



A multiple motive/multi-dimensional approach to measure smokeless tobacco dependence

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HIGHLIGHTS

- We used a multidimensional approach to measure dependence among ST users.
- OSSTD identified seven latent constructs including 23 items to measure ST dependence.
- OSSTD possesses better psychometric properties than FTND-ST.
- OSSTD is an effective tool to measure ST dependence as a multidimensional construct.

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ABSTRACT

Background: Unlike various research studies conducted to address dependence among smokers, only a few studies have examined smokeless tobacco (ST) dependence. The Fagerström Tolerance Questionnaire (FTQ) and Fagerström Test for Nicotine Dependence (FTND) based scales are the most widely used measures of nicotine dependence for both ST users and smokers. These scales were initially developed to measure physical dependence and tolerance and not to assess other salient dimensions of dependence such as craving, compulsion, or withdrawal, as defined by DSM-IV and ICD-10. The aim of this study is to develop and validate a multidimensional scale that has better content coverage, factor structure, and psychometric properties to measure dependence among ST users.

Methods: 100 adult male smokeless tobacco users were recruited through email distribution lists and community referral. Participants completed three different nicotine dependence questionnaires and provided information related to their tobacco use and demographic characteristics. They also provided a saliva sample for cotinine measurement. In order to develop the new ST scale, subscales and items were selected based on correlation and factor analysis of the modified WISDM-68. Reliability and validity of the new scale, Oklahoma Scale for Smokeless Tobacco Dependence (OSSTD) were also assessed.

Results: The new ST scale identified seven latent constructs including 23 items to measure ST dependence. Internal consistency as measured by Cronbach's coefficient ($\alpha = 0.925$) indicated better reliability of OSSTD than FTND-ST. Concurrent validity of OSSTD as evaluated by comparing it with dependence diagnosis and FTND-ST was affirmative. There was a significant correlation between the OSSTD total score and the cotinine levels and tobacco use characteristics among study participants.

Conclusion: OSSTD possesses better psychometric properties and provides an effective and efficient tool to measure ST dependence as a multidimensional construct.

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1. Introduction

Despite a decline in smoking prevalence, smokeless tobacco use is increasing in the United States (SAMHSA, 2010). The Surgeon General's report of 1986 recognized that nicotine dependence associated with smokeless tobacco use follows an addiction pattern similar to other

substance abuse (USDHHS, 1986). Clinical and laboratory studies have identified tolerance and withdrawal effects among ST users (Giovino, Henningfield, Tomar, Escobedo, & Slade, 1995; Hatsukami, Gust, & Keenan, 1987). For example in a study of baseball players, withdrawal effects related to ST abstinence were observed in the form of cognitive impairment affecting players' performance during the game (Robertson et al., 1995). ST has unique pharmacokinetics; unlike cigarette smoking that delivers nicotine to arterial blood through the alveoli of the lungs, nicotine is absorbed through the oral mucosal membranes into the venous blood. Bioavailability of nicotine from ST differs

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from that of cigarettes, as it depends on the nicotine concentration, pH level, and the tobacco cuttings of the ST product (Henningfield, Radzins, & Cone, 1995). ST users have higher concentrations of nicotine, as measured by cotinine levels, compared to cigarette smokers (Fant, Henningfield, Nelson, & Pickworth, 1999). Due to these differences in the pharmacokinetics of the two nicotine delivery systems, behavioral and psychosocial factors explaining dependence among ST users may be different from cigarette smokers. Relative to cigarette smoking, there are discrete sensory stimulations and cues associated with ST use. A recent study of product-specific assessment of dependence elaborated the role of nicotine and non-nicotine factors in repeated use of tobacco products and noted product-specific behaviors and stimuli as a function of dependence (Fagerstrom & Eissenberg, 2012). These findings highlighted the importance of product-specific measures of dependence for different tobacco products.

Unlike various research studies conducted to address dependence among smokers, only a few studies have been conducted for smokeless tobacco dependence (Boyle, Jensen, Hatsukami, & Severson, 1995; Ebbert, Patten, & Schroeder, 2006; Ferketich, Wee, Shultz, & Wewers, 2007; Thomas et al., 2006). Most of these studies used the modified Fagerstrom Tolerance Questionnaire (FTQ) or the Fagerstrom Test for Nicotine Dependence (FTND) to measure ST dependence. The FTQ developed in 1989 was derived from the original Fagerstrom test, to measure nicotine dependence among smokers (Fagerstrom & Schneider, 1989). FTQ and FTND are the most widely used measures in nicotine dependence assessment and their predictive validity has been studied among cigarette smokers (Fagerstrom & Schneider, 1989; Kozlowski, Porter, Orleans, Pope, & Heatherton, 1994; Pinto, Abrams, Monti, & Jacobus, 1987). The FTQ for smokers was not developed according to standard psychometric methods. However, this questionnaire was intended to measure physical dependence and tolerance as the aim was to provide a tool for smoking cessation treatments to assess different levels of dependence of individual smokers. Thus the FTQ and FTND do not assess other salient dimensions of dependence — craving or compulsion to smoke, as defined by DSM-IV and ICD-10. FTND is also criticized for its multifactorial structure as it does not measure a single construct of physical dependence (Etter, Duc, & Perneger, 1999; Heatherton, Kozlowski, Frecker, Rickert, & Robinson, 1989). The FTQ and FTND heavily rely on two constructs: heaviness of tobacco use and withdrawal. Due to inconsistent scores to the item responses, questions related to the heaviness of use have more contributions to the total score. Therefore, using cotinine levels, either salivary or serum cotinine, to validate these dependence measures resulted in criterion contamination (DeVon et al., 2007; Piper et al., 2004). Validity of these scales against other criterion variables was not consistently established.

