

# Agreement between the Fagerström test for nicotine dependence (FTND) and the heaviness of smoking index (HSI) for assessing the intensity of nicotine dependence among daily smokers

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## ABSTRACT

**INTRODUCTION** Measuring the level of nicotine addiction among smokers is an integral part of enhancing smoking cessation as nicotine dependence is one of the barriers to smoking cessation. In this study, we compared the level of agreement between FTND and HSI in detecting high nicotine dependence among daily smokers.

**METHODS** We collected data from participants of a public smoking cessation clinic in Selangor. A trained pharmacist conducted face-to-face interviews with 152 daily smokers using a structured validated questionnaire. Respondents were classified as having high nicotine dependence using both the HSI (score  $\geq 4$ ) and the FTND (score  $\geq 6$ ), and concordance between the two measures, kappa statistics and sensitivity, specificity of the HSI were then determined with the FTND classification as the reference standard.

**RESULTS** The HSI had a substantial agreement with the FTND (Cohen's kappa=0.72) in measuring high levels of nicotine addiction, with good sensitivity (83.3%) and specificity (89.4%).

**CONCLUSIONS** The findings suggest that the HSI can be used instead of the FTND in clinical-based investigations to screen for high nicotine dependence among daily smokers in the clinical setting.

Tob. Induc. Dis. 2022;20(November):105

<https://doi.org/10.18332/tid/155376>

## INTRODUCTION

Diseases and deaths due to smoking are among the major public health problems in Malaysia, with a high burden of morbidity and mortality (estimated 20000 deaths reported annually) over the past two decades<sup>1</sup>. In response, the Malaysian Ministry of Health (MOH) has introduced various policies and measures to address this problem<sup>2</sup>. Among the measures proposed by the Framework Convention on Tobacco Control (FCTC) to reduce smoking-related morbidity and mortality is to increase smoking cessation rates<sup>3</sup>. The MOH provides smoking cessation services in public healthcare facilities and collaborates with the private health sector to expand smoking cessation services, in addition to working with local universities to train health personnel to help increase the quit rate among smokers in the country.

Measuring the level of nicotine addiction among smokers is an integral part of enhancing smoking cessation<sup>4</sup> as nicotine dependence is one of the barriers to

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## KEYWORDS

smoking cessation, smokers, reference standard, nicotine addiction

Received: 14 May 2022

Revised: 18 June 2022

Accepted: 13 October 2022

smoking cessation<sup>5</sup>. Various tools have been used to measure the level of addiction among smokers, among them are the Fagerström test for nicotine dependence (FTND)<sup>6</sup>, the Cigarette Dependence Scale (CDS)<sup>7</sup>, and the Hooked-on Nicotine Checklist<sup>8</sup>. Among these, the FTND<sup>5,6,9,10</sup> is the most widely used, as it has only six items, is simple to administer, and is non-invasive. In addition, it provides a quantitative assessment, conceptualizes addiction levels using behavioral and physiological symptoms, and shows better measurement results for nicotine addiction in genetic studies<sup>11</sup>. However, the time it takes to complete the six items may be too long for patients attending quit smoking clinic sessions, during which limited time, counselling, dispensing of medication and such, are also conducted. Thus, a simpler more rapid method is needed. The heaviness of smoking index (HSI) is a subset of the FTND and consists of two items: 1) time to the first cigarette upon waking, and 2) number of cigarettes smoked in a day. The HSI has shown high consistency (kappa agreement 0.72–0.78) with the FTND in several population-based studies<sup>5,12–17</sup>. Lim et al.<sup>18</sup> evaluated its use among Malaysian adult males in a population-based study and reported a kappa statistic for agreement of 0.63, and rather low sensitivity (67.0%) but high specificity (92.3%). However, it only included 363 daily smokers, males aged 25–64 years. Furthermore, their definition of daily smokers as those who smoke every day with a few exclusions such as religious fasting days and during acute illness, may affect the validity of the reported findings to some extent. Moreover, an updated evaluation of the level of agreement between HSI and FTND in various sociodemographic groups would help ascertain its current validity. Hence, we conducted this study to examine the level of agreement of HSI and FTND among daily smokers who attended government smoking cessation clinics in Selangor, Malaysia.

## METHODS

### Study design and setting

The data for this study were derived from a larger study on the prevalence and factors associated with smoking cessation among daily smokers seeking smoking cessation treatment in a government quit-smoking clinic in Selangor. A representative sample was obtained using a two-stage sampling strategy.

