to 19. Item detail and their response frequencies for the current sample are shown in Table 1. Cronbach's coefficient alpha for this scale was 0.60.

2.4.2. Glover-Nilsson Smokeless Tobacco Behavioral Questionnaire (GN-STBQ)

—The GN-SBQ was developed as a simple, easily administered pencil-and-paper questionnaire to determine the degree to which behavioral patterns play a role in smoking dependence. A modified Delphi technique was used to identify initial items and to eliminate obvious duplications. Multiple statistical methods (i.e., principal components analysis, cluster analysis, stepwise multiple linear regression, cross tables, Mantel-Haenszel χ^2 -test, and a Gamma test) were used to evaluate and reduce the number of items from 18. These analyses yielded an 11-item scale to assess behavioral dependence (Glover, et al., 2005). The authors have developed the GN-SBQ for ST users (GN-STBQ) using original scale items with wording adapted to be appropriate for ST users. The scale consists of 11 items, and scores can range from 0 to 44. Items and response frequencies for the current sample are shown in Table 2. The Cronbach coefficient alpha was 0.81.

2.4.3. Severson Smokeless Tobacco Dependence Scale (SSTDS) Short Form

—The SSTDS represents the first use of an item response theory (IRT) for assessing tobacco dependence. IRT is a nonclassical statistical methodology widely used in educational assessment (Lord & Novick, 1968) that is becoming increasingly popular in psychology (Embretson & Reise, 2000). IRT analyses simultaneously fit scale items and individuals to the same metric on a single latent trait, and the resulting scale properties are not sample dependent. Scale items may be chosen to discriminate between lower and higher levels of the trait along a continuum.

Candidate items for this scale were drawn from the following sources: a version of the Fagerström scale used in previous studies (Severson, Andrews, Lichtenstein, Danaheer, & Akers, 2007; Severson, et al., 2000); a 5-item version of the Cigarette Dependence Scale (CDS-5) (Etter, et al., 2003) we adapted for ST; items from subscales for stimulation, sedation, and morning use (Hudmon, et al., 2003) adapted for ST; and items representing behavioral and withdrawal facets of ST use created by the research team. The resulting 36-item scale was completed by 247 participants in an earlier ST cessation intervention who reported that they were still using ST (Severson, et al., 2000).

Scale items were selected with the aid of a 2-parameter model using the PARSCALE software (Scientific Software International, Lincolnwood, IL). Items were chosen for the following characteristics: maximum information values generally exceeding 0.25 (which represents item reliability), nonmonotonic changes (with each possible response locally dominant in turn), and chi-square goodness of fit values greater than 0.025. The final selection of seven items was based on proper coverage of the full range of dependence levels, without duplication, and an eighth item was added to assess tobacco exposure. A more complete description of the development of the SSTDS is available as a technical

report (Akers, Severson, Yovanoff, & Boles, 2011). Items and response frequencies are shown in Table 3. Cronbach's coefficient alpha for this scale was 0.69.

2.5. Data analysis

Responses for items from each of the three scales were summarized using frequency counts and percentages. For each questionnaire a scree plot was constructed to confirm that a unidimensional factor structure was appropriate (Reise, Waller, & Comrey, 2000). Scores for the scales were calculated and summarized using descriptive statistics (mean $\pm$ SD, median, and interquartile range [IQR]). To assess convergent validity, bivariate correlations among the three dependence scales were assessed using Pearson product-moment correlation. Convergent validity was further evaluated by assessing the bivariate correlation of each dependence scale with baseline assessments of serum nicotine concentration, serum cotinine concentration, and self-reported number of tins/cans of ST consumed per week. Among ST users attempting to quit, we hypothesized that higher dependence would be associated with increased nicotine withdrawal, increased craving, and a lower likelihood of successfully quitting ST use. Therefore, to evaluate predictive validity, a series of additional analyses were performed to assess whether higher scores for the given dependence scales were negatively associated with tobacco abstinence outcomes.

Daily diaries for the first 14 days following the target quit date were used to obtain the average composite withdrawal score and average craving score for each individual (Hughes, 2007b). We selected this time course because most withdrawal symptoms peak in the first week (Hughes, 2007a). We used a series of linear regression models to assess the association of dependence scale scores with nicotine withdrawal and craving. One set of models used the composite withdrawal score as the dependent variable, and a second set of models used the craving score as the dependent variable. Withdrawal and craving were kept separate in the analyses. The dependence scales were modeled as continuous variables and were included along with the treatment group as explanatory variables in the models. Initial models were fit to assess each of the three dependence scales separately, and a final model that included all dependence scales was also assessed.

