



Evaluation of tobacco dependence measures in South Asian smokeless tobacco users



Nasir Mushtaq^{a,*}, Rumana Huque^b, Laura A. Beebe^c, Sarwat Shah^d, Kamran Siddiqi^d

^a Department of Biostatistics and Epidemiology, University of Oklahoma Health Sciences Center, 4502 East 41st Street, SAC 1G06, Tulsa, OK 74135, United States

^b Department of Economics, University of Dhaka, Dhaka, 1000, Bangladesh

^c Department of Biostatistics and Epidemiology, University of Oklahoma Health Sciences Center, Oklahoma City, OK 73104, United States

^d Department of Health Sciences, University of York, Heslington, York, YO10 5DD, United Kingdom

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ABSTRACT

Background: Despite the high prevalence of smokeless tobacco (ST) use in South Asia, ST dependence in this population has not been studied. Therefore, it is of interest to explore if ST dependence measures developed and validated in the western countries are of similar relevance to ST users who are culturally different and use distinct ST products. The aim of this study is to assess ST dependence among its users in Bangladesh by employing ST dependence scales based on three different approaches to measure tobacco dependence.

Methods: Data collected from a community-based sample of exclusive ST users living in Dhaka, Bangladesh (n = 200) were used for this study. Three ST dependence measures, Tobacco Dependence Screener (TDS), Fagerström Test for Nicotine Dependence for ST users (FTND-ST), and Oklahoma Scale for Smokeless Tobacco Dependence (OSSTD), were translated in Bangla and administered to the study participants. Saliva samples were collected for cotinine measurement. Reliability and concurrent and construct validity of FTND-ST and OSSTD were examined.

Results: Median cotinine concentration of the study participants was 440.2 (min = 2.9, max = 1874) ng/ml and 47% of them had TDS-based dependence diagnosis. Women had higher mean OSSTD, FTND-ST, and TDS scores as compared to men (p < 0.001). OSSTD demonstrated better reliability ($\alpha = 0.93$) than FTND-ST, and TDS ($\alpha = 0.64$ and 0.86, respectively). Concurrent validity of FTND-ST as evaluated by TDS, OSSTD, and cotinine concentration was affirmative.

Conclusion: The FTND-ST is a valid and reliable tool to measure physical dependence among ST users in Bangladesh. The study was unable to replicate the structure of OSSTD.

1. Introduction

Worldwide, more than 300 million people consume smokeless tobacco (ST) and most (90%) of them live in the WHO SouthEast Asia Region (National Cancer Institute and Centers for Disease Control and Prevention, 2014). Bangladesh has the highest prevalence of adult ST use in the region where 25.9 million (27.2%) adults are current ST users; and in certain subgroups of the population, ST use prevalence is more than 40% (Ministry of Health and Family Welfare (Bangladesh), 2009). It is notable that in Bangladesh, ST use among women is similar if not greater than that of men (27.9% vs. 26.4%) (Ministry of Health and Family Welfare (Bangladesh), 2009; National Cancer Institute and Centers for Disease Control and Prevention, 2014). Approximately, 50% of the oral cancer in Asia is attributed to ST (Boffetta et al., 2008) therefore, ST use is an important public health issue in the South-East

Asia Region that has the highest burden of oral cancer. It was estimated that in 2002, incidence of oral cancer in Bangladesh was more than 6.9% (WHO, 2005).

In addition to other health consequences, ST delivers a high dose of nicotine resulting in dependence. Nicotine dependence is a predictor of maintenance of tobacco use and unsuccessful quit attempts. ST dependence among Bangladeshi adults is evident from the findings of the Global Adult Tobacco survey which reported that the majority of the current ST users in Bangladesh believe ST use causes serious illness but only 28.5% of users made a quit attempt in the past 12 months which was lower than past quit attempts among current smokers (47.3%) (Ministry of Health and Family Welfare (Bangladesh), 2009; WHO, 2009).

The assessment of ST dependence is based on extensive research assessing cigarette dependence. ST dependence measures are either

* Corresponding author.

E-mail address: Nasir-Mushtaq@ouhsc.edu (N. Mushtaq).

