Addictive Behaviors 147 (2023) 107833

Contents lists available at ScienceDirect

Addictive Behaviors

journal homepage: www.elsevier.com/locate/addictbeh

Psychometric properties and factor structure of the brief Wisconsin Inventory of Smoking Dependence Motives among Spanish smokers from the general population

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ARTICLE INFO

Keywords:
Nicotine dependence
Tobacco
Smoking motives
Psychometric properties
Smoker
Spanish

ABSTRACT

Introduction: The brief version of the Wisconsin Inventory of Smoking Dependence Motives (B-WISDM) is a well-established instrument to measure the multidimensional nature of nicotine dependence. However, no previous research has assessed its psychometric properties in the Spanish context. The aim of the present study was to analyze the factor structure and measurement invariance across gender of this instrument among Spanish smokers from the general population.

Methods: This cross-sectional study assessed 480 smokers through an online questionnaire including information on tobacco use and several nicotine dependence measures. Confirmatory Factor Analysis was used to assess the factorial structure of the Spanish B-WISDM, its internal consistency, measurement invariance across gender and convergent validity with the Fagerström Test for Nicotine Dependence (FTND) and the Glover-Nilsson Smoking Behavioral Questionnaire (GN-SBQ) scores.

Results: Results indicate that the eleven correlated factors solution had a better fit when compared to the other tested models (two correlated factors and two second-order factors with eleven first-order correlated factors solution), remaining such structure invariant across gender. Internal consistency of the scale was high (α = 0.950; dimension α values ranged between 0.657 and 0.921). Overall scores and dimensions of the scale significantly and positively correlated with other nicotine dependence measures (except for Social/Environmental Goads and FTND).

Conclusions: This is the first version of the B-WISDM validated to assess nicotine dependence with a multidimensional perspective within the Spanish culture. Results show adequate psychometric properties regarding its factor structure and measurement invariance across gender, supporting its utility to evaluate the motives driving tobacco use among Spanish smokers from the general population.

1. Introduction

Nicotine dependence (ND) is a complex phenomenon that goes well beyond cigarette use since the vulnerability to such addictive behavior varies among smokers, with reasons for these disparities being multidimensional (Le Foll et al., 2022; Martínez-Ortega, Jurado, & Gurpegui, 2008). Nonetheless, diagnosis of ND has been sometimes misused assuming that all daily smokers are nicotine dependent (Hughes, 2001) or even conceptualizing this construct as dichotomous (dependence vs. non-dependence) (Piper, McCarthy, & Baker, 2006), therefore disregarding the additional parameters that account for its multidimensionality (Adkison, Rees, Bansal-Travers, Hatsukami, & O'Connor, 2016; Hughes et al., 2004; Le Foll et al., 2022; Piper et al., 2004). For instance, it is well known that ND is manifested through the core symptoms of addiction such as withdrawal, tolerance, or continued use despite physical and psychological negative consequences, among others (Adkison et al., 2016; Le Foll et al., 2022). In addition, researchers and clinicians should explore the smoker's motivations to initiate and

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https://doi.org/10.1016/j.addbeh.2023.107833
Received 22 April 2023; Received in revised form 27 July 2023; Accepted 9 August 2023
Available online 10 August 2023

maintain tobacco use, as well as to relapse after several quitting attempts (Adkison et al., 2016; Piasecki, Piper, & Baker, 2010; Piasecki, Piper, Baker, & Hunt-Carter, 2011; Piper et al., 2004).

Multiple instruments have been developed to evaluate ND such as the Glover-Nilsson Smoking Behavioral Questionnaire (GN-SBQ) (Glover et al., 2005), the Nicotine Dependence Syndrome Scale (NDSS) (Shiffman, Waters, & Hickcox, 2004) or the Fagerström Test for Nicotine Dependence (FTND) (Heatherton, Kozlowski, Frecker, & Fagerström, 1991). However, these questionnaires do not account for the multiple factors included in the multidimensional construct of ND. For example, the FTND represents the widely most self-reported used questionnaire to measure ND. Nonetheless, the FTND does not cover relevant features of dependence such as the difficulties in controlling tobacco use, unsuccessful efforts to quit smoking or withdrawal symptomatology (Etter, 2005; Pérez-Ríos et al., 2009). Therefore, additional screening instruments measuring such features are needed, as well as their appropriate validation with clinical and nonclinical samples of smokers, in line with previous research (Adkison et al., 2016).

