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Psychometric properties of the Iranian version of the fagerstrom test for nicotine dependence and of heaviness of smoking index

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Abstract

Fagerstrom test for nicotine dependence (FTND) is one of the tests widely used to measure the nicotine dependence. The shorter copy of the test is known as the heaviness of smoking index (HSI). The aim of this study was psychometric properties of Persian version of FTND and HSI in smokers. The questionnaire was assessed in terms of validity and reliability. The internal consistency and stability of the questionnaire was examined through Cronbach's alpha and intraclass correlation coefficient (ICC). The participants were 230 smokers with mean age of 35.64 (±7.40) years. The mean score of FTND and HSI was estimated 2.38 (±1.05) and 1.06 (±0.954), respectively. In analysis of the construct validity, the exploratory factor analysis (on 130 samples) showed a factor with variance coverage of 42.73% for all items. Furthermore, the confirmatory factor analysis showed rather favorable fit for the indexes (NFI=0.92, CFI=0.95, GFI=0.93, RMSEA=0.07, $\chi 2$/df=2.0). The Cronbach's alpha coefficient confirmed the internal consistency (FTND=0.71 and HSI=0.68); and ICC also indicated the favorable reliability of the instruments (FTND=0.63 and HSI=0.70). The results showed that the Persian version of the instrument had favorable validity and reliability and could be used in smoking control programs in order to evaluate the cigarette dependence.

Keywords: Dependence, fagerstrom, Nicotine, Reliability, Validity

Introduction

Smoking is a major public health concern in the world [1], as the World Health Organization introduced it as one of the 20 causes of death [2]. Estimations show that over 4 million people die of diseases caused by smoking annually. It has been predicted that smoking-induced death increases to 10 million people per year up to 2030, as 70% of the deaths occur in developing countries [3].

Fortunately, smoking cessation can reduce the risk of smoking-induced diseases, such as cancers, cardiovascular diseases, and stroke [4]. One of the main and important components of smoking control programs is smoking cessation [5]. Statistics show that few quitters can remain in the cessation status [6]. There are obviously many variables that may affect the maintenance of the cessation status; however, nicotine dependence is one of the most influential factors resulting in returning to smoking [7].

Therefore, clinicians and researchers need a valid and reliable instrument to measure cigarette dependence. Several instruments have been developed for measuring nicotine dependence. The instruments widely used in this regard include Fagerstrom tolerance questionnaire (FTQ) that was designed in 1978 [8] and its abridged version, FTND. Both instruments were developed by Fagerstrom et al. [9 & 10]. The main reason for designing FTND was the psychometric disadvantages of FTQ, such as its unacceptable internal consistency and item loading in some factors [11]. FTND consisted of 6 out of 8 items of FTQ. The score of the instrument is determined from zero to 10. The score obtained for this instrument classifies nicotine dependence under 5 levels: very low (0-2 points), low (3-4 points), moderate (5 points), high (6-7 points), and very high (8-10 points) [12].

Moreover, another abridged version of FTQ has been proposed, HSI that consists of 2 items [13]. The studies evaluating HSI and comparing it with FTND indicated that results of HSI were similar to those of FTND [12].

FTND has been translated and validated in many languages and is still psychometrically controversial despite its wide use. In validation studies, the psychometrics of FTND have been reported as very weak to very suitable in terms of validity and reliability [9 & 13-16]. A study on evaluation and comparison of FTND and FTQ reported that FTND had a low reliability (0.56) [17]. Moreover, some factor analysis studies have shown that the instrument did not have a consistent factor [18]. On the contrary, some other studies have shown that FTND had a favorable reliability (0.87), and results of factor analysis have shown that the items were loaded on one factor [12].

As treatment methods and types of alternative drugs for nicotine can be determined after the measurement of nicotine dependence in cigarette smokers [19], it is of special importance to achieve a valid instrument for smoking control programs both in interventions and in studies. This study was conducted to examine the psychometric properties of the Persian version of FTND and HSI in cigarette smokers.