To assess the association between dependence scale scores and tobacco abstinence outcomes, an analysis was performed that included the 7-day point-prevalence tobacco abstinence outcomes from all study visits following the target quit date for the duration of the medication phase. These data were analyzed using Generalized Estimating Equations with a logit link function. Robust variance estimates based on a first order autoregressive structure were used to account for the correlation of repeated outcome assessments within individuals. Dependence scales were modeled as continuous variables, and the treatment group was modeled using a dichotomous indicator variable. Separate models were fit to assess the individual dependence scales after adjusting for treatment. These models were constructed to predict abstinence; therefore, odds ratios (OR) greater than 1.0 indicated an increased likelihood of abstinence, adjusting for treatment with bupropion SR. In order to be consistent across the three dependence scales, the ORs presented for each scale corresponded to an increase in score equal to the interquartile range of the given scale. In all cases, we used two-tailed p -values < 0.05 to determine statistical significance.

3. Results

3.1. Correlations of dependence scales

The correlations between the FTQ-ST, GN-STBQ, SSTDS, serum alkaloids, and cans per week are shown in Table 4. The FTQ-ST was significantly correlated with both the GN-STBQ and the SSTDS. The GN-STBQ and the SSTDS were most highly correlated with each other. However, the highest correlation (0.68) indicates that the two most highly

correlated scales shared only 46% of common variance, thus collinearity is not a concern. The FTQ-ST was the only scale significantly correlated with serum nicotine and cotinine. All scales were significantly correlated with ST cans consumed per week.

3.2. Association of dependence scales with nicotine withdrawal and craving

After adjusting for treatment with bupropion SR, the FTQ-ST was associated with the craving score but not withdrawal. Both the GN-STBQ and the SSTDS were significantly associated with withdrawal and craving. In the model that contained all of the scales, only the SSTDS predicted both withdrawal and craving (Table 5, Model 4).

3.3. Association of dependence scales with tobacco abstinence

After adjusting for bupropion SR, none of the three scales were found to be significantly associated with tobacco abstinence (FTQ-ST OR = 0.95, 95% CI: 0.69–1.30; GN-STBQ OR = 0.96, 95% CI: 0.72–1.26; SSTDS OR = 0.85; 95% CI: 0.58–1.24).

4. Discussion

We observed that the FTQ-ST was significantly correlated with serum concentrations of nicotine and cotinine and with craving. The GN-STBQ and the SSTDS were significantly associated with both craving and withdrawal. We also observed that all the tobacco dependence scales we tested were correlated with ST cans consumed per week, but none were significantly associated with ST abstinence. The internal reliability of the FTQ-ST is low and modest for the SSTDS.

The correlation of the FTQ-ST with the criterion variables of serum concentrations of nicotine and cotinine was likely largely attributed to two items (time to first chew in the morning and the frequency of swallowing tobacco juice) which displayed the strongest correlation with cotinine concentrations as single items in similar but unique populations of ST users (Boyle, et al., 1995; Ebbert, et al., 2006). However, the application and potential precision of the FTQ-ST is limited because it requires data on the nicotine content of the ST product which is not readily available. Indeed, analyses of ST products have shown considerable variability in nicotine concentrations within the same product over time (Djordjevic, Hoffman, Glynn, & Connolly, 1995). The FTND-ST was developed to address this limitation (Ebbert, et al., 2006). However, the FTND remains limited in its application because it relies heavily on the narrow construct of physical dependence on tobacco.

The overall clinical and research utility of a measure that predicts serum nicotine and cotinine concentration is uncertain if that measure cannot also predict withdrawal. The complexity of tobacco dependence requires a multidimensional measure of high validity and reliability for both effective intervention and for research purposes. Both the GN-STBQ and SSTDS offer the promise of greater utility because they were developed to assess broader constructs and to be sensitive to the multiple dimensions of tobacco dependence. In addition, the SSTDS may also have an advantage because it was developed using IRT. This approach has been used primarily in education but increasingly it is being applied to other areas of assessment.

Unlike the FTQ-ST which predicted only craving, the GN-STBQ and the SSTDS were found to predict both craving and withdrawal. We observed that when all scales were entered simultaneously into a multivariable analysis, only the SSTDS was found to be independently associated with withdrawal and craving. In other words, results from the current research indicated that the GN-STBQ and the Fagerström Test for Nicotine Dependence-Smokeless Tobacco (FTND-ST) did not contribute significantly to the prediction of withdrawal and craving beyond what could be derived from using the SSTDS.

