Original Investigation

Psychometric Properties and Construct Validity of the Brief Wisconsin Inventory of Smoking Dependence Motives in an Internet-Based Sample of Treatment-Seeking Hungarian Smokers

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Abstract

Introduction: Both full and brief versions of the Wisconsin Inventory of Smoking Dependence are promising new measurement tools for studying tobacco dependence. We assessed the psychometric properties and construct validity of the Wisconsin Inventory of Smoking Dependence Motives (WISDM)-68 and WISDM-37.

Methods: Participants were adult, treatment-seeking Hungarian daily smokers ($N = 720$) with Internet access who were also registered on a smoking cessation Web site. Using confirmatory factor analyses (CFAs), we tested the measurement models of both WISDM-68 and WISDM-37, internal consistency of subscales of WISDM-37, and gender invariance. We tested the associations between heaviness of smoking, tobacco dependence symptoms, smoking environment, and subscales of WISDM-37.

Results: Although the measurement model of WISDM-68 did not fit adequately, the measurement model of WISDM-37, including 11 correlating factors (affiliative attachment, automaticity, loss of control, cognitive enhancement, craving, cue exposure/associative processes, social/environmental goads, taste, tolerance, weight control, affective enhancement), satisfactorily represents the data. Latent structures are equal in both genders. Internal consistency of subscales of WISDM-37 ranges between 0.67 and 0.90. Tobacco dependence symptoms were significantly linked with all motives, heaviness of smoking was related significantly only to affiliative attachment, automaticity, loss of control, cognitive enhancement, craving, and tolerance, while tobacco dependence symptoms and gender were controlled. Gender was associated only with the weight control motive.

Conclusions: Concurring with previous reports using other types of sample, WISDM-37 has sufficient psychometric properties and good construct validity to make it useful in measuring the multidimensional nature of tobacco dependence even in Internet-based research. Without precedent, gender equality of WISDM-37 is also supported.

Introduction

Nicotine dependence is undoubtedly a crucial determinant of smoking (U.S. Department of Health and Human Services, 1988). Despite several theories and a large body of research, agreement is still needed on both the conceptualization of and the appropriate measurement model for nicotine dependence. Traditionally, there are two main approaches to nicotine dependence. The medicopsychiatric approach is based on the diagnostic criteria of *DSM-IV* (American Psychiatric Association, 2000). In this model, dependence is necessarily handled as a binary construct and provides only slight insights into the mechanism or structure of dependence (Piper, McCarthy, & Baker, 2006). The physical dependence approach handles nicotine dependence as a continuous variable. Well-known and frequently used measurements are related to this model such as the Fagerström Tolerance Questionnaire (FTQ; Fagerstrom & Schneider, 1989) and its revised version, the Fagerström Test for Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991). There are still, however, many psychometric concerns relating to the internal consistency (Etter, 2008) and the predictive validity (Sledjeski et al., 2007) of this measurement.

To identify fundamental dependence processes and to reflect on the deficiencies of previous approaches, Piper et al.

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(2004) have recently developed a new theoretically based measurement: the Wisconsin Inventory of Smoking Dependence Motives (WISDM). Unlike previous approaches, this model focuses on smoking motivations and handles nicotine dependence as a multidimensional construct. WISDM contains 13 motives, namely affiliative attachment, automaticity, loss of control, behavioral choice–melioration, cognitive enhancement, craving, cue exposure/associative processes, negative and positive reinforcement, social/environmental goads, taste–sensory properties, and tolerance and weight control. As the original paper (Piper et al., 2004) has revealed, WISDM subscales are appropriate for various populations. Others have also found excellent internal consistency in a sample of adult heavy smokers (Shenassa, Graham, Burdzovic, & Buka, 2009) and among pregnant women (Tombor, Urbán, Berkes, & Demetrovics, 2010). Although Shenassa et al. have supported the original latent factor structure, this 13-factor model was not confirmed in a sample of Hungarian university students who were essentially light smokers (Tombor & Urbán, 2010). Nevertheless, exploratory factor analysis supported the multidimensionality of smoking dependence motives in this young light smoker sample as well. Eight factors were identified, and seven factors were similar to the original ones, including loss of control, automaticity, social/environmental goads, weight control, cognitive enhancement, taste, and tolerance. The vast majority of further items were represented in one factor, which was named “smoking as coping.” We also observed several cross-loadings, which also explain the misfit of the data with the theoretical model.