The first stage consisted of all government smoking cessation clinics in Selangor, and the second stage involved the selection of respondents via systematic random sampling. The minimum required sample size, based on a 10% prevalence of smoking cessation and 5% precision, was 139. The sample size was increased to 153 after adding an additional 10% for expected non-response.

In this investigation, participants were recruited via the intercept method, whereby every third person who came to the government quit-smoking clinic was approached to participate in the study. If the respondent did not meet the inclusion criteria or refused to participate, the next person was approached. The research team members explained to potential respondents the study's goals and procedure, and gave assurances of respondents' anonymity, data protection and confidentiality. After explaining the above and obtaining written informed consent from the participant, a qualified pharmacist then conducted a face-to-face interview with the respondent.

### Questionnaires

Validated questionnaires in Malay or English (depending on the respondent's preference) were used for data collection. The questionnaire included items on sociodemographic profiles, smoking status, age started smoking, number of cigarettes smoked per day, type of cigarette, and the FTND. Daily smokers were defined as those who smoked a cigarette at least once a day. We excluded individuals who used other types of tobacco products from the analysis. The FTND had six items with a total score ranging 0–10, whereas the HSI had two items with a total score ranging 0–6. Based on previous studies<sup>12–14,19</sup>, the cut-off scores for high nicotine dependence using the FTND and HSI were 6 and 4, respectively.

### Statistical analysis

We described the characteristics of respondents using descriptive statistics. Mean FTND scores in different sociodemographic subgroups were compared using the independent t-test or one-way ANOVA, where appropriate. The sensitivity and specificity of the HSI were determined using the FTND as the reference standard. Cohen's kappa<sup>20</sup> was used to assess the agreement of the HSI with the FTND. The data were analyzed using SPSS Version 20.0 at a 95% confidence level.

## RESULTS

A total of 152 daily smokers participated in the study, giving a 99.4% response rate. A majority of the respondents were male (93.3%,  $n=142$ ), and from urban areas (58.6%,  $n=89$ ). The respondents' mean age was 44.4 years ( $SD=13.05$ ), and almost one-third (35.5%) had tertiary education. The respondents' average daily tobacco intake was 17.3 cigarettes ( $SD=5.5$ ). The average age at smoking initiation and daily smoking were 16.78 ( $SD=5.45$ ) and 19.26 years ( $SD=6.29$ ), respectively. Approximately 4 in 10 respondents (40.5%) started smoking daily at age  $\leq 18$  years. The average FTND score was 4.16 ( $SD=2.67$ ), with no significant differences in mean scores across

all sociodemographic subgroups, except for marital status (Table 1).

A scatterplot and bivariate correlation analysis of the HSI and FTND scores revealed a strong linear correlation between the scores ( $r=0.904$ ) (Figure 1). The prevalence of high nicotine dependence based on the FTND and HSI was 33.6% ( $n=51$ ) and 31.6% ( $n=48$ ), respectively. The agreement between the HSI and the FTND was substantial (kappa statistic for agreement of 0.716). The HSI had 83.3% sensitivity and 89.4% specificity. The sensitivity remained consistently high when further stratified by sociodemographic variables, except for age, exhibiting low sensitivity among respondents aged  $\geq 50$  years (Table 2).

**Table 1. Sociodemographic characteristics and FTND scores of daily smokers attending public primary care clinics in Selangor, Malaysia (N=152)**

Characteristics	n	%	FTND score Mean (SD)	p
<b>Gender</b>				0.13 <sup>a</sup>
Male	142	93.4	4.07 (2.65)	
Female	10	6.6	5.40 (2.67)	
<b>Locality</b>				0.14 <sup>a</sup>
Urban	89	58.6	3.77 (2.28)	
Rural	63	41.4	4.42 (3.12)	
<b>Age (years)</b>				0.174 <sup>b</sup>
18–29	21	13.8	3.47 (2.87)	
30–39	37	24.3	5.05 (2.64)	
40–49	36	23.7	4.06 (2.53)	
50–59	33	21.7	3.76 (2.71)	
$\geq 60$	25	16.4	4.08 (2.55)	
<b>Ethnicity</b>				0.984 <sup>b</sup>
Malay	101	66.4	4.15 (2.93)	
Chinese	26	17.1	4.23 (2.19)	
Indian	21	13.8	4.00 (2.14)	
Other	4	2.6	4.05 (0.58)	
<b>Education level</b>				0.36 <sup>a</sup>
Primary/secondary	98	64.5	4.31 (2.60)	
Tertiary	54	35.5	3.89 (2.79)	
<b>Marital status</b>				0.04 <sup>a</sup>
Single/divorced	36	23.7	4.94 (2.79)	
Married	116	76.3	3.91 (2.59)	

<sup>a</sup> Statistical analysis using independent t-test. <sup>b</sup> Statistical analysis using one-way ANOVA.