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modified versions of smoking dependence scales adapted for ST or based on items drawn from these scales (Ebbert et al., 2012; Mushtaq and Beebe, 2012; Mushtaq et al., 2014). Variants of Fagerström Tolerance Questionnaire (FTQ) and Fagerström Test for Nicotine Dependence (FTND) are commonly used to measure dependence among ST users. FTND-ST with six items has demonstrated superior psychometric properties compared to other variants of FTND (Ebbert et al., 2006). Although FTQ, FTND, and their variants for ST dependence are continuous measures and provide more insight into the mechanism of dependence but these scales only evaluate physical dependence and does not examine other salient features of dependence (Boyle et al., 1995; Ebbert et al., 2006; Ferketich et al., 2007; Piper et al., 2004). In order to address the shortcomings of the other approaches to measure ST dependence, more recently, multidimensional scales have been developed to study ST dependence. The Oklahoma Scale for Smokeless Tobacco Dependence (OSSTD) was developed to measure dependence through seven underlying constructs. Similar to other ST dependence scales, items for the OSSTD were drawn from a smoking dependence scale, Wisconsin Inventory of Smoking Dependence Motives (WISDM-68) (Mushtaq et al., 2014; Piper et al., 2004).

Culture shapes tobacco use, as the core cultural values influence thoughts and feelings of individuals towards tobacco and their tobacco use (Poland et al., 2006). Due to the differences in ST products and complex social, cultural, and biological factors, ST users in different countries are not homogeneous as they exhibit distinct tobacco use behaviors. Therefore, expressions of ST dependence may vary across cultures (Nichter, 2003). Despite the cultural differences and high prevalence of ST use in South Asia, there is a paucity of research evaluating ST dependence among South Asian ST users. Most of the ST dependence research is conducted in the United States and Europe, therefore ST dependence scales were developed in English to evaluate dependence among Western ST users. Although various smoking dependence scales have been cross-culturally validated, no such attempt has been made for the ST dependence scales (Castro et al., 2014; de Meneses-Gaya et al., 2009; Meneses-Gaya et al., 2009; Vajer et al., 2011). Adapting existing ST dependence scales to measure dependence among South Asian ST users is the first step to identify underlying factors which facilitate the continuation of ST use. Employing the existing ST dependence measures will help in understanding the differences in aspects of dependence across cultures. In addition to the cultural context, this approach will provide deeper appreciation of other processes such as tobacco use behaviors influencing ST dependence.

The aim of this study is to measure dependence among ST users in Bangladesh. A comprehensive approach was used to assess ST dependence by adapting three dependence scales that are based on different approaches to measure ST dependence. Tobacco Dependence Screener (TDS), Fagerström Test for Nicotine dependence for ST users (FTND-ST), and Oklahoma Scale for Smokeless Tobacco Dependence (OSSTD) were translated into Bangla and their psychometric properties were evaluated. Specifically, reliability and concurrent and construct validity of FTND-ST and OSSTD were assessed among a community-based sample of exclusive ST users in Bangladesh.

2. Methods

2.1. Procedure

Data were collected from a convenience sample of adult ST users in Dhaka, Bangladesh. Current exclusive ST users were enrolled in the study through community referrals and snowball sampling. Study personnel who were trained in field research approached the community leaders and the vendors selling ST products in the study area to obtain references of the ST users in the community. Those who consented to participate were requested to provide saliva sample and respond to a set of questionnaires, including ST dependence measures, administered by trained interviewers. The study protocol was approved by the

Bangladesh Medical Research Council (BMRC) and the Research Governance Committee at the University of York, UK.

2.2. Participants

Participants of this study were recruited from two urban localities, Mohakhali and Mirpur, in Dhaka. Self-reported current ST users were eligible for enrollment if they were 18 years or older, had consumed ST at least for the past year, and used at least one can or pouch of ST per week at the time of enrollment. Exclusion criteria included: current smoking, history of other substance abuse, or history of psychiatric illness. A total of 200 current ST users with equal proportion of male and female were enrolled in the study. The mean age of the study sample was 46.8 (\pm 13.3) years and 47% had no formal education. 20% of the study participants were former cigarette smokers who had a mean duration of smoking abstinence of 12.2 (\pm 7.6) years. The majority (69%) used Paan with Zarda, while 24% reported using more than one ST product. Additional information on sociodemographic and tobacco use characteristics of the study participants are described elsewhere (Huque et al., 2016).