Two new synthetic WISDM scales based on extensive psychometric analyses were proposed by Piper et al. (2008), including primary dependence motives consisting of automaticity, loss of control, craving, and tolerance subscales and secondary dependence motives summarizing nine subscales including positive and negative reinforcement, taste–sensory properties, behavioral choice–melioration, cognitive enhancement, affiliative attachment, weight control, cue exposure associative processes, and social–environmental goads.

WISDM subscales correlate moderately with FTND and with DSM-IV nicotine dependence symptom counts, suggesting good convergent validity of the test (Shenassa et al., 2009; Tombor & Urbán, 2010). Both convergent and discriminant validity of several nicotine dependence scales including WISDM are supported by Japuntich, Piper, Bolt, Schlam, and Baker (2009) by means of real-time data collection. Other research has demonstrated that primary dependence motives score has an incremental validity over FTND to predict self-administration of nicotine and present desire to smoke in an operant self-administration paradigm (Piasecki, Piper, & Baker, 2010). On the other hand, secondary dependence motives score also has incremental validity over FTND to predict the withdrawal symptoms and expectations for negative reinforcement (Piasecki et al., 2010).

Recognizing that the length of WISDM-68 decreases its applicability in many studies, Smith et al. (2010) have recently developed the Brief WISDM-37. They report that this 37-item inventory contains 11 subscales with adequate psychometric properties, such as appropriate internal consistency, good convergent validity, and predictive validity. Analyzing the data of three independent samples, they also provide evidence of good internal consistency of each subscale (p. 492), including affiliative attach-

ment ($\alpha = .83-.90$), automaticity ($\alpha = .89-.92$), loss of control ($\alpha = .77-.87$), cognitive enhancement ($\alpha = .88-.92$), craving ($\alpha = .80-.86$), cue exposure/associative processes ($\alpha = .68-.72$), social/environmental goads ($\alpha = .91-.94$), taste ($\alpha = .87-.91$), tolerance ($\alpha = .73-.85$), weight control ($\alpha = .84-.90$), and affective enhancement ($\alpha = .076-.78$). Nevertheless, further research is required to examine the psychometric properties and construct validity of the WISDM-37 in different populations and in different languages.

One of our main goals was to investigate the psychometric properties of WISDM-68 and WISDM-37 in an Internet-based sample of smokers. Internet-related smoking cessation services attract many smokers who are willing to quit, and therefore, it is important to evaluate the feasibility and validity of using psychometric scales tested in this context of administration. Our second goal was to provide data about the psychometric properties of the measurement model of WISDM-68 and WISDM-37 in another culture and in another language. Our third goal was to test the gender equivalence of the measurement models of smoking motives. Our fourth goal was to support the construct validity of these measurements in order to contribute to a better understanding of the processes underlying smoking behavior and to refine the nicotine dependence construct.

Methods

Procedure

Data were collected from those individuals who registered on a smoking cessation Web site (www.leszokasvonal.hu; www.quitline.hu) and wanted to be contacted later for proactive counseling in quitting smoking. Smokers were informed about this Web site by electronic and printed media communication and also leaflets in physicians' offices. Direct advertising was not used owing to budget limitations. The Web site is in Hungarian; therefore, smokers speaking Hungarian could register. There was no restriction regarding the accessibility of this service. When users first registered on the Web site, we also informed them that we would collect information for research purposes as well. According to the user's smoking status (daily smokers, nondaily smokers, ex-smokers, and nonsmokers), different questions were presented. The present study was approved by the Institution Review Board of Eötvös Loránd University, Hungary.

Participants

Seven hundred and eighty-four users completed the questionnaire on our Web site from September 15, 2009 until July 2010. Among them, 720 reported daily smoking, 21 reported nondaily smoking, 36 stated that they had quit smoking, and 7 announced that they never smoked. We included only daily smokers in the analysis because the low number of nondaily smokers in this sample (less than 3% of the total sample) does not adequately represent the nondaily smoker population. Therefore, our participants in the present analysis were 720 daily smokers (320 males and 400 females, mean age = 38.80 years, $SD = 12.02$).