Method

The data in this study were collected in 2012. This study was a part of a study for planning and implementing smoking cessation intervention. In this respect, to achieve a sample appropriate to an interventional study, the inclusion and exclusion criteria of the study were determined as follows:

- Inclusion criteria: Cigarette- smoking men with a history of smoking at least 100 cigarettes, literacy, and tendency to cease smoking, and consent to participate in the study.
- Exclusion criteria: People with a history of psychotic diseases and medication use for psychotic diseases.

In this study, factories were selected randomly, and people interested in participating in the study were registered. The eligible people were included in the study. As the number of samples for factor analysis should be 5-10 times as the number of items [20], and the questionnaire contained 6 items, 120 samples could fulfill the sample size required for the factor analysis. However, based on the available references, 100-200 samples should be determined for non-complicated models in order that the significance of Chi-square would be valuable [21]. Therefore, regarding the probable loss of samples, 240 registered smokers were invited for the study. Eventually, 230 samples from 7 factories participated in the study and completed the

questionnaire. Then, 130 and 100 samples were selected randomly, respectively for the exploratory factor analysis and confirmatory factor analysis.

In this study, the questionnaire of FTND was used. Table 1 provides the items of FTND, HSI, and scoring.

The total score of FTND ranges from 0 (minimum dependence) to 10 (maximum dependence). HSI consists of only two items and is scored from 0 to 6. For validation external variables, expired air carbon monoxide level (CO) were used. The exhaled carbon monoxide level was measured using Bedfont Pico Smokerlyzer. Based on the standards, the exhaled carbon monoxide level higher than 6 ppm indicated cigarette smoking [18].

Table 1 *Fagerstrom test: scoring rule and percent of respondents*

Items	Response options	Points	%
1. How soon after you wake up do you smoke your first cigarette?*	Within 5 minutes	3	10.0
	6- 30 minutes	2	9.2
	31- 60 minutes	1	9.2
	After 60 minutes	0	71.5
2. Do you find it difficult to refrain from smoking in places where it is forbidden, e.g in a restaurant, cinema, on a bus, etc.?	Yes	1	24.6
	No	0	75.4
3. Which cigarette would you hate most to give up?	The first one in the morning	1	37.7
	All others	0	62.3
4. How many cigarettes/day do you smoke? *	10 or less	0	63.1
	11- 20	1	26.9
	21- 30	2	7.7
	31 or more	3	2.3
5. Do you smoke more frequently during the first hours after waking than during the rest of the day?	Yes	1	37.7
	No	0	62.3
6. Do you smoke when you are so ill that you are in bed most of the day?	Yes	1	31.5
	No	0	68.5

* HSI

FTND was translated from English into Persian by two translators and back translated by two independent translators. The translators were fluent in both English and Persian. The research team and translators examined the accuracy of the questionnaire [22]. A panel of experts including 10 specialists (out of the research team) was used to determine the qualitative content validity. The researchers evaluated the questionnaire in terms of its adaptation to scientific materials, use of appropriate terms, position of items in proper places, and appropriate scoring [23]. Then, the qualitative face validity of the questionnaire was examined by 20 cigarette-smoking men similar to the studied samples in order to ensure the comprehensibility of the items and lack of any difficulty with answering the items [24].

The exploratory factor analysis with principal component analysis, varimax rotation, Kaiser-Meyer-Olkin (KMO) index, and value of Bartlett's test was examined to categorize the variables having internal consistency in this study [25]. Then, the confirmatory factor analysis was performed to confirm the structure obtained from the exploratory analysis. Indexes used to examine the fit of the model were as follows: the relative chi-square (x2/df), root-mean-square error of approximation (RMSEA), goodness of fit index (GFI), comparative fit index (CFI), and normed fit index (NFI). In this study, the

Chi-square to the degree of freedom ratio less than 3 was acceptable. The RMSEA values less than 0.08 indicated the appropriate fit of the model [26]. Moreover, GFI, CFI, and NFI more than 0.90 indicated the appropriateness of the model [21]. To determine the reliability of the instrument, the internal consistency was examined using the Cronbach's alpha coefficient. The Cronbach's alpha coefficient greater than 0.7 indicated the acceptable reliability of the instrument [23]. The retest with intraclass correlation coefficient (ICC) was used to evaluate the reliability. The ICC values ≥ 0.4 were acceptable [27]. To calculate ICC, the questionnaires were distributed among 40 cigarette-smoking people. The study questionnaire were filled twice, with two weeks apart [28]. Furthermore, the correlation of instruments with expired air carbon monoxide level was evaluated using Pearson's correlation coefficient in order to validate the instrument through an external variable. The correlation coefficient of 0.3-0.5, 0.5-0.8, and over 0.8 was determined as moderate, strong, and very strong correlation, respectively [23]. The data were analyzed using the SPSS16 statistical software and LISREL 8.8.

