#### Methods of smoking cessation and factors influencing effectiveness of the cessation

process

PhD thesis

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According to the WHO there are approximately 1,5 Billion daily smoker worldwide. Yearly more than five million people die prematurely from tobacco use worldwide, this number will probably reach 10 Million by 2025. The toll of tobacco use and the enormous health and economic burden it imposes on individuals and society will continue to rise worldwide and up to half of all persistent tobacco users will die prematurely.

According to a WHO reaserch from 2006 the most important risk factor for both Hungarian men and women is cigarette smoking. Tobacco use is a known cause of cardiovascular diseases, multiple cancers, COPD and several others (osteoporosis, impotence etc.)

Quitting leads to several benefits on health even after smoking cigarettes for several years.

Anti-tobacco programs are very important for both on individual and populational level. In order to reach this goal several tools such as raising taxes, ban on advertising, information sharing, offering cesaation etc. should be used.

Recently the basis of a smoking cessation network has been established in Hungary. In order to use proper intervention tools we need to know the motivation elements of starting and continuing smoking, and the personal differences in this matter.

The factors that may contribute to addictive behaviors include neuroadaptations that occur with the persistent use of nicotine, withdrawal symptoms experienced when intake of the drug is stopped, and the effects of nicotine that reinforce dependence. The primary reinforcing effects can entail the rewarding effects of nicotine (positive reinforcement) and/or the alleviation of aversive or negative states or stimuli— for example, relief from withdrawal symptoms (negative reinforcement). Nicotine addiction besides the physical dependence also includes all the complex biological, psychological and social process which ends up in everyday smoking. Could be concluded that not only the physical dependence should be assessed but also the motivational background of smoking.

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There are two approaches in the measurement of nicotine dependence. The first approach examines physical dependence and tolerance, the most widely known and used tool is Fagerstrom Tolerance Questionnaire, or its modified version Fagerström Test for Nicotine Dependence, these measurement tools look at dependence like a continuous variable. The other approach is the medical-psychiatric approach, which is based on the DSM-IV criterion system, in which dependence is a dichotomic structure.

The criticism of both measurement tools says that from the psychometric point of view these are not sufficient, do not describe the whole spectrum of nicotine dependence. Their asset is in their shortness and thatthey measure the heaviness of smoking directly.

The starting point of the motivational approach is that different reasons are in the background of smoking, so different motivations could be found at each smoker. In this theory motivational factors are crucial in the explanation of dependence, nicoitne dependence is multidimensional. This theory could be very useful in the explanation of starting smoking, and in the descreption of the differences between smokers.

From the practical point of view knowing the motivation is espacially important if the fact is taken into account that pharmacotherapeutic methods are succesful only at a bit more than one third of smokers. Which motivational and other factors play role in refusing quit attempts or explain unsucces at 60% of smokers?

Unlike previous approaches, the motivational model focuses on smoking motivations and handles nicotine dependence as a multidimensional construct. The different dimensions describe different motivational factors. The developers of this theoretically-based measurment treat dependence as a marker of the strength of the motavtional basis, number and variablity of motivational factors. The Wisconsin Inventory of Smoking Dependence Motives (WISDM) contains thirteen 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, Tolerance and Weight Control. The intensity of presence of each factor correlates with difficulties in quitting, which means higher level of dependence. WISDM subscales correlate moderately with FTND and with DSM-IV nicotine dependence symptom counts

Certain motivational factors could be determining in different smoking status (heavy smokers: craving, tolerance, loss of control).

## Objectives

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 support the construct validity of these measurements in order to contribute to a better understanding of the processes underlying smoking behaviour and to refine the nicotine dependence construct.

# Methods

#### Procedure

Data were collected from those individuals who registered on a smoking cessation website (www.leszokasvonal.hu [www.quitline.hu]) and wanted to be contacted later for proactive counselling in quitting smoking. Smokers were informed about this website by electronic and printed media communication and also leaflets in physicians' offices. Direct advertising was not used owing to budget limitations. The website 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 website, we also informed them that we would collect information for research purposes as well. According to the user's smoking status (daily smokers, non-daily smokers, ex-smokers and non-smokers), 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 website from 15 September 2009 until July 2010. Among them 720 reported daily smoking, 21 reported nondaily smoking, 36 stated that they had quit smoking, and seven announced that they never smoked. We included only daily smokers in the analysis because the low number of non-daily smokers in this sample (less than 3 % of the total sample) does not adequately represent the non-daily smoker population. Therefore our participants in the present analysis were 720 daily smokers (320 males, 400 females, mean age=38.80 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 four-point ordinal scale (smoking is not allowed in the house/home; in certain places, at certain times smoking is allowed in the house/home; there is no rule regarding smoking in the house/home).

*Wisconsin Inventory of Smoking Dependence Motives:* The full version of WISDM (WISDM-68) contains 68 items with a seven-point Likert scale and thirteen motives. Using the same seven-point Likert scale, the brief version of WISDM contains 37 items and eleven motives. The scores are calculated by averaging the items of each scale. A translation/back-translation procedure was performed 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.

*Heaviness of Smoking Index* 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.