Measures

Demographics and Smoking History

We collected information about the respondents' gender, age, education level, occupational status, cigarette consumption per

day, age at the first cigarette, number of previous quit attempts during the last twelve months, importance of quitting, self-efficacy about quitting, optimism about quitting, partner's smoking status, household smoking rules, and social support in quitting. We selected two indicators for smoking environment in the current analysis, namely presence of a smoking partner and household smoking rule. Presence of a smoking partner was binary coded (yes or no), and household rule was coded on a 4-point ordinal scale (smoking is not allowed in the house/home; in certain places, at certain times, smoking is allowed in the house/home; smoking is allowed anywhere in the house/home; there is no rule regarding smoking in the house/home).

Wisconsin Inventory of Smoking Dependence Motives

The development of this theoretically based questionnaire is described by Piper et al. (2004). The full version of WISDM (WISDM-68) contains 68 items with a 7-point Likert scale and 13 motives. Using the same 7-point Likert scale, the brief version of WISDM (Smith et al., 2010) contains 37 items and 11 motives. The scores are calculated by averaging the items of each scale. Although the Behavioral Choice–Melioration scale has been dropped, negative reinforcement and positive reinforcement have been contracted into a single subscale labeled affective enhancement. The second author of this report performed a translation/back-translation procedure of WISDM-68. Moreover, we received help from Megan Piper who compared the result of the back translation and the original scale and also provided clarification where mismatches in meaning occurred. Hungarian versions of both WISDM-68 and WISDM-37 are available from the second author of this report.

“Heaviness of Smoking Index (HSI)” (Heatherton, Kozlowski, Frecker, Rickert, & Robinson, 1989) measures the number of cigarettes smoked per day and the time from waking to the first cigarette of the day. The scale ranges from zero to six, where a higher score means a higher level of dependence. Internal consistency of this index varies ranges from 0.49 to 0.72 (Meneses-Gaya, Zuairi, Loureiro, & Crippa, 2009); the internal consistency is satisfactory (Cronbach's $\alpha = .61$) in the present sample.

“Tobacco Dependence Screener (TDS)” (Kawakami, Takatsuka, Inaba, & Shimizu, 1999) is a self-report questionnaire based on International Classification of Diseases (ICD-10), *DSM-III-R*, and *DSM-IV* dependence criteria. Each question asks about a symptom of nicotine dependence and should be answered with a dichotomous response category (i.e., yes or no). If the question was not applicable to the subject (e.g., a question on withdrawal symptoms for those who have never quit smoking), the subject was instructed to answer “no.” The sum of the score is the number of affirmative responses, and therefore, it generates a continuous score. No identified cutoff score for this questionnaire is available to distinguish dependent and nondependent smokers. The items in the TDS were translated to Hungarian and back-translated to English, and differences were resolved. Cronbach's α of this scale is .64 in this sample.

Data Analyses

In the first step in our analysis, confirmatory factor analyses (CFAs) were used to assess the factor structure and item performance of both WISDM-68 and WISDM-37. We also compared the degree of fit of two measurement models: one contains 11

correlating factors and the other includes further two second-order factors, which were called primary and secondary dependence motives (Piper et al., 2008). Our sample size is adequate for this type of analysis as it is larger than the recommended 10 cases per indicator (Brown, 2006).

Internal consistencies were assessed by Cronbach's α , which was considered satisfactory if the values were at least .70 (Nunnally & Bernstein, 1994). The evaluation of internal consistency also depends, however, on the number of items of the scale in question (Nunnally & Bernstein, 1994). In the case of a short scale with a low number of items, the criteria of internal consistency should be relaxed.

Testing structural and measurement invariance between men and women, we carried out a series of multigroup CFAs. Four nested models with increasing constraints were estimated: First, the measurement model was estimated freely in men and women. In this stage, factors were allowed to correlate freely. Second, the factor loadings and intercepts were set as equal between the genders. Third, the factor variances, and fourth, the correlations between the factors were set as equal in both groups.