2.3. Measures

2.3.1. Socio-demographic and tobacco use characteristics

Information about participants' age, gender, level of education, and tobacco use behaviors such as age of onset and years of regular ST use, quantity of ST use, number of dips/chews per day, type of ST product, and past history of cigarette smoking was obtained through questionnaires administered by trained interviewers. Due to the varying packaging sizes containing different amounts of ST in commercially available ST products, quantity of ST use was estimated as grams of ST consumed per week. Participants were shown different sizes of cans and packets of ST products and were asked to identify the can/packet that they commonly purchased and the duration, in terms of number of days, it lasted. Based on this information, quantity was standardized; 20 g were considered as one can/pouch (Huque et al., 2016).

2.3.2. Cotinine concentration

Saliva samples were collected from all the participants at the time of interview to measure cotinine concentration. Within four days of the collection of saliva samples, they were shipped to ABS Laboratories in UK. The samples were tested for cotinine using a validated liquid chromatography-tandem mass spectrometry (LC-MS/MS) assay (Huque et al., 2016).

2.3.3. Dependence measures

2.3.3.1. Tobacco dependence screener (TDS-ST). A 10-item scale is based on the Diagnostic and Statistical Manual (DSM-IV) and International Classification of Diseases (ICD-10) criteria of nicotine dependence (Mushtaq and Beebe, 2016). Each question about a symptom of nicotine dependence has a dichotomous response (yes = 1/ no or not applicable = 0). The total score ranging from 0 to 10 is calculated as the sum of all the items. A score of five or more is used to classify tobacco dependence.

2.3.3.2. Fagerström test for nicotine dependence for smokeless tobacco (FTND-ST). A six-item scale which provides a continuous measure of nicotine dependence among ST users (Ebbert et al., 2006). Total score of FTND-ST ranges from 0 to 10 with a higher score indicating higher dependence.

2.3.3.3. Oklahoma scale for smokeless tobacco dependence (OSSTD). A multidimensional scale has 23 items and measures dependence through seven subscales which are grouped into two broader domains, primary dependence motives (PDM) and secondary dependence motives (SDM) (Mushtaq et al., 2014). Participants responded to 23 questions using a

7-point likert scale ranging from ‘not true of me at all’ to ‘extremely true of me’. Scores for each of the subscales is calculated by computing the mean item scores constituting the subscale. Total score of OSSTD is calculated as the sum of the means of the seven subscales PDM and SDM scores are the means of the subscales belonging to the corresponding domain (Mushtaq et al., 2014).

Since the above mentioned dependence measures were developed in English speaking countries, Bangla versions of these measures were created through forward-backward translation by translators who were fluent in both English and Bangla (Sousa and Rojjanasrirat, 2011). Items were not simply translated word-by-word or phrase-by-phrase but efforts were made to retain the overall equivalence of the translated items to the source items.

2.4. Statistical analysis

Descriptive statistics were obtained by performing exploratory analysis of the dependence measures and other study variables. Scores for the dependence scales were summarized by mean and standard deviation (SD), whereas, median and range for salivary cotinine concentration and frequency and proportion for TDS based dependence diagnosis were calculated.

The reliability of dependence scales was assessed using measures of internal consistency. These measures include Cronbach's coefficient alpha (α) and item-total correlation (Pearson correlation coefficient (r)). Correlation and regression analyses were performed to evaluate validity of the dependence scales. Due to the potential confounding effect of gender, partial correlation analysis was conducted. Bivariate associations of dependence scales among each other and with salivary cotinine concentration were computed to assess concurrent validity. Salivary cotinine concentration was used as a primary criterion variable (Mushtaq and Beebe, 2012). Cotinine values were skewed; therefore, square root transformation was applied to analyze cotinine data. FTND-ST and OSSTD were also validated against TDS-based dependence diagnosis and TDS total score.