In this regard, the Wisconsin Inventory of Smoking Dependence Motives (WISDM-68; Piper et al., 2004) offers the advantage of evaluating the underlying motives and mechanisms of ND. This scale conceptualizes ND as a result not only of internal states, behaviors and contextual influences, but also as an individual's disposition (motivation) to respond to them by using substances (Piper et al., 2004). However, despite its high internal consistency (Parrott et al., 2015; Shenassa, Graham, Burdzovic, & Buka, 2009; Tombor, Urbán, Berkes, & Demetrovics, 2010), a 37-item Brief WISDM (B-WISDM) (Smith et al., 2010) has been developed to overcome the burden associated with the length of the original version. The B-WISDM includes 11 motivational domains accounting for the physical, psychological, and social dimensions of ND reorganized in two distinct scales: Primary Dependence Motives (PDM) and Secondary Dependence Motives (SDM).

So far, there is a paucity of studies analyzing the psychometric properties of the B-WISDM, and no consensus exists with regards to its factor structure (Adkison et al., 2016), highlighting the necessity of continuing to explore which is the most appropriate structure. On one hand, most studies (Ma, Li, & Payne, 2012; Mauduy, Mauny, & Beaunieux, 2023; Pancani et al., 2015; Vajer, Urbán, Tombor, Stauder, & Kalabay, 2011) have shown that the eleven first-order correlated factors accounted for the best fit for the data, supporting the original model proposed by Smith et al. (2010). On the other hand, other authors have proposed different models such as a two second-order factors (PDM and SDM) with eleven first-order factors solution among a nonclinical sample of U.S. adults (e.g., Adkison et al., 2016). Furthermore, hardly any study has assessed measurement invariance of the B-WISDM and, in fact, only two studies have explored such invariance by gender (Mauduy et al., 2023, Vajer et al., 2011) and by type of smoker (Mauduy et al., 2023), showing that the factorial structure remains invariant. In this sense, it would be necessary to evaluate whether the Spanish version of the scale is sensitive to gender differences in the motives leading Spanish smokers to initiate and maintain their smoking behavior. This information would be essential in order to design preventive and intervention programs accounting for the specific motives of ND among male and female Spanish smokers.

The B-WISDM has been adapted to different languages and sociocultural contexts, giving rise to different versions in Hungarian (Vajer et al., 2011), in Italian (Pancani et al., 2014), in French (Mauduy et al., 2023) and in English, with African- and European-American heavy smokers (Ma et al., 2012). To our knowledge, however, no previous study has assessed the psychometric properties of the B-WISDM among the Spanish population. In fact, only one previous study has used a Spanish-speaking sample of Latino smokers, being the only exception. This was carried out by Castro et al. (2014) across three independent samples of Latino smokers in United States, with the authors being unable to replicate the original structure of the scale. This study highlights several limitations that need to be overcome regarding the translation process, such as the need of using focus groups of smokers or independent translations. Because of this, the adaptation of this scale to the Spanish cultural context seems essential in order to provide Spanish clinicians and researchers with an instrument that assesses the underlying motives and mechanisms that could explain ND among Spanish smokers from the general population. Overall, this psychometric analysis of the Spanish B-WISDM will allow us to overcome some of the precedent mentioned shortcomings, as well as to fill the gap of such tools not being available in languages other than English to evaluate ND in all its complexity (Castro et al., 2014).

Consequently, the goal of the present study was to analyze the psychometric properties of the Spanish version of the B-WISDM among a sample of tobacco smokers from the general population, including its factor structure and measurement invariance by gender, following the international guidelines for adapting tools across different cultures (Hambleton & Zenisky, 2011; Muñiz, Elosua, & Hambleton, 2013).