In the next stage, we performed a CFA with covariates to test the association between smoking dependence motives, gender, two other indicators of nicotine dependence, and two indicators related to smoking environment. The CFA with covariates technique was chosen for the present study because it can estimate the effect of indicators and grouping variables (such as gender) on latent variables at the same time.

Descriptive analyses were performed with the SPSS 15.0 statistical software package (SPSS Inc., 2006). All SEM analyses were performed with Mplus 6.0. We performed all CFAs with maximum likelihood parameter estimates with SEs and chi-square test statistics that were robust to deviation from normal distribution (Muthén & Muthén, 1998–2007, p. 484).

In the CFAs, a satisfactory degree of fit requires the comparative fit index (CFI) and the Tucker–Lewis Index (TLI) to be close to 0.95, and the model should be rejected when these indices are <0.90 (Brown, 2006). The next fit index was root mean squared error of approximation (RMSEA). RMSEA below 0.05 indicates excellent fit, a value around 0.08 indicates adequate fit, and a value above 0.10 indicates poor fit. Closeness of model fit using RMSEA (CFit of RMSEA) is a statistical test (Browne & Cudek, 1993), which evaluates the statistical deviation of RMSEA from the value 0.05. Nonsignificant probability values ($p > .05$) indicate acceptable model fit, though some methodologists would require larger values such as $p > .50$ (Brown, 2006). The last fit index is the standardized root mean square residual (SRMR). An SRMR value below 0.08 is considered a good fit (Kline, 2005).

Results

Descriptive Statistics

The descriptive statistics of demographic and smoking-related variables are presented in Table 1. Daily smokers in our sample smoked 21.1 cigarettes/day ($SD = 10.7$), 56.3% of participants reported at least one quit attempt during the past twelve months,

Table 1. Demographics and Other Characteristics

	Total sample, N = 720	Males, N = 320	Females, N = 400	Statistics for gender difference
Demographics	Value			
Age, years, mean (<i>SD</i>)	38.80 (12.02)	35.87 (11.50)	41.23 (11.80)	$t = 5.36^{***}$
Gender (female, %)	55.6			
Education				
Less than high school (%)	24.5	28.8	19.3	$\chi^2 = 15.58^{**}$
High school graduate (%)	32.3	28.2	36.1	
Some college (%)	12.9	15.8	11.0	
College graduate or more (%)	30.3	27.2	33.6	
Employment				
Employed (%)	72.4	75.6	70.9	$\chi^2 = 13.91^{**}$
Unemployed (%)	10.3	7.0	13.0	
Student (%)	6.5	8.9	4.8	
Retired (%)	4.6	3.2	5.8	
Unable to work (%)	5.4	5.4	5.5	
Place of residence				
Budapest (%)	37.4	31.6	42.0	$\chi^2 = 8.28^{**}$
Other than Budapest (%)	62.6	68.4	58.0	
Smoking-related characteristics				
Cigarettes smoked daily, mean (<i>SD</i>)	21.1 (10.7)	22.4 (9.87)	20.1 (11.1)	$t = 2.90^{**}$
At least one quit attempt during the last twelve months (%)	56.3	60.6	52.8	$\chi^2 = 4.48^*$
Smoking onset at age 14 years or younger (%)	20.4	21.9	19.3	$\chi^2 = 0.73$
Heaviness of Smoking Index score, mean (<i>SD</i> ; possible range is 0–6)	3.46 (1.46)	3.55 (1.49)	3.39 (1.44)	$t = 1.44$
Tobacco Dependence Screener score, mean (<i>SD</i> ; possible range is 0–10)	7.23 (2.03)	7.07 (2.06)	7.36 (2.00)	$t = 1.92$
Living with a smoking partner (%)	40.7	40.3	41.0	$\chi^2 = 0.04$
Household smoking rules				
Smoking is not allowed in the house/home (%)	26.0	29.4	23.3	$\chi^2 = 4.00$
In certain places, at certain times, smoking is allowed in the house/home (%)	45.0	41.9	47.5	
Smoking is allowed anywhere in the house/home (%)	15.0	15.3	14.8	
There is no rule regarding smoking in the house/home (%)	14.0	13.4	14.5	
Readiness of quitting				
Ready to quit within the next thirty days (%)	60.4	66.9	55.8	$\chi^2 = 9.18^{**}$