Simple linear regression analysis was conducted to examine the association of cotinine concentration with individual item of FTND-ST and subscales of OSSTD. Similarly, multiple regression analysis was performed to adjust the effect of gender as a confounder. Convergent validity of dependence measures was evaluated by Pearson product-moment correlation coefficient. Correlation of each dependence scale with tobacco use characteristics, that is, quantity of ST use per week, frequency of ST use – dips/chews per day, years of ST use, age of initiation, and past quit attempts was examined. Quantity of ST use was categorized into three groups; 1 can per week (CPW), 2–3 CPW, and > 3 CPW. Frequency of ST use was examined both as a continuous variable and a categorical variable classified as, < 3, 3–6, and > 6 dips/chews per day.

Confirmatory factor analysis (CFA) was performed to examine the structure model of FTND-ST and OSSTD. Dimensionality of FTND-ST was examined in accordance with a previous study that examined the structure model of the FTND-ST (Mushtaq and Beebe, 2017). Factorial model of OSSTD was examined according to the original study of OSSTD; CFA was performed with 7 first-order freely correlating factors (Mushtaq et al., 2014). Overall model fit was assessed by standard fit criteria that included non-significant chi square indicating goodness of fit, Tucker-Lewis index (TLI) and comparative fit index (CFI) greater than 0.95, root mean square residual (RMSR) value less than 0.10, and root means square error of approximation (RMSEA) value of 0.8 or less.

Analyses were performed with SAS v9.4 and an alpha level of 0.05 was used for statistical significance.

Table 1
Dependence measures and tobacco use characteristics by gender (n = 200).

Dependence measure	Overall mean \pm sd	Male mean \pm sd	Female mean \pm sd	p-value*
Cotinine, median (min – max)	440.15 (2.90 – 1874.90)	450.50 (2.90 – 1874.90)	429.35 (27.50 – 1799.50)	0.8690
TDS based dependence, n(%)				< 0.0001
Yes	94 (47.00)	27 (27.00)	67 (67.00)	
No	106 (53.00)	73 (73.00)	33 (33.00)	
TDS	4.77 \pm 3.08	3.53 \pm 2.38	6.00 \pm 3.22	< 0.0001
FTND-ST	4.72 \pm 2.47	3.77 \pm 2.17	5.68 \pm 2.39	< 0.0001
OSSTD	35.58 \pm 7.24	33.03 \pm 7.33	38.14 \pm 6.19	< 0.0001
PDM	5.52 \pm 1.13	5.24 \pm 1.24	5.81 \pm 0.94	0.0003
SDM	4.91 \pm 1.08	4.51 \pm 1.06	5.30 \pm 0.95	< 0.0001
Loss of Control and Craving	6.04 \pm 0.97	5.79 \pm 1.07	6.29 \pm 0.78	0.0002
Tolerance and Automaticity	5.01 \pm 1.55	4.69 \pm 1.61	5.33 \pm 1.43	0.0030
Affective enhancement	5.76 \pm 1.03	5.43 \pm 1.07	6.09 \pm 0.87	< 0.0001
Affiliative attachment	5.40 \pm 1.08	5.06 \pm 1.12	5.73 \pm 0.93	< 0.0001
Cognitive enhancement	5.20 \pm 1.39	4.65 \pm 1.44	5.75 \pm 1.11	< 0.0001
Weight control	3.24 \pm 1.94	2.87 \pm 1.63	3.61 \pm 2.15	0.0070
Cue experience	4.94 \pm 1.21	4.55 \pm 1.18	5.33 \pm 1.11	< 0.0001
Number of dips/chews per day	11.67 \pm 5.79	12.83 \pm 6.74	10.51 \pm 4.38	0.0044
Number of dips/chews per day, n(%)				0.7102
Less than 3	1 (0.50)	1 (1.00)	0	
3 – 6	35 (17.50)	16 (16.00)	19 (19.00)	
More than 6	164 (82.00)	83 (83.00)	81 (81.00)	
Cans/pouches per week, n(%)				0.2011
1	105 (52.50)	53 (53.00)	52 (52.00)	
2 – 3	74 (37.00)	33 (33.00)	41 (41.00)	
More than 3	21 (10.50)	14 (14.00)	7 (7.00)	
Years of ST use	18.83 \pm 11.25	17.25 \pm 10.46	20.41 \pm 11.82	0.0467
Past smoking status				< 0.0001
Smokers	40 (20.00)	37 (37.00)	3 (3.00)	
Never smokers	160 (80.00)	63 (63.00)	97 (97.00)	

* For categorical variables χ^2 test of independence was used to evaluate association between gender and dependence measures, Wilcoxon-Mann-Whitney test was used for cotinine, whereas for other continuous variables, Student's *t*-test was used.