The ability to predict craving and withdrawal is a profound strength of a baseline assessment tool as such information can be used to guide therapy. Using this approach, study participants anticipated as having higher degrees of craving and withdrawal could receive specially tailored behavioral interventions and/or pharmacotherapy to help them avoid relapse to tobacco use.

None of the scales predicted ST abstinence. However, the current study may have been underpowered for this particular analysis. These results are consistent with the inconsistent pattern of results observed among smokers. For example, the FTQ has been observed to predict success in smoking cessation (Haddock, Lando, Klesges, Talcott, & Renaud, 1999; Pinto, Abrams, Monti, & Jacobus, 1987), although this relation was not found among smokers with moderate to high levels of dependence (Kozlowski, Porter, Orleans, Pope, & Heatherton, 1994). In a previous study of a variation of the FTQ for ST users (i.e., the 9-item FTQ-ST), the measure predicted ST abstinence at 3 months but not at 6 months (Thomas, et al., 2006).

The main limitation of the current research is that the study participant was seeking treatment. The ability of these scales to predict abstinence among the broader audience of ST users who are not as motivated as those seeking treatment in the setting of a clinical trial needs to be explored.

The proliferation of new ST products and the extensive marketing of snus products to smokers make it likely that there will be both an increase in prevalence of ST use and higher levels of dual use of both smoked and oral tobacco. Measures of ST dependence are likely to have an increasing importance in tobacco cessation as clinicians treat more dual users who seek assistance in quitting. Future studies should include subsamples of dual users to determine the clinical and research applications of ST dependency scales for this population of tobacco users.

The three scales tested in this research highlighted the fact that physical dependence is only one of multiple dimensions of dependence. The three dimensions of tobacco addiction have been referred to as physical dependence, psychological dependence, and social dependence, which are all part of the biopsychosocial approach to addiction (Borrell-Carrio, Suchman, & Epstein, 2004). This model considers biological, psychological, and social factors in clinical assessment and emphasizes the relationship between them as central to the development of a tailored intervention. Other dimensions of dependence have been proposed as in the three subscales proposed in the Autonomy Over Smoking Scale: a withdrawal subscale, a psychological reliance subscale, and a cue-induced desire to smoke (DiFranza, Sweet, Savageau, & Ursprung, 2011). Future research could consider other measures of ST dependence that focus on the core concepts of craving, subjective compulsion to use tobacco, nicotine withdrawal, behavioral saliency, and behavior automaticity (Shiffman, et al., 2004). While different authors have used different terms, it is clear that we need to assess the physical aspects and the behavioral and psychological aspects of tobacco dependence as well.

Our findings support the concept that existing scales measuring ST dependence should be selected based upon the theoretical construct driving the measurement and/or the interventional target (i.e., physical withdrawal or behavior). Failure to pay attention to the designed intent of the scale may compromise the ability of these scales to predict outcomes and hamper progress in the field of ST research. Based on this research, it appears that using more than one assessment measure of dependence can provide a more complete assessment of multiple dimensions of tobacco dependence.

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Abbreviations

ST	smokeless tobacco
FTQ-ST	Fagerström Tolerance Questionnaire for Smokeless Tobacco
SSTDS	Severson Smokeless Tobacco Dependency Scale
GN-STBQ	Glover-Nilsson Smokeless Tobacco Behavioral Questionnaire

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Highlights

- Smokeless tobacco (ST) dependence scales correlate with ST use.
- None of the ST dependence scales were associated with ST abstinence.
- Dependence scale use should be guided by the scale's theoretical construct.

Table 1

Fagerström Tolerance Questionnaire for Smokeless Tobacco (FTQ-ST) * [N=224]

Item	Response	Points	Observed No. (%)
1. After a normal sleeping period, do you use smokeless tobacco within 30 minutes of waking?	Yes	1	159 (71)
	No	0	65 (29)
2. Is it difficult for you not to use smokeless tobacco where its use would be unsuitable or restricted?	Yes	1	91 (41)
	No	0	133 (59)
3. Do you use smokeless tobacco when you are sick or have mouth sores?	Yes	1	150 (67)
	No	0	74 (33)
4. Nicotine content	Low	1	10 (4)
	Medium	2	3 (1)
	High	3	211 (94)
5. How many days does a tin/can last you?	6 to 7	1	35 (16)
	3 to 5	2	58 (26)
	<3	3	131 (58)
6. On average how many minutes do you keep a fresh dip or chew in your mouth?	10 to 19	1	20 (9)
	20 to 30	2	49 (22)
	>30	3	155 (69)
7. How often do you swallow tobacco juices?	Never	0	55 (25)
	Sometimes	1	101 (45)
	Always	2	68 (30)
8. Do you keep a dip or chew in your mouth almost all the time?	Yes	1	135 (60)
	No	0	89 (40)
9. Do you experience strong cravings for a dip/chew when you go for more than 2 hours without one?	Yes	1	189 (84)
	No	0	35 (16)
10. On average how many dips or chews do you take each day?	1 to 9	1	113 (50)
	10 to 15	2	88 (39)
	>15	3	23 (10)