Note. * $p < .05$; ** $p < .01$; *** $p < .001$.

and 40.7% of our participants lived with a smoking partner. The majority of our respondents (71%) reported some restrictions regarding household smoking. We found significant gender differences in several demographic variables, such as age, education level, employment status, and place of residence. Females were older, and a higher proportion of females than males had high school and college education. We also found gender differences in several smoking-related variables: Males smoked more cigarettes per day on average and were also more motivated to quit smoking since a higher proportion of males reported at least one quit attempt during the last twelve months. A higher proportion of males also stated readiness to quit smoking within 30 days.

Confirmatory Factor Analyses

The CFA of the original measurement model of WISDM (Piper et al., 2004) indicated inadequate fit with data ($\chi^2 = 7,408.4$, $df = 2132$, CFI = 0.0824, TLI = 0.811, RMSEA = 0.059, Cfit < .05; SRMR = 0.069). Modification indices highlighted several error

covariances and significant cross-loadings. Moreover, the latent variable covariance matrix was not positive definite owing to correlations close to 1.00 between some factors. Because specification searches based on modification indices are more likely to be successful when the model contains only minor misspecifications (Brown, 2006; MacCallum, 1986), we did not examine further the cross-loadings and error covariances, and we decided to test the shorter version, the brief version of WISDM.

With the brief version of WISDM, we performed a series of CFA with four models. The fit indices of these models are presented in Table 2. Model 1—a one-factor model—indicated inadequate fit, so we cannot support this measurement option. Model 2 with 11 first-order freely correlating factors and no error covariances yielded fit indices in the acceptable range. Model 3 includes 11 first-order freely correlating factors with the error covariances documented by Smith et al. (2010). This latter model yielded significantly better fit than earlier models. Finally, with Model 4, we also tested a model containing 11 first-order factors with the error covariances and 2 second-order factors, namely

Table 2. Degree of Model Fit of Four Competing Measurement Models of Brief Wisconsin Inventory of Smoking Dependence Motives.

	Description of the model	χ^2	df	CFI	TLI	RMSEA	Cfit of RMSEA	SRMR
Model 1	One-factor model	6521.2	629	.577	.552	.114	<.000	.102
Model 2	11 first-order factors	1772.7	574	.914	.900	.054	.011	.048
Model 3	11 first-order factors with error covariances	1528.9	570	.931	.920	.048	.807	.046
Model 4	11 first-order factors with error covariances and 2 second-order factors	1771.3	613	.917	.910	.051	.212	.059

Note. CFI = comparative fit index; RMSEA = root mean squared error of approximation; SRMR = standardized root mean square residual.

primary dependence motive and secondary dependence motive (Smith et al., 2010). This latter model also yielded fit indices in the acceptable range, but the indices are significantly lower than for Model 3 (Satorra–Bentler scaled χ^2 difference test = 198.9, $df = 43$, $p < .001$). Therefore, our data support best Model 3, which contains 11 first-order factors with four freely estimated error covariances (Items 9 and 54; Items 62 and 63; Items 6 and 28; and finally Items 47 and 63), although we cannot reject Model 4.

Detailed analysis of Model 3 demonstrated that all standardized factor loadings are above 0.62. All factor determinacies are above 0.92. Correlations between factors are presented in Table 3, and the range of correlations is between 0.15 and 0.94. Two correlations are higher than 0.90, which indicates limited discriminant validity between craving, loss of control, and tolerance scales. Internal consistencies of each scale are reported in Table 3. All scales have Cronbach's α higher than .80, with the exception of the cue exposure/associative processes scale.

Detailed analysis of Model 4 showed that all standardized factor loadings of primary dependence motives are above 0.80, and standardized loadings of secondary dependence motives range between 0.25 and 0.95. The correlation between the two second-order factors is 0.73. The inspection of modification indices reveals large correlations between social/environmental goads and cues and between tolerance and automaticity. Freeing these error covariances increased the model fit ($\chi^2 = 1,672.0$, $df = 610$, CFI = 0.924, TLI = 0.920, RMSEA = 0.049, Cfit of RMSEA = 0.658, SRMR = 0.057), but it is still significantly less adequate than for Model 3.