3. Results

3.1. Descriptive statistics

47% of the study participants had TDS based dependence diagnosis. Females had higher prevalence of dependence diagnosis than males (67% vs. 27%, $p < 0.001$). Mean total FTND-ST score was 4.72 \pm 2.47 and mean total OSSTD score was 35.58 \pm 7.24. There was no floor or ceiling effect in the score distribution for any of the items of the three dependence scales. Females had significantly higher scores on the OSSTD, FTND-ST, and TDS than males ($p < 0.0001$). There were significant gender differences in tobacco use characteristics too. Almost all the participants reported more than 3 dips per day and 82% had more than 6 dips per day. Majority of the ST users (53%) consumed one or less than one can/pouch (20gm) of ST per week and only 17% made at least one quit attempt in the past year. Table 1 summarizes the descriptive statistics of the study variables according to gender.

3.2. Reliability

Evaluation of Internal consistency of dependence scales measured with Cronbach's coefficient showed that the OSSTD ($\alpha = 0.921$) had better reliability than the TDS ($\alpha = 0.857$) and FTND-ST ($\alpha = 0.640$).

Table 2
Pearson's partial correlation between dependence measures.

Measures	Dependence Diagnosis (TDS yes/no)	TDS Score	FTND-ST	OSSTD
TDS Score	0.846			
FTND-ST	0.269	0.369		
OSSTD	0.138	0.207	0.469	
Loss of Control and Craving	-0.037*	-0.034*	0.415	0.698
Tolerance and Automaticity	-0.086*	-0.018*	0.379	0.807
Affective Enhancement	0.122*	0.086*	0.459	0.812
Affiliative Attachment	0.151	0.205	0.496	0.828
Cognitive Enhancement	0.283	0.262	0.436	0.808
Weight Control	0.127*	0.250	0.154	0.670
Cue Exposure	0.193	0.311	0.354	0.825

* p-value > 0.05 indicates that Pearson correlation was not significantly different from 0.

Pearson's correlation coefficients adjusted for gender.

Results of item-total correlation indicated that all FTND-ST items were significantly associated with the FTND-ST total score (range, $r = 0.47$ to $r = 0.80$). Similarly, all item-total correlations for the OSSTD were significant, ranged between 0.38 and 0.75.

3.3. Validity

3.3.1. Concurrent validity

Results of the correlation between the TDS, FTND-ST, OSSTD, and subscales of OSSTD are shown in Table 2. All three dependence measures were significantly correlated with each other and TDS based dependence diagnosis after adjusting for gender. Highest correlation was observed between the FTND-ST and the OSSTD ($r = 0.47$, $p < 0.0001$), indicating 22% common variance shared by the two scales. The FTND-ST was the only scale significantly correlated with the transformed cotinine ($r = 0.22$, $p = 0.0017$). Linear regression analysis showed that the association between the FTND-ST and transformed cotinine was not different after adjusting for gender (Table 3, unadjusted $\beta = 0.56$ and adjusted $\beta = 0.61$).

The FTND-ST was significantly correlated with all three components of ST use characteristics, frequency (dips/chews per day), quantity (cans/pouches per week), and duration (years of ST use). Whereas, the OSSTD has significant correlation with frequency and quantity of ST use. The TDS total score was only associated with the duration of ST use (Table 4).

3.3.2. Construct validity

Results of the confirmatory factor analysis showed that the data had good fit for the single factormodel of FTND-ST. The unidimensional

structure of FTND-ST yielded an exceptionally good fit based on the model fit indices ($\chi^2 = 8.24$, $df = 8$, $p = 0.31$, $SRMR = 0.036$, $TLI = 0.99$, $CFI = 0.99$, and $RMSEA = 0.03$). The dimensional structure of the OSSTD was evaluated according to the pre-specified factor solution identified in the original study of the OSSTD. The structure model with seven first-order freely correlating factors and no error covariances showed inadequate fit with data (Table 5). The latent variable covariance was not positive definite due to correlations greater than 1 between some of the factors. Modification indices identified numerous error correlations and cross-loadings of items.