Figure 1. Comparison of FTND and HSI scores of daily smokers attending government smoking clinics in Selangor, Malaysia

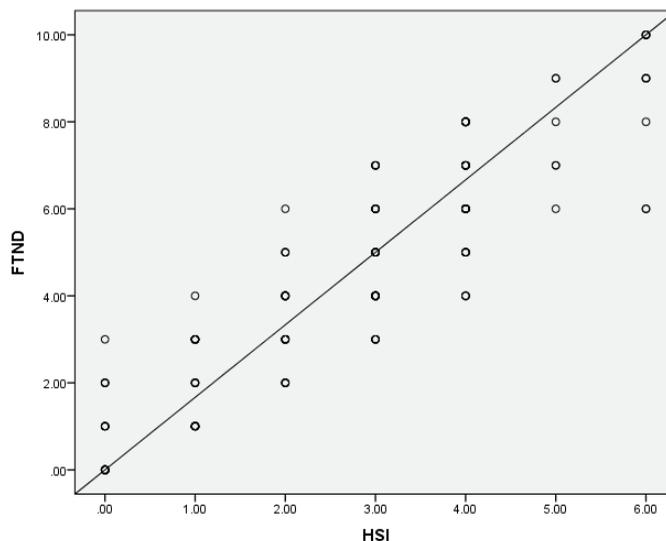


Table 2. High nicotine dependence as measured by the heaviness of smoking index (HSI) compared to the Fagerström test of nicotine dependence (FTND), among daily smokers attending government smoking cessation clinics in Selangor, Malaysia (N=152)

Variable	High nicotine dependence identified by HSI but not FTND % (n/N)	High nicotine dependence identified by FTND but not HSI % (n/N)	kappa	HSI sensitivity %	HSI specificity %	p
Overall	16.7 (8/48)	10.6 (11/104)	0.716	83.3	89.4	
<b>Gender</b>						
Male	17.1 (7/41)	10.9 (11/101)	0.700	82.9	89.1	<0.001*
Female	14.3 (1/7)	0 (0/3)	0.783	85.7	100	0.033**
<b>Locality</b>						
Urban	20.3 (6/29)	13.3 (8/60)	0.648	79.7	86.7	<0.001*
Rural	10.5 (2/19)	6.8 (3/44)	0.814	89.5	93.2	<0.001*
<b>Age (years)</b>						
18–29	0 (0/5)	6.3 (1/16)	0.877	100	93.7	<0.001**
30–39	12.5 (2/16)	19.0 (4/21)	0.674	87.5	81.0	<0.001*
40–49	9.1 (1/11)	0.0 (0/25)	0.933	90.9	100	<0.001**
50–59	32.5 (3/8)	12.0 (3/25)	0.505	62.5	88.0	0.01**
≥60	25 (2/8)	17.6 (3/17)	0.555			0.01**
<b>Ethnicity</b>						
Malay	12.5 (4/32)	10.1 (7/69)	0.755	87.5	89.8	<0.001*
Chinese	12.5 (1/8)	11.1 (2/18)	0.738	87.5	88.9	<0.001**
Indian	0.0 (0/5)	12.5 (2/16)	0.769	100	87.5	0.001**
Other	0.0 (0/1)	0.0 (0/3)		100	100	
<b>Education level</b>						
Primary/secondary	18.8 (6/32)	7.6 (5/66)	0.743	81.2	95.4	<0.001*
Tertiary	12.5 (2/16)	15.8 (6/38)	0.669	87.5	84.2	<0.001*
<b>Marital status</b>						
Single/divorced	7.1 (1/14)	18.2 (4/22)	0.719	92.1	81.8	<0.001*
Married	20.6 (7/34)	8.5 (7/82)	0.709	79.4	91.5	<0.001*

\*Chi-squared test. \*\*Fisher's exact test.