* The total score for the FTQ-ST was calculated as the sum of the 10 items. Possible scores ranged from 4 to 19. For the current sample, the Cronbach coefficient alpha for the FTQ-ST was 0.60.

Table 2

Glover-Nilsson Smokeless Tobacco Behavioral Questionnaire (GN-STBQ) * [N=225]

Item	Response	Points	Observed No. (%)
1. My smokeless tobacco is very important to me.	Not at all	0	9 (4)
	Somewhat	1	32 (14)
	Moderately so	2	49 (22)
	Very much so	3	99 (44)
	Extremely so	4	36 (16)
2. I maneuver and manipulate smokeless tobacco in my mouth as part of the ritual use.	Not at all	0	36 (16)
	Somewhat	1	43 (19)
	Moderately so	2	56 (25)
	Very much so	3	62 (28)
	Extremely so	4	28 (12)
3. Do you place something in your mouth to distract you from smokeless tobacco?	Never	0	54 (24)
	Seldom	1	64 (28)
	Sometimes	2	89 (40)
	Often	3	13 (6)
	Always	4	5 (2)
4. Do you reward yourself with smokeless tobacco after accomplishing a task?	Never	0	26 (12)
	Seldom	1	43 (19)
	Sometimes	2	98 (38)
	Often	3	45 (24)
	Always	4	19 (8)
5. If you find yourself without smokeless tobacco, will you have difficulty concentrating before attempting a task?	Never	0	20 (9)
	Seldom	1	43 (19)
	Sometimes	2	98 (44)
	Often	3	45 (20)
	Always	4	19 (8)
6. If you are not allowed to use smokeless tobacco in certain places, do you then play with your smokeless tobacco can or pouch?	Never	0	124 (55)
	Seldom	1	60 (27)
	Sometimes	2	27 (12)
	Often	3	11 (5)
	Always	4	3 (1)
7. Do certain environmental cues trigger your smokeless use, e.g., favorite chair, sofa, room, car, sports, friends, hunting, or drinking alcohol?	Never	0	9 (4)
	Seldom	1	10 (4)
	Sometimes	2	53 (24)
	Often	3	85 (38)
	Always	4	68 (30)
8. Do you find yourself using smokeless tobacco routinely (without craving)?	Never	0	2 (1)
	Seldom	1	10 (4)
	Sometimes	2	49 (22)
	Often	3	95 (42)

Item	Response	Points	Observed No. (%)
9. Do you find yourself placing other objects (pen, tooth pick, chewing gum, etc) in your mouth and sucking to get relief from stress, tension or frustration?	Always	4	69 (31)
	Never	0	53 (24)
	Seldom	1	65 (29)
	Sometimes	2	74 (33)
	Often	3	26 (12)
10. Does part of your smokeless tobacco enjoyment come from the steps (ritual) you take when handling your smokeless tobacco?	Always	4	7 (3)
	Never	0	68 (30)
	Seldom	1	80 (36)
	Sometimes	2	48 (21)
	Often	3	22 (10)
11. When you are alone in a restaurant, bus terminal, party, etc, do you feel safe, secure, or more confident if you are in possession of smokeless tobacco?	Always	4	7 (3)
	Never	0	43 (19)
	Seldom	1	55 (24)
	Sometimes	2	63 (28)
	Often	3	50 (22)
	Always	4	14 (6)

* The total score for the GN-STBQ was calculated as the sum of the 11 items. Possible scores range from 0 to 44. For the current sample, the Cronbach coefficient alpha for the GN-STBQ was 0.81.