4. Discussion

Despite high prevalence of ST use in the South Asian region, dependence among ST users in this diverse culture had thus far not been studied. Specifically, there is limited research on the multiple aspects of ST dependence among South Asian ST users. To our knowledge this is the first study to use different ST dependence scales to measure dependence in this population. Another unique aspect of this study is the inclusion of both male and female ST users. The study findings showed significant correlation of the FTND-ST with cotinine concentration and other dependence measures. The OSSTD was significantly correlated with both the FTND-ST and TDS.

Our study showed strong dependence among ST users in Bangladesh as they had relatively higher median cotinine concentration and mean FTND-ST and OSSTD scores compared to ST users in the United States (Mushtaq and Beebe, 2017; Mushtaq et al., 2012, 2014). Women demonstrated higher levels of ST dependence across all dependence scales as compared to men. These findings are expected, as these are consistent with higher prevalence of ST use among women in Bangladesh (Flora et al., 2009; Huque et al., 2017; Nargis et al., 2015). Significantly higher ST dependence among female ST users may be attributed to their higher frequency and duration of ST use compared to male users (Huque et al., 2016).

FTND-ST is the most commonly used measure of dependence among ST users. Findings of this study showed that reliability of the FTND-ST assessed by Cronbach's alpha was below the recommended threshold of 0.7. Past studies of the FTND-ST and modified FTQ among ST users in the U.S. showed internal consistency, ranging from 0.47 to 0.72 (Ebbert et al., 2006; Mushtaq and Beebe, 2012, 2017; Thomas et al., 2006). Our findings of marginally acceptable internal consistency and significant item-total correlations suggest that this is a reliable scale. The unidimensional structure model of the FTND-ST for this sample is consistent with our previous evaluation of the construct of the FTND-ST based on the U.S. data (Mushtaq and Beebe, 2017).

Cotinine has consistently been used as a criterion variable in ST dependence studies, as it is a recommended biomarker to assess severity of tobacco dependence (Ebbert et al., 2004; Mushtaq and Beebe, 2012). In accord with the findings of the previous studies of the FTND-ST, this

Table 3
Association between square root transformed salivary cotinine concentration and ST dependence measures.

Measure	Univariate Model				Multivariable Model*			
	Parameter estimate	Standard error	t-value	p-value	Parameter estimate	Standard error	t-value	p-value
TDS Score	0.123	0.143	0.86	0.3898	0.110	0.156	0.71	0.4811
FTND-ST	0.557	0.176	3.17	0.0017	0.607	0.191	3.18	0.0017
OSSTD	0.073	0.061	1.20	0.2334	0.070	0.065	1.07	0.2845
Loss of Control and Craving	0.010	0.456	0.02	0.9820	-0.057	0.473	-0.12	0.9046
Tolerance and Automaticity	0.324	0.283	1.14	0.2539	0.305	0.290	1.05	0.2933
Affective Enhancement	0.191	0.430	0.44	0.6574	0.130	0.456	0.29	0.7753
Affiliative Attachment	0.573	0.405	1.41	0.1587	0.560	0.428	1.31	0.1916
Cognitive Enhancement	0.242	0.316	0.77	0.4437	0.208	0.345	0.60	0.5463
Weight Control	0.217	0.227	0.96	0.3401	0.201	0.232	0.87	0.3860
Cue Exposure	0.580	0.362	1.60	0.1107	0.578	0.384	1.51	0.1336

* Multiple regression model included individual ST dependence scale and Gender.

Table 4
Pearson's partial correlation* between dependence scales and ST use characteristics.