Tobacco Dependence Screener is a self-report questionnaire based on 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). The items in the Tobacco Dependence Screener were translated to Hungarian and backtranslated to English, and differences were resolved.

## Data analyses

In the first step in our analysis, confirmatory factor analyses 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 eleven correlating factors and the other includes further two second-order factors which were called primary and secondary dependence motives. Our sample size is adequate for this type of analysis as it is larger than the recommended ten cases per indicator.

Internal consistencies were assessed by Cronbach's  $\alpha$ , which was considered satisfactory if the values were at least 0.70. The evaluation of internal consistency also depends, however, on the number of items of the scale in question. 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 multi-group confirmatory factor analyses. 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 confirmatory factor analysis 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 confirmatory factor analysis 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. All SEM analyses were performed with Mplus 6.0. We performed all CFAs with maximum likelihood parameter estimates with standard errors and chi-square test statistics that were robust to deviation from normal distribution.

In the CFAs, a satisfactory degree of fit requires the CFI and the Tucker-Lewis Index to be close to 0.95, and the model should be rejected when these indices are <0.90. The next fit index was 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 which evaluates the statistical deviation of RMSEA from the value 0.05. Non-significant probability values (p>.05) indicate acceptable model fit, though some methodologists would require larger values such as p>.50. The last fit index is

the standardized root mean square residual (SRMR). An SRMR value below 0.08 is considered a good fit.

Results

# Descriptive statistics

Daily smokers in the sample smoke 21.1 cigarettes per day (SD=10.7), 56.3 % of participants reported at least one quit attempt during the past twelve months and 40.7 % of our participants live 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 are older and a higher proportion of females than males have high school and college education. We also found gender differences in several smoking-related variables: males smoke more cigarettes per day on average, and are 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 confirmatory factor analysis of the original measurement model of WISDM indicated inadequate fit with data ( $\chi 2=7408.4$  df=2132; CFI=.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, 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. Model 1 – a one-factor model – indicated inadequate fit, so we cannot support this measurement option. Model 2 with eleven first-order freely correlating factors and no error covariances yielded fit indices in the acceptable range. Model 3 includes eleven first-order freely correlating factors with the error covariances. This latter model yielded significantly better fit than earlier models. Finally, with Model 4 we also tested a model containing eleven first-order factors with the error covariances and two second-order factors, namely Primary Dependence Motive and Secondary Dependence Motive. This latter model also yielded fit indices in the acceptable range, but the indices are significantly lower than for Model 3

(Satorra-Bentler scaled  $\chi^2$ difference test =198.9 df=43 p<.001). Therefore our data support best Model 3 which contains eleven first-order factors with four freely estimated error covariances (items 9 and 54; items 62 and 63; items 6 and 28; 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. 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. All scales have Cronbach's  $\alpha$  higher than 0.80, 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 ( $\chi 2$ =1672.0 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.

## Multi-group 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 Wisconsin Inventory of Smoking Dependence Motives was examined in men and women by use of multiple-group CFA. The model fit was estimated in both genders separately, which yielded an adequate degree of fit in both groups (males:  $\chi 2=1001$  df=570; CFI=0.923, TLI=0.910, RMSEA=0.050, Cfit of RMSEA=0.498, SRMR=0.055; females:  $\chi 2=1153$  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. 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 ( $\chi^2$ ) decreased significantly (Satorra-Bentler scaled  $\chi^2$ 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 ( $\chi^2$ ) decreased further significantly (Satorra-Bentler scaled  $\chi^2$ 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 ( $\chi^2$ ) did not change significantly (Satorra-Bentler scaled  $\chi^2$  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. All eleven 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, heaviness of smoking index, tobacco dependence screener, presence of smoking partner and household smoking rule. The degree of model fit was adequate ( $\chi$ 2=1784.8 df=700; CFI=0.923, TLI=0.906, RMSEA=0.046, Cfit of RMSEA=0.987, SRMR=0.046).

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

The analysis presented in the dissertation 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. The source of the misfit is rooted in the large modification indices which indicate several correlated errors and cross-loadings.

The original measurement model of WISDM-37 which contains eleven correlating factors and some correlated errors was confirmed in the thesis. 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, and similarly cue exposure/associative processes has the lowest

consistency among them. Therefore the dissertation 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 websites.

The previous research suggested two higher-order factors, namely primary and secondary dependence motives. Comparing two competing models, we found that eleven 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.

The gender invariance was also tested in the measurement model, and found that latent structure is similar in both genders. The factor loadings and intercepts are not, 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

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. The current analysis differs from the previous ones in that, as well as the analysis of correlations, we applied a CFA with covariates model which provides 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, in contrast to other scales, tended to have a stronger link with dependence criteria measured by heaviness of smoking index. 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.

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.

The dissertation demonstrates 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. The thesis also demonstrated the gender equality in structure of measurement model of WISDM-37. This research also provides evidence of the construct validity of the WISD-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 counselling. Improving the efficacy of smoking cessation services with the knowledge of individual patterns of smoking dependence motives.

#### List of publication

## Publications relevant to the thesis:

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