Multigroup CFA: Gender Differences

The measurement invariance (equal latent form, equal factor loadings, equal indicator intercepts, equal factor variances, and equal factor correlations) of the Brief WISDM was examined in men and women by use of multiple group CFA.

Table 3. Internal Consistencies and Estimated Means and Correlations of Smoking Dependence Motives as Latent Variables

Variables	1	2	3	4	5	6	7	8	9	10	11
WISDM-37 subscales											
1. Affiliative attachment											
2. Automaticity	.48										
3. Loss of control	.56	.77									
4. Cognitive enhancement	.55	.52	.55								
5. Craving	.53	.76	.94	.56							
6. Cue exposure/associative processes	.64	.71	.70	.65	.78						
7. Social/environmental goads	.22	.20	.18	.15	.22	.51					
8. Taste	.54	.42	.44	.52	.47	.61	.20				
9. Tolerance	.46	.85	.91	.54	.86	.67	.21	.40			
10. Weight control	.36	.20	.17	.39	.21	.38	.15	.26	.18		
11. Affective enhancement	.76	.56	.64	.76	.67	.74	.18	.69	.62	.46	
Nicotine dependence measures											
12. Tobacco Dependence Screener	.36	.39	.47	.36	.51	.44	.14	.23	.51	.18	.45
13. Heaviness of Smoking Index	.20	.47	.39	.24	.39	.24	.07	.11	.76	.08	.19
Mean ^a	3.03	4.57	5.01	3.95	5.00	4.29	3.83	3.88	4.98	3.05	4.07
SD	1.78	1.84	1.58	1.92	1.51	1.54	1.87	1.65	1.73	1.77	1.69
Cronbach's α	.84	.90	.85	.90	.86	.67	.86	.86	.82	.81	.82

Note. All correlations above .08 are significant at least $p < .05$. WISDM = Wisconsin Inventory of Smoking Dependence Motives.

^aSimple average of the items.

We estimated the model fit in both genders separately, which yielded an adequate degree of fit in both groups (males: $\chi^2 = 1,001$, $df = 570$, CFI = 0.923, TLI = 0.910, RMSEA = 0.050, Cfit of RMSEA = 0.498, SRMR = 0.055; females: $\chi^2 = 1,153$, $df = 570$, CFI = 0.923, TLI = 0.910, RMSEA = 0.051, Cfit of RMSEA = 0.315, SRMR = 0.051).

Four nested models with increasing constraints were estimated. The fit indices are reported in Table 4. First, the measurement model was estimated freely in men and women together. This unconstrained solution fitted the data satisfactorily. In the second model, the factor loadings and intercepts were set as equal between the genders. The degree of fit (χ^2) decreased significantly (Satorra–Bentler scaled χ^2 difference test = 71.8, $df = 52$, $p < .04$), but the other indices still remained in the acceptable range. In the third model, the factor variances were set as equal. The degree of fit (χ^2) decreased further significantly (Satorra–Bentler scaled χ^2 difference test = 20.41, $df = 11$, $p < .04$). In the fourth, the correlations between the factors were set as equal in both groups. The degree of fit (χ^2) did not change significantly (Satorra–Bentler scaled χ^2 difference test = 43.9, $df = 56$, $p > .05$); therefore, the correlations between factors are equal in men and women.

Concurrent Validity: CFA With Covariates

Before the estimation of the CFA with covariates model, we also examined the correlations between two smoking dependence motives and the number of nicotine dependence symptoms measured by TDS and heaviness of smoking measured by HSI. Table 3 presents the correlations. All 11 smoking dependence motives correlate significantly with both measures of nicotine dependence, and only the correlation between social/environmental goads and TDS was not significant.

In order to estimate the concurrent validity of smoking dependence motives, we estimated a CFA with covariates model. This model has two parts: a measurement and a structural model. The measurement model includes the smoking dependence motives, and the structural part contains the covariates, including gender, HSI, TDS, presence of smoking partner, and household smoking rule. The degree of model fit was adequate ($\chi^2 = 1,784.8$, $df = 700$, CFI = 0.923, TLI = 0.906, RMSEA = 0.046, Cfit of RMSEA = 0.987, SRMR = 0.046). The standardized regression coefficients are presented in Table 5.