To respect the ethics in this study, a license was adopted from the Ethics Committee of Tarbiat Modares University, and an informed consent was adopted from the participants.

Results

The participants included 230 cigarette-smoking men with a mean age of 35.64 ±7.40 years (range 24-58 years). The mean age of initiation of smoking was 19.49 (±5.73) years. The demographic specifications of the participants are shown in Table 2.

Mean score of FTND and HSI was 2.38 (±1.05) and 1.06 (±0.954), respectively. The response rate for the items is shown in Table 1.

Once the instrument was translated and back-translated, it was evaluated in terms of qualitative content and face validity. Some changes were made to the items for the purpose of disambiguation and better comprehensibility of items. Then, the factor structure of the questionnaire was examined through the exploratory factor analysis. The first output, the KMO index and the value of Bartlett's test, respectively showed the adequacy of the sample size and appropriateness of the factor analysis for detection of the structure of factor pattern ($P<0.0001$, $df=15$, $\chi2=163.841$, $KMO=0.71$). A factor with eigenvalue more than one was detected in the principal component analysis with varimax rotation. Maximum and minimum loading occurred at "Time to first cigarette" and "Difficult to refrain," respectively (Table 3).

Table 2 *Demographic characteristics and smoking history of partcipants (n = 230)*

		%	Mean (SD)
Age	-	-	35.64 ± 7.40
22-30	67	29.1	-
31-38	87	37.8	-
39-46	55	23.9	-
47-58	21	9.2	-
Marital status			
Single	32	13.9	-
Married	198	86.1	-
Education			
< 12 years	80	34.8	-
12 years	108	46.9	-
> 12 years	42	18.3	-
Smoking status			
live with smoking	16	6.9	-
age of initiation of smoking	-	-	19.42 ± 5.55
Duration of cigarette smoking	-	-	14.05 ± 7.29
Cigarettes per day	-	-	11.64 ± 6.29
CO level (ppm)	-	-	14.12 ± 6.17

The results of the confirmatory factor analysis

indicated relatively favorable fit (Table 4). Figure 1 also shows the results.

The result of evaluating the internal consistency of the questionnaire through the Cronbach's alpha coefficient for the two versions did not significantly differ: FTND=0.71 and HSI=0.68. The reliability evaluation through calculation of ICC was more favorable for HSI: FTND=0.63 and HSI=0.70.

The Pearson's correlation coefficient between items and total score of FTND was 0.83, 0.50, 0.55, 0.74, 0.65, and 0.56, respectively (P<0.001).

On the correlation between expired air carbon monoxide level and nicotine dependence, the results through FTND and HSI respectively were as follows: r=0.42 (P<0.0001) and r=0.40 (P<0.0001).

Table 3 *Factor loading of the Fagerstrom test (n = 130)*

	Factor loading
1. Time to first cigarette	0.760
2. Difficult to refrain	0.493
3. Hate most to give up	0.605
4. Cigarettes per day	0.712
5. Morning smoking	0.723
6. Smoke if ill	0.588
Eigenvalue	2.56
% of variance	42.73

Discussion

This study was conducted to evaluate the psychometric properties of FTND and HSI. In general, the results showed that the instrument was valid for the measurement of nicotine dependence.

The results revealed that the mean score of FTND in the studied participants (2.38) was lower than that in other validation studies [9, 17, & 28]. Moreover, regarding that mean cigarette consumption in this study was almost 12 cigarettes a day, which indicates that most of the participants were not heavy smokers.