2. Methods

2.1. Participants and procedure

A sample of Spanish-speaking smokers from the general population were recruited via a non-probabilistic sampling method. Data was collected using Qualtrics® XM and an online questionnaire was advertised through multiple social networking sites and applications (Facebook, Instagram, Twitter, WhatsApp, etc.). Moreover, the study was posted on electronic bulletin boards of local associations and universities. The questionnaire was also sent via email to other colleagues and institutions for its dissemination among other target participants (college students, relatives, friends, etc.) from the general population, therefore using the snowball method. Participants were included if they reported: (i) current smoking behavior and (ii) having smoked at least 100 cigarettes in their lifetime. Participants were excluded if they (i) provided incomplete questionnaires. After signing the informed consent, participants completed the questionnaire. Participation in the study was rewarded with the inclusion in a raffle of a 50€ shopping voucher. The study protocol was approved by the Institutional Review Board of *Universidad Loyola Andalucía* (Code ULA-2020.01.20).

The initial sample consisted of 819 smokers aged 18–65 years old. Overall, 339 participants were excluded due to (1) completing their questionnaire in less than 5 min (n = 180), giving rise to the possible risk of having been filled out erratically or randomly; (2) providing incomplete questionnaires, not having filled out at least 70% of the survey (n = 56); (3) not completing the B-WISDM in their assessments (n = 31), making it impossible to consider their participation in this research; (4) reporting not having used more than 100 cigarettes in their lifetime (n = 45); (5) falling out of the selected age range (18–65 years; n = 13); and (6) not signing the informed consent (n = 14). The final sample consisted of 480 smokers (63.1% females; mean age = 32.42 years, *SD* = 11.79).

2.2. Measures

2.2.1. Sociodemographic information and tobacco use

Information was collected regarding participant's age, gender, marital status, education, and employment status. Information regarding their smoking pattern was collected through specific questions about the mean number of cigarettes smoked per day, years of regular smoking and previous quit attempts.

2.2.2. Nicotine dependence instruments

The *Brief Wisconsin Inventory of Smoking Dependence Motives (B-WISDM)* is the brief version (Smith et al., 2010) of the WISDM-68 developed by Piper et al. (2004). It includes 37 items loading onto 11 subscales with a 7-point Likert scale response format (ranging from 1 = *Not true of me at all* to 7 = *Extremely true of me*). Scores are obtained by averaging the items of each subscale, and the total score represents the

sum of means for the 11 subscales. Following guidelines by Piper et al. (2008), Smith et al. (2010) conceptualized two different higher order factors: (1) PDM (mean of Automaticity, Craving, Loss of control, and Tolerance); and (2) SDM (mean of Affiliative Attachment, Cognitive Enhancement, Cue Exposure/Associative Processes, Social/Environmental Goads, Taste, Weight Control and Affective Enhancement). The PDM encompasses the core characteristics of tobacco consumption and is highly associated with traditional ND, whereas the SDM scale includes both the instrumental and context-bound effects of smoking (Smith et al., 2010).

In the present study, the original version of the 37-item B-WISDM (Smith et al., 2010) was translated and back-translated into Spanish following the recommendations by Hambleton and Zenisky (2011) and the guidelines established by the International Test Commission (Muñiz et al., 2013). Following the guidelines established by Vaughn, Schumm, and Sinagub (1996), a focus group of three facilitators and seven frequent smokers (four females and three males) checked the scale for its adequacy, understandability, and clarity (see supplementary material for the Spanish version of the scale).

Fagerström Test for Nicotine Dependence (FTND). This six-item scale was developed by Heatherton et al. (1991) and adapted into Spanish by Becoña and Vázquez (1998). The FTND evaluates ND through different questions answered using yes/no (1–0) responses and scores ranging between 0 and 3 points. Cronbach's alpha coefficient for the Spanish adaptation (Becoña & Vázquez, 1998) was 0.66, whereas in the present study an alpha of 0.69 was obtained.

Glover-Nilsson Smoking Behavioral Questionnaire (GN-SBQ). This questionnaire developed by Glover et al. (2005) focuses on behavioral patterns involved in ND. The GN-SBQ includes 11 items with a Likert-format response between 0 (not at all/never) and 4 (extremely so/always). The Spanish version created by Nerín et al. (2005) was administered (Cronbach's alpha coefficient not provided; alpha of original scale = 0.82, as stated by Rath, Sharma, and Beck (2013)), showing a reliability coefficient of 0.84.