Gender predicted only weight control motive, whereas TDS significantly predicted all motives, HSI predicted significantly

only affiliative attachment, automaticity, loss of control, cognitive enhancement, craving, and tolerance while TDS was controlled for.

Discussion

Our analysis confirmed the measurement model of the brief version of WISDM (WISDM-37), but the full version of WISDM (WISDM-68) was not confirmed in our Internet-based treatment-seeking Hungarian sample. Although WISDM-68 was validated in several studies with adult smokers (Piper et al., 2004; Shenassa et al., 2009), the misspecification of the WISDM-68 was observed by our research group in the present sample and in an independent sample of university students (Tombor & Urbán, 2010) as well. The source of the misfit was rooted in the large modification indices, which indicated several correlated errors and cross-loadings.

We could confirm the original measurement model of WISDM-37 (Smith et al., 2010), which contains 11 correlating factors and some correlated errors. Besides the shorter length, the other advantage of WISDM-37 over WISDM-68 is that it contains fewer factors that overlap in content and therefore decreases the chance of cross-loadings and model misspecification.

Internal consistencies of the WISDM-37 subscales are also satisfactory and comparable with those reported earlier (Smith et al., 2010), and similarly, cue exposure/associative processes have the lowest consistency among them. Therefore, the current study provides important data about smokers in another culture and in another language and also implies that this shorter inventory will be useful with smokers using Internet Web sites.

The previous research (Piper et al., 2008; Smith et al., 2010) suggested two higher order factors, namely primary and secondary dependence motives. Comparing two competing models, we found that 11 freely correlated factors model fitted the data significantly better than the alternative model, which implies two second-order factors. Even so, more refinement is needed in the second-order factor structure since the present analysis also documented that this model still has adequate fit indices indicating only minor misspecifications.

We also tested the gender invariance in the measurement model and found that latent structure is similar in both genders despite the different smoking rate and cessation motivation in men and women. The factor loadings and intercepts are not,

Table 4. Multigroup Analysis of Brief Wisconsin Inventory of Smoking Dependence Motives With Four Nested Models

	χ^2_{men}	χ^2_{women}	df	CFI	TLI	RMSEA	Cfit of RMSEA	SRMR
1. Unconstrained model	988.2	1168.0	1140	.923	.910	.051	.355	.053
2. Intercepts and factor loadings are constrained	1026.3	1201.0	1192	.922	.912	.050	.482	.054
3. Intercepts, factor loadings, and factor variances are constrained	1039.3	1211.8	1203	.921	.912	.050	.466	.060
4. Intercepts, factor loadings, factor variances, and factor covariances are constrained	1070.7	1231.4	1259	.921	.916	.049	.714	.062

Note. CFI = comparative fit index; RMSEA = root mean squared error of approximation; SRMR = standardized root mean square residual.

Table 5. Confirmatory Factor Analysis With Covariates Model: Predictors of Smoking Dependence Motives

Smoking dependence motives	Gender	TDS	HSI	Smoking partner	Household rules	R ²
1. Affiliative attachment	.02	.33***	.09*	-.07	.05	14.7%
2. Automaticity	.02	.27***	.36***	.01	.08*	29.6%
3. Loss of control	.00	.39***	.26***	-.05	.05	29.3%
4. Cognitive enhancement	.00	.31***	.13**	-.04	.06	15.2%
5. Craving	-.02	.43***	.24***	-.01	.03	31.8%
6. Cue exposure / associative processes	-.07	.42***	.07	.06	.08	22.2%
7. Social/environmental goads	-.06	.16**	-.05	.28***	.14**	11.8%
8. Taste	-.08	.22**	.04	-.02	-.01	6.1%
9. Tolerance	.01	.30***	.66***	-.01	.04	66.4%
10. Weight control	.14***	.16***	.05	-.01	-.02	5.3%
11. Affective enhancement	.04	.43***	.05	-.02	.01	20.7%

Note. HSI: Heaviness of smoking index; TDS: Tobacco Dependence Screener. This table contains partial regression coefficients.