In an effort to address the shortcomings of the FTQ and DSM-IV based smoking dependence measures, Piper et al. developed the Wisconsin Inventory of Smoking Dependence Motives (WISDM-68) (Piper et al., 2004). This theory driven measure of smoking dependence identifies 13 motives of nicotine dependence among smokers which are measured by 68 items. Contrary to the other measures of tobacco dependence among smokers, WISDM-68 measures multiple motives for smoking that contribute to compulsive use and result in nicotine dependence. Preliminary studies focused on WISDM-68 have demonstrated excellent internal consistency for the overall scale ($\alpha = 0.96$) although subscales had internal consistency ranging from 0.74 to 0.94. Other than some exceptions to the individual subscales, concurrent validity of this tool showed significant correlation with FTND, Nicotine Dependence Syndrome Scale (NDSS), smoking rate, alveolar carbon monoxide, and DSM-IV based criteria of smoking dependence (Piper et al., 2004; Piper et al., 2008).

Regardless of the better psychometric properties and broader coverage of dependence motives by WISDM-68, its length limits its use in research or clinical settings. More recent research on WISDM-68 has explored different possibilities to shorten the original scale, ranging

from simply combining highly correlated subscales to applying more rigorous strategies by integrating person centered analyses and variable centered analysis to categorize subscales into broader constructs. For example, subscales such as Negative reinforcement and Positive reinforcement were highly correlated; similarly Affiliative attachment and Behavioral choice-melioration subscales had stronger correlation (Smith et al., 2010). Latent class analysis and factor mixture models identified two synthetic WISDM scales. The Primary Dependence Motives (PDM) scale consisting of Automaticity, Loss of craving, Tolerance, and Craving subscales and the Secondary Dependence Motives (SDM) scale containing the remaining nine subscales (Piper et al., 2008). Based on these findings a shorter form of WISDM-68, Brief WISDM which included 11 subscales and 35 items was developed. It provided reliable and representative content coverage and demonstrated comparable psychometric properties (Smith et al., 2010). To our knowledge, neither the WISDM-68 nor Brief WISDM scales have ever been applied to a ST using population.

A recent study of ST dependence measures compared modified FTQ with two newer scales, Glover-Nilsson Smokeless Tobacco Behavioral Questionnaire (GN-STBQ), a variant of Glover-Nilsson Smoking Behavioral Questionnaire (GN-SBQ), and Severson Smokeless Tobacco Dependency Scale (SSTDs) which included FTQ items and items assessing behavioral patterns of ST use and withdrawal symptoms. GN-STBQ and SSTDs had diverse items which measured other dimensions of ST dependence in combination with physical dependence. Both the scales were significantly associated with craving and withdrawal but did not predict ST abstinence. These findings underscore the importance of a multidimensional scale to evaluate ST dependence (Ebbert, Severson, Danaher, Schroeder, & Glover, 2012). Similar to the previous ST dependence scales, this study employed a cigarette dependence measure to develop a ST dependence scale, however, we adapted the WISDM-68, one of the most comprehensive and multiple motive measures of smoking dependence.

The goal of this study is to develop and validate a multidimensional scale that has better content coverage, factor structure, and psychometric properties to measure dependence among ST users, as compared to previously used ST dependence measures. Specifically, the study examined a modified version of the WISDM-68 to assess dependence among ST users and retained sufficient items and subscales to measure multiple motives of ST dependence.

2. Methods

2.1. Study population

Participants of this study were adult ST users living in Oklahoma from May 2010 to December 2010. They were recruited through email distribution lists and community referrals. Eligibility criteria included ages 18 to 65 years, no current smoking, at least 1 year use of smokeless tobacco, and consuming at least one pouch or can of ST each week. Participants with a history of other substance abuse or history of psychiatric illness were not included. Following an initial telephone screening to verify eligibility and obtain consent, study materials were mailed to participants. This study was approved by the University of Oklahoma Institutional Review Board (IRB#15079) and the Oklahoma State University IRB.

2.2. Data

140 adult ST users were screened for the eligibility criteria and 100 of them completed three different nicotine dependence questionnaires and provided information related to their tobacco use and demographic characteristics. To assess saliva cotinine, saliva collection tubes were also sent to the study participants. The saliva samples were returned in the mail along with the surveys to the study center and were frozen at -20°C upon receipt. The samples were tested for salivary

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