Table 3

Severson Smokeless Tobacco Dependence Scale (SSTDS)* Short Form) [N=223]

Item	Response	Points	Observed No. (%)
1. How many days does a tin or pouch last you?	<1	NA	15 (7)
	1		73 (33)
	2		61 (27)
	3		27 (12)
	4		8 (4)
	5		10 (4)
	6		4 (2)
	7		21 (9)
	>7		4 (2)
2. Do you experience strong cravings for a dip/chew when you go more than 2 hours without one?	Yes	1	188 (84)
	No	0	35 (16)
3. How soon after you wake up do you use chew/snuff?	0 to 30 min	1	159 (71)
	>30 min	0	64 (29)
4. When you go without a dip or chew do you find yourself getting anxious more quickly?	Never	0	13 (6)
	Seldom	1	20 (9)
	Sometimes	2	65 (29)
	Often	3	81 (36)
	Always	4	44 (20)
5. When you go without a dip or chew do you find yourself getting drowsy more quickly?	Never	0	49 (22)
	Seldom	1	78 (35)
	Sometimes	2	68 (30)
	Often	3	22 (10)
	Always	4	6 (3)
6. I use more snuff/chew when I am worried about something.	Not at all	0	16 (7)
	A little	1	58 (26)
	Quite a bit	2	86 (39)
	Very much so	3	63 (28)
7. I use more snuff/chew when I am rushed and have lots to do.	Not at all	0	16 (7)
	A little	1	67 (30)
	Quite a bit	2	67 (30)
	Very much so	3	73 (33)
8. I get a definite lift and feel more alert when using snuff/chew.	Not at all	0	20 (9)
	A little	1	73 (33)
	Quite a bit	2	79 (35)
	Very much so	3	51 (23)

* The total score for the SSTDS was calculated as the sum of items 2 through 8. Possible scores range from 0 to 19. For the current sample, the Cronbach coefficient alpha for the SSTDS was 0.69.

Table 4
Correlation of Dependence Scales with Baseline Serum Nicotine, Serum Cotinine, and ST Use*

Measure	FTQ-ST	GN-STBQ	SSTDs	Serum Nicotine	Serum Cotinine	Cans per week
Number	N=224	N=225	N=223	N=221	N=221	N=225
mean±SD	13.8±2.5	20.7±6.8	11.0±3.6	31.4±14.2	431±224	4.1±3.1
median (IQR)	14 (12 to 15.5)	21 (17 to 25)	11 (8 to 14)	29 (21 to 39)	404 (262 to 551)	3 (2 to 5)
FTQ-ST	1.0	0.24 [†]	0.38 [†]	0.36 [†]	0.45 [†]	0.26 [†]
GN-STBQ		1.0	0.68 [‡]	0.04	0.02	0.18 [‡]
SSTDs			1.0	0.08	0.03	0.28 [†]

* Bivariate correlations were assessed using Pearson's product moment correlation.

[†] $p < 0.001$

[‡] $0.001 < p < 0.01$

Table 5

Association of dependence scales with nicotine withdrawal and craving^{*}

Composite Withdrawal Score				Craving Score				
	Parameter estimate	SE	p	Semipartial correlation	Parameter estimate	SE	p	Semipartial correlation
Model 1 (FTQ-ST)								
Intercept	0.576	0.262	0.029		1.656	0.356	<0.001	
Bupropion	-0.113	0.094	0.231		-0.341	0.128	0.008	
FTQ-ST	0.035	0.019	0.062	0.13	0.062	0.025	0.014	0.17
Model 2 (GN-STBQ)								
Intercept	0.537	0.154	<0.001		1.858	0.212	<0.001	
Bupropion	-0.087	0.092	0.347		-0.303	0.126	0.017	
GN-STBQ	0.024	0.007	<0.001	0.24	0.031	0.009	0.001	0.22
Model 3 (SSTDs)								
Intercept	0.307	0.151	0.043		1.612	0.209	<0.001	
Bupropion	-0.094	0.089	0.295		-0.324	0.124	0.009	
SSTDs	0.068	0.013	<0.001	0.35	0.082	0.017	<0.001	0.31
Model 4 (All 3 scales)								
Intercept	0.297	0.264	0.263		1.365	0.365	<0.001	
Bupropion	-0.093	0.090	0.302		-0.327	0.124	0.009	
FTQ-ST	0.000	0.019	0.995		0.021	0.026	0.431	
GN-STBQ	0.002	0.008	0.856		0.003	0.012	0.803	
SSTDs	0.066	0.017	<0.001		0.073	0.023	0.002	

* Daily diaries for the first 14 days following the target quit date used to obtain the average composite withdrawal score and average craving score for each individual. Data were analyzed using a series of linear regression models with composite withdrawal score and craving score as dependent variables. Dependence scales were modeled as continuous variables and treatment group was modeled using a dichotomous indicator variable. Initial models (Models 1-3) were fit to assess the individual dependence scales after adjusting for treatment. A final multivariable model (Model 4) that included all dependence scales was also assessed. Due to missing data, the number of participants included in these analyses ranged from 213 to 215.