Measures	Quantity (Number of cans/pouches per week)	Frequency (Number of dips/chews per day)		Duration (Years of ST use)
		Categorical Variables	Continuous variable	
TDS Score	0.042 (0.5579)	−0.145 (0.0422)	−0.022 (0.7637)	0.353 (< 0.0001)
FTND-ST	0.559 (< 0.0001)	0.201 (0.0047)	0.400 (< 0.0001)	0.258 (0.0002)
OSSTD	0.213 (0.0027)	0.276 (< 0.0001)	0.288 (< 0.0001)	0.126 (0.0785)
Loss of Control and Craving	0.365 (< 0.0001)	0.354 (< 0.0001)	0.402 (< 0.0001)	0.087 (0.2239)
Tolerance and Automaticity	0.258 (0.0002)	0.302 (< 0.0001)	0.213 (0.0025)	0.062 (0.3846)
Affective Enhancement	0.252 (0.0003)	0.229 (0.0011)	0.336 (< 0.0001)	0.122 (0.0871)
Affiliative Attachment	0.241 (0.0006)	0.328 (< 0.0001)	0.462 (< 0.0001)	0.117 (0.0997)
Cognitive Enhancement	0.187 (0.0082)	0.179 (0.0116)	0.231 (0.0010)	0.082 (0.2473)
Weight Control	−0.075 (0.2927)	0.037 (0.6034)	−0.069 (0.3350)	0.063 (0.3773)
Cue Exposure	0.103 (0.1472)	0.194 (0.0060)	0.232 (0.0010)	0.096 (0.1778)

* Pearson correlation coefficients adjusted for gender.

Table 5
Evaluation of structure models of FTND-ST and OSSTD.

Model fit indices	FTND-ST		OSSTD		
	Single Factor	Respecified Single factor*	7 first order freely correlating factors	PDM 2 factors	SDM 5 factors
Chi-square	44.657 (df 9, p = 0.0001)	8.237 (df = 7, p = 0.312)	1164.55 (df = 209, p = 0.0001)	197.72 (df = 19, p = 0.0001)	424.62 (df = 80, p = 0.0001)
SRMR	0.073	0.036	0.131	0.115	0.095
RMR	0.033	0.015	0.403	0.378	0.302
TLI	0.733	0.988	0.662	0.641	0.776
CFI	0.840	0.994	0.721	0.756	0.829
RMSEA (90%CI)	0.142 (0.102, 0.185)	0.030 (0.000, 0.096)	0.152 (0.143, 0.160)	0.217 (0.191, 0.245)	0.147 (0.134, 0.161)

* Model respecification was performed by specifying correlated errors between item 1 and item 6 and between item 3 and item 6.

study found significant association between FTND-ST and salivary cotinine concentration (Ebbert et al., 2006; Mushtaq and Beebe, 2017). Similar to past studies we found the strongest correlation between FTND-ST item related to time to first chew/dip (TTF) and cotinine, however, two other items – number of cans/pouches of ST used per week and frequent use during the first hour of awakening – were also significantly associated with cotinine concentration. (Ebbert et al., 2006, 2012; Mushtaq and Beebe, 2017). The concurrent validity of the FTND-ST as evaluated by comparing it with other ST dependence measures and TDS based dependence diagnosis was affirmative. Similarly, significant association was observed between the FTND-ST and tobacco use characteristics, such as, quantity, frequency, and duration of use.

The FTND-ST is a valuable scale to evaluate physical dependence; however, the complexity of ST dependence requires a multidimensional scale to measure various aspects of dependence. The OSSTD was developed to use a comprehensive approach to evaluate ST dependence through multiple underlying constructs. Our findings showed that the OSSTD was significantly associated with the TDS based dependence diagnosis and the FTND-ST. Further evaluation of the subscales of the OSSTD indicated that the PDM based subscales, Loss of control and Craving and Tolerance and Automaticity, were not significantly associated with the dependence diagnosis and TDS total score. Furthermore, compared to PDM based subscales, some of the SDM based subscales exhibited stronger correlation with FTND-ST. These results are contrary to the theoretical rationale that the subscales constituting PDM assess the magnitude of physical dependence as does the FTND-ST and the findings of the previous study that showed stronger association of PDMs with TDS and FTND-ST (Mushtaq et al., 2014).