2.3. Data analysis

All analyses were carried out using SPSS 26.0 and EQS 6.1 software. Firstly, exploratory analyses were carried out to detect extreme values or missing data. No participant was eliminated from the analysis due to this circumstance. Secondly, normality was evaluated using Kolmogorov-Smirnov test (univariate normality) and Mardia test (multivariate normality). In both cases the fulfillment of this assumption could not be assumed. At a descriptive level, the asymmetry and kurtosis indicators and the analysis of each B-WISDM item's floor and ceiling effect were explored.

Confirmatory Factor Analysis (CFA) was carried out with the Robust Maximum Likelihood method to study the evidence of validity based on the internal structure of the scale. Since there is no consensus in the available literature with regards to the factor structure of the scale, those models with the strongest theoretical support were tested: (a) the original scale proposed by Smith et al. (2010), including an eleven correlated factors solution. These authors have reported good internal consistency, high concurrent and predictive validity as well as appropriate long-term stability of this version (Smith et al., 2010); (b) two second-order factors with eleven first-order correlated factors solution, therefore including the primary (PDM) and secondary (SDM) second-order factors reported in the literature (see Piper et al., 2008) and (c) two correlated factors solution (PDM and SDM; see Mauduy et al., 2023). These studies have yielded in mixed results with regards to such models and, therefore, it is necessary to assess whether some of these models show a better fit in our sample of Spanish smokers than the original one.

Following Alavi et al. (2020) indications, the indices used to evaluate the model fit were: the Satorra-Bentler goodness-of-fit statistic χ^2 (χ^2S-B), the Comparative Fit Index (CFI), the Non-Normalized Fit Index (NNFI), the Root Mean Square Error of Approximation (RMSEA) and Standardized Root Mean Squared Residual (SRMR). CFI and NNFI values above 0.90 are indicative of acceptable fit (McDonald & Ho, 2002). However, Hu and Bentler (1999) recommend values $\geq$ 0.95. For RMSEA and SRMR indices, values close to 0.08 and lower than 0.05 are also indicative of a good fit (Hu & Bentler, 1999). Considering the model with the best fit, the internal consistency of the total scale and its dimensions were evaluated providing item-test correlations and Cronbach's alpha coefficient. Additionally, analyses of Factorial Invariance (FI) across gender were carried out. Following Byrne (2008), FI was progressively tested at different levels: configural, weak, strong, and strict. An increase in CFI higher than 0.01 was considered an indicator of a significant change in the model (Cheung & Rensvold, 2002). Finally, to assess the validity or the B-WISDM scale scores concerning other variables, Spearman correlations were used.

3. Results

3.1. Sample characteristics

Descriptive statistics (see Table 1) showed that most smokers were single (64.8%), employed (52.2%) and had finished Bachelor's, Master's or Doctorate (Ph.D.) studies (44.6%). Participants smoked an average of 10.10 cigarettes per day (SD = 8.85), reported 13.92 years of regular smoking (SD = 10.85) and 2.02 quit attempts (SD = 2.58). Mean FTND scores were between low to medium ND levels (M = 3.14; SD = 2.45) and GN-SBQ scores were in the moderate range of ND (M = 15.78; SD = 7.77). No statistically significant differences were found in any of the sociodemographic or smoking variables, except for employment status (χ^2 (6, n = 479) = 19.701, p = .003).

3.2. Item analysis of the Spanish version of B-WISDM

Descriptive analyses of each item are shown in Table 2 (see also Supplementary Tables 1 and 2 for the descriptive analyses by gender). To assess both the floor and ceiling effects (Ware & Gandek, 1998), the percentage of responses with a value of 1 (the lowest score on the instrument) and a value of 7 (the highest score) were calculated. Considering the entire sample, Item 22 showed the lowest score on the B-WISDM scale (M = 1.78; SD = 1.52) and, conversely, Item 24 obtained the highest score (M = 4.61; SD = 1.88). Distribution of the B-WISDM scores regarding the asymmetry values ranged from −0.47 to 2.03, and kurtosis values ranged from −1.69 to 3.28. Most of the items (75.7%) showed a floor effect (i.e., percentages were above 15%), and some of them (29.7%) also presented a ceiling effect (see Table 2).