## DISCUSSION

This study on the agreement between the HSI and the FTND in detecting high nicotine dependence is the second in Malaysia, following the study of Lim et al.<sup>18</sup> among 373 daily smokers aged 25–64 years. However, in this study, we focused on daily smokers attending government smoking clinics in Selangor whereas Lim et al.<sup>18</sup> examined daily smoking participants of a nationwide population-based survey. In our study, the Cohen's kappa for agreement between the HSI and FTND of 0.716 and sensitivity and specificity of more than 80% matched the figures obtained in the study of Diaz et al.<sup>13</sup> of 1655 daily smokers in Spain. Sujal et al.<sup>17</sup> studied smokers seeking smoking cessation services in India, Chabrol et al.<sup>15</sup> studied 819 daily smokers aged  $\geq 15$  years in France, and Lee et al.<sup>16</sup> among 943 current smokers in Korea. However, our agreement, sensitivity, and specificity were lower than those reported by de Leon et al.<sup>14</sup> among 1462 smokers (5 samples from the USA and Spain)<sup>14</sup> and Diaz et al.<sup>13</sup> among 1655 smokers aged 18–64 years. Variations in the number of cigarettes smoked, duration of smoking and the nicotine content in cigarettes might explain the difference between countries/studies. However, future studies are strongly recommended to test this hypothesis. Furthermore, compared to an earlier study by Lim et al.<sup>18</sup> which was conducted ten years ago, our study demonstrated a higher degree of agreement ( $\text{kappa}=0.716$ ) and sensitivity of the HSI. Although in our study the specificity was lower, the sensitivity was nearly 15% higher. This finding is possibly due to the different definitions of daily smokers used in the study by Lim et al.<sup>18</sup> which excluded everyday smokers. We postulate that daily smokers who seek help in government smoking clinics are less likely to be subjected to recall bias because they are more focused on their behavior than those who do not seek treatment to quit smoking. However, this hypothesis needs to be tested in future research.

Similar to Chabrol et al.<sup>15</sup>, our study showed that HSI had reasonable concordance with the FTND among male and female daily smokers. In gender-specific analysis, we found higher sensitivity of the HSI among females compared to Diaz et al.<sup>13</sup>. There was also high concordance between the HSI and FTND across all sociodemographic subgroups, i.e. education level, location, ethnicity, marital status, and age group (except  $\geq 50$  years), which were not

reported by previous studies.

Our findings are similar to those of de Leon et al.<sup>14</sup> from a study involving 1462 smokers in the USA and Spain, Chabrol et al.<sup>15</sup> among 749 cigarette smokers in France, and Sujal et al.<sup>17</sup> among daily smokers in India. This study also reveals that the HSI performs equally well for both men and women, and other sociodemographic groups. According to de Leon et al.<sup>14</sup>, Chabrol et al.<sup>15</sup>, and Sujal et al.<sup>17</sup>, the HSI is an excellent rapid tool for assessing high nicotine dependence which makes it especially useful in clinical and epidemiological studies.

We found that approximately 30% of smokers attending the smoking cessation clinics had a high dependence on nicotine, which is compatible with the finding of Kõks et al.<sup>11</sup> among Vietnamese male smokers. The level of agreement between HSI and the FTND in our study is also consistent with Kõks et al.<sup>5</sup>, Heatherton et al.<sup>6</sup>, Diaz et al.<sup>13</sup>, and Chabrol et al.<sup>15</sup>. However, a more recent study by Perez-Rios et al.<sup>12</sup> reported lower agreement with the FTND.

## Limitations

This study has a few limitations. Firstly, respondents' smoking status was acquired from self-report without biochemical proof, and thus there is the possibility of bias. Second, the self-reported smoking status may influence other related variables dependent on it, such as the number of cigarettes consumed per day<sup>21</sup>. Third, the resulting prevalence in turn may affect the kappa values. Finally, this study was conducted in only one state, i.e. Selangor. Future studies need to be conducted in multiple states to ensure better generalizability to the Malaysian population.

## CONCLUSIONS

The findings suggest that the HSI can be used instead of the FTND in clinical-based investigations to screen for high nicotine dependence among daily smokers in the clinical setting.

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#### ACKNOWLEDGEMENTS

We would like to thank the Director-General of Health Malaysia for his permission to publish this article. We thank those who were involved in the study and who assisted in the collection and management of the data for their support and cooperation.

#### CONFLICTS OF INTEREST

The authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest and none was reported.

#### FUNDING

The research was funded by National Institute of Health, Ministry of Health, Malaysia.

#### ETHICAL APPROVAL AND INFORMED CONSENT

The study was approved by the Malaysian Ministry of Health's Medical Research Ethical Committee [Approval number: NMRR-17-866=35234(IIR); Date: 24 July 2017]. Participants provided informed consent.

#### DATA AVAILABILITY

The data supporting this research are available from the authors on reasonable request.

#### PROVENANCE AND PEER REVIEW

Not commissioned; externally peer reviewed.