As culture shapes tobacco use behaviors and attitudes, it may have implications surrounding ST dependence and underlying factors which facilitate its continued use. The SDM related subscales of the OSSTD

measure the psychosocial and behavioral aspects of dependence. Although we observed modest association of the OSSTD and most of its subscales with quantity and frequency of tobacco use, the Weight control subscale was not associated with any of the tobacco use characteristics. Similarly, Cue exposure was not associated with frequency and duration of ST use. These subscales had relatively lower mean score compared to others. Therefore, the evidence clearly supported the notion that some of the behavioral and social aspects of dependence among South Asian ST users may not be the same as observed in the Western ST users.

The study was unable to replicate the original structure model of the OSSTD (Mushtaq et al., 2014). The lack of construct validity may be due to the differences in the cultural and social factors, tobacco use behaviors, and the ST products used in Bangladesh. However, it is noteworthy that these discrepancies may be attributed to the possible lack of achievement of linguistic and cultural equivalence of the translated scale. Past validation studies of multidimensional smoking dependence scales translated to other languages had shown inconsistent results. (Castro et al., 2014; Vajer et al., 2011) A study of Spanish version of Brief WISDM failed to replicate the original scale dimensionality among Spanish speaking smokers in the United States (Castro et al., 2014). The OSSTD demonstrated superior reliability compared to other dependence measures. However, the lack of association of OSSTD and its subscales with the criterion variable and inconsistent associations of OSSTD subscales with TDS and tobacco use characteristics suggest that OSSTD requires revisions and refinement to effectively assess multiple dimensions of ST dependence in this population.

This study has numerous strengths. A comprehensive approach was used to measure dependence among ST users as various ST dependence measures including the one based on clinical criteria of dependence, cotinine concentration, unidimensional scale measuring physical dependence, and a multidimensional scale were used. The study is based

on a large community sample of non-treatment seeking exclusive ST users with equal representation of males and females. This is the first study to examine the psychometric properties of FTND-ST and OSSTD among South Asian ST users. Despite these strengths, there are a few limitations. Use of convenience sampling may have introduced selection bias. Study participants were recruited from an urban area. Convenience sampling and lack of representation of rural ST users who may differ from urban ST users regarding the type of ST products and consumption patterns would limit the external validity of the study findings (Flora et al., 2009). Although a thorough translation process was used to adapt ST dependence measures, it is possible that the linguistic equivalence and adequate cultural adaptation might not have been achieved. Moreover, respondents may not have a clear understanding of the Likert-scale response for the OSSTD items that would have resulted in measurement error. Future research with independent translation and more rigorous process involving cross-cultural adaptation of the OSSTD may address these shortcomings and provide a better insight into the psychometric properties of the scale.

While various tests were used to examine the psychometric properties of ST dependence measures, the predictive validity as assessed by tobacco cessation and withdrawal symptoms, while abstinent, was not evaluated. Predicting cessation is an important property of tobacco dependence scales. Future research focusing on establishing the predictive validity of ST dependence measures will identify their role as effective tools in clinical and research setting.

5. Conclusions

Worldwide ST users are not homogenous in regards to the ST products and tobacco use behaviors. These differences coupled with variations in cultural and social factors have implications for measuring ST dependence. Due to high prevalence of ST use in the South Asian region, valid and accurate ST dependence measures are needed for research purposes and for effective ST prevention and cessation. The FTND-ST is found to be a valid measure of physical dependence among ST users in Bangladesh. Although the OSSTD, a multidimensional scale, which outlines important dimensions of ST dependence did not have apparently meaningful results in this study, it is an important first step towards measuring multiple dimensions of ST dependence in this population. Findings of the current study suggest that revision and further refinement of this scale is necessary to measure underlying aspects of dependence among South Asian ST users. A comprehensive scale assessing conceptually distinct dimensions of ST dependence in this population is needed.

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Author's contributions

NM and KS designed the original study. NM conducted the literature review and statistical analysis, and wrote the draft of the manuscript. RH implemented the study and collected the study data. LB contributed to the interpretation and presentation of the results and performed critical revision of the manuscript. SS contributed to the data management and conduct of the study. KS performed critical revision of the manuscript. All authors contributed to and have approved the final manuscript.

Declaration of Competing Interest

No conflict declared.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.drugalcdep.2019.05.034>.

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