In this study, FTND had satisfactory properties. As observed, no item was unanswered, and this revealed the acceptability and comprehensibility of the instrument. Furthermore, unlike some studies in which the items were loaded on two factors [17, 29, & 30], the FTND in this study had a one-dimensional structure. This structure conformed to the objective of the test that was designed to measure the construct "nicotine dependence" [9 & 10]. The results of the confirmatory factor analysis showed that the data were fit to the model based on the recommended standards [31].

Table 4 *The confirmatory factor analysis of the Fagerstrom test (n = 100)*

	Fit indices
Relative chi-square (x2/df)	2.0
Root mean square error of approximation (RMSEA)	0.07
Goodness of fit index (GFI)	0.93
Comparative fit index (CFI)	0.95
Normed of fit index (NFI)	0.92

*P< 0.001

In this study, the reliability of the instrument was determined through two statistical tests. The Cronbach's alpha coefficient (FTND=0.71 & HSI=0.68) showed favorable internal consistency [32]. A review of 14 studies in order to evaluate the internal consistency of FTND showed the Cronbach's alpha coefficient as 0.55-0.74 that revealed the moderate internal consistency of instrument [12]. ICC also showed the reliability of the instrument (FTND=0.63 & HSI=0.70). Results of Etter et al.'s study on non-heavy smokers indicated that the ICC of FTND was favorable. In that study, the correlation HSI was slightly higher than that of FTND [14].

In this study, the inter-item correlation in FTND was strong and direct. However, the inter-item correlation increased in HSI. Certainly, the increase was important in estimation of the correlation between items and the test score. It might be argued that the level of nicotine dependence in smokers could be estimated using the answers given to the two items of HSI. In this regard, the European Lung Foundation also recommended the evaluation of the first item for estimation of nicotine dependence [33].

In this study, the correlation between FTND and expired air carbon monoxide level was evaluated to validate the instrument through an external variable. The Pearson's correlation coefficient in FTND and HSI was respectively 0.42 and 0.40, which showed moderate correlation. This result revealed that the instrument was valid for the cigarette-smoking condition. Other studies showed weak to moderate correlation of FTND and HSI with biochemical scales [12].

One of the limitations of the test was that no item addressed people's belief about

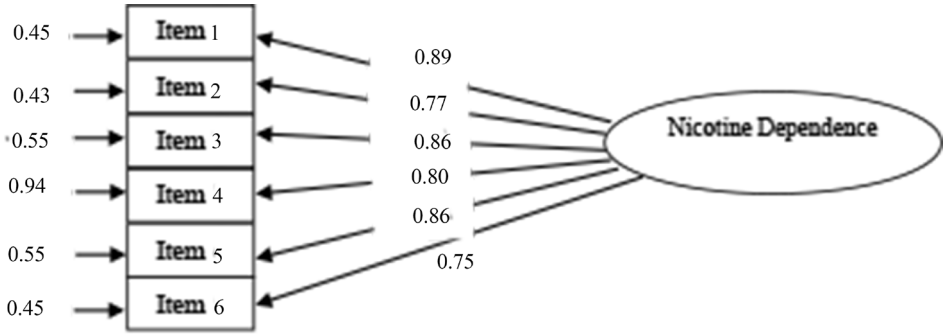

Figure 1 *The results obtained from the confirmatory factor analysis*

cigarette-smoking directly. Whereas, such an item is considered as an addiction index for other narcotics [34]. Furthermore, it may be better to change the name of the test (nicotine dependence test) into cigarette-smoking measurement because its items are only about cigarette and do include other smoking habits. The limitation of the present study was the participation of non-heavy smokers. Therefore, it is recommended to evaluate the test for other types of smokers.

Conclusion

In general, the results of this study showed that the Persian version of FTND and HSI had favorable validity and reliability. In this respect, the results are useful considering that a valid and reliable instrument is essential for measurement of cigarette dependence in experimental and interventional studies of smoking control programs.

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Contributions

Study design: FS, SN, EH
Data collection and analysis: FS, EH, AH, SE
Manuscript preparation: FS, SN, AH, HA

Conflict of interest

"The authors declare that they have no competing interests."

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