* $p < .05$; ** $p < .01$; *** $p < .001$.

however, invariant. Correlations between factors and the mean of factors are equal, with the exception of the weight control motive, which is significantly higher in females. A large amount of research has documented that women put more emphasis on weight control aspects of smoking (U.S. Department of Health and Human Services, 2001). We are not aware of any other study, which tested the gender invariance of the measurement model of WISDM-37. Based on this measurement invariance, further research could examine if the smoking motives have different influence on smoking cessation outcomes in men and women.

The mostly endorsed motives were tolerance, loss of control, craving, tolerance, and automaticity. The least endorsed motives were weight control and affiliative attachment motives. The similar patterns were found with the WISDM-68. For example, in three independent samples, the mostly endorse motives were the tolerance, the craving, the automaticity, and the loss of control (Smith et al., 2010). In these samples—similarly to our results—weight control and the affiliative attachment were the least endorsed motives.

Subsequently, we tested the association of the subscales of WISDM-37 with smoking heaviness, number of tobacco dependence symptoms, and the presence of smoking partner and household smoking. In this study, the size of correlations between subscales and validity measures of nicotine dependence was similar to the size of the correlations reported by Smith et al. (2010). The current multivariate analysis differed from the previous ones because we applied a CFA with covariates model, which provided the opportunity to estimate each association in one model while controlling for other predictor variables included in the model. Tobacco dependence symptoms and heaviness of smoking were associated significantly with smoking dependence motives; however, when we controlled for tobacco dependence, heaviness of smoking had a relatively large incremental association with four subscales only, including automaticity, craving, loss of control, and tolerance. This result supports the finding that these subscales from WISDM-68, in contrast to other scales, tended to have a stronger link with dependence criteria measured by HSI (Piper et al., 2008). Similarly to our results, in another research using WISDM-68, craving, cue exposure

associative processes, and tolerance explained large proportion of variance in DSM-IV criteria of dependence (Piper et al., 2004). In this research, we also identified two other subscales (cognitive enhancement and affiliative attachment), which have much weaker, though significant, association with heaviness of smoking while tobacco dependence is controlled for.

This study tested the associations between smoking motives and two components of smoking environment. We used two indicators for environment namely having a smoking partner and the household rule of smoking. The presence of a smoking partner and the household rule of smoking were associated only with the social/environmental goads subscale, which supports the divergent validity of this subscale and also highlights the importance of environmental factors within the smoking motives. There is only one study that tested the household rule of smoking and found that both primary and secondary smoking motives predicted lower likelihood of having household smoking restriction (Piper et al., 2008).

Our study has several strengths and limitations. Using Internet-based sampling may have had inherent selection biases toward a younger and better educated sample of smokers. Moreover, owing to this sampling, we could not use biological verification of smoking heaviness, and we therefore had to base our research solely on self-reports. Another limitation of this study is that the analyses of WISDM-68 and WISDM-37 are based on administration of WISDM-68 in a similar way to the other report by Smith et al. (2010). The third limitation is that the present sample involves daily smokers, and therefore, the factor structure of WISDM-37 could not be tested in light smokers. External validity of the present study is limited to daily smokers. Analyzing the data from daily smokers also limits the variances of the study variables related to nicotine dependence; consequently, the covariances between study variables are underestimated; therefore, the associations between study variables may be weaker than we detected.

This study demonstrated the usefulness and feasibility of the administration of WISDM in Internet-based research and supported the construct validity of the brief version of WISDM in a

treatment-seeking Hungarian sample of smokers with access to the Internet. We also demonstrated the gender equality in structure of measurement model of WISDM-37. This research also provides evidence of the construct validity of the WISDM-37. A further question is how, with greater understanding of smoking dependence motives, we could improve outreach to smokers in terms of interventions and the effectiveness of in-person, telephone, and Internet-based smoking cessation counseling. Improving the efficacy of smoking cessation services with the knowledge of individual patterns of smoking dependence motives would be a promising application of the construct of smoking dependence motives.

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Declaration of Interests

None declared.

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