Regarding the descriptive statistics of the B-WISDM's dimensions in the total sample (see Table 3), dimension 1 (Affiliative Attachment) showed the lowest score (M = 2.10; SD = 1.49), while dimension 7 (Social/ Environmental Goads) obtained the highest score (M = 4.26; SD = 1.86). Similar results were obtained in female participants (Affiliative Attachment: M = 2.13; SD = 1.61; Social/ Environmental Goads: M = 4.41; SD = 1.94). However, in male participants, dimension 8 (Taste) scored the highest (M = 4.11; DT = 1.69) and dimension 10 (Weight Control) the lowest (M = 1.90; DT = 1.25).

Altogether, the average scale score in the total sample was 36.69 (SD = 12.60), and the PDM and SDM scores were 3.56 (SD = 1.59) and 3.21 (SD = 1.04), respectively. Similar results were obtained by gender (see Table 3) with no statistically significant differences (p > 0.05 in all cases).

3.3. Confirmatory factor analysis

Results of each analyzed model (see Supplementary Table 3) demonstrated that the first option (eleven correlated factors solution) resulted in the best fit for the data (χ^2S-B = 1201.68; CFI = 0.943; NNFI = 0.934; RMSEA = 0.048 [0.044, 0.052]; SRMR = 0.045) compared to

Table 1
Sociodemographic and smoking characteristics of the sample.

	Total sample (N = 480)	Males (n = 177)	Females (n = 303)	Gender differences (statistical analyses)
Age (years, M/SD)	32.42 (11.79)	33.08 (12.16)	32.05 (11.59)	t (474) = 0.921
Education (%)				χ^2 (n = 480) = 3.498
No education	0.4	0.2	0.2	
Up to Secondary Education	32.3	12.3	20.1	
Vocational Education and Training (Basic)	11.2	3.7	7.5	
Vocational Education and Training (Higher)	11.5	3.8	7.7	
Bachelor's Degree	30.4	12.5	17.9	
Master's Degrees/Doctorate (Ph. D.)	14.2	4.4	9.8	
Marital status (%)				χ^2 (n = 480) = 0.398
Single	64.8	23.8	41.0	
Married	27.7	10.6	17.1	
Separated/Divorced	7.5	2.5	5	
Employment (%)				χ^2 (n = 479) = 19.701*
Employed (full time)	38.4	18.0	20.4	
Employed (partial time)	13.8	4.6	9.2	
Unemployed	15	4.6	10.4	
Student	28.4	9.2	19.2	
Housewife	3.1	0.0	5.0	
Retired	1.3	0.65	0.65	
Tobacco consumption (M/ SD)				
Cigarettes per day	10.10 (8.85)	10.74 (8.59)	9.71 (8.99)	t (441) = 1.183
Years of regular smoking	13.92 (10.85)	14.19 (11.21)	13.75 (10.64)	t (451) = 0.419
Previous quit attempts	2.02 (2.58)	2.22 (3.14)	1.89 (2.14)	t (246.924) = 1.169
FTND score	3.14 (2.45)	3.27 (2.34)	3.06 (2.52)	t (390.606) = 0.892
GN-SBQ score	15.78 (7.77)	15.09 (6.61)	16.18 (8.36)	t (399.668) = -1.521

Note. M = Mean; SD = Standard deviation; FTND = Fagerström Test for Nicotine Dependence; GN-SBQ = Glover-Nilsson Smoking Behavioral Questionnaire.
* $p < 0.05$.

the second option (two second-order factors (PDM and SDM) with eleven first-order correlated factors solution; χ^2S-B = 1539.09; CFI = 0.913; NNFI = 0.899; RMSEA = 0.059 [0.056, 0.063]; SRMR = 0.150) and the third option (two correlated factors (PDM and SDM); χ^2S-B = 3881.97; CFI = 0.706; NNFI = 0.689; RMSEA = 0.014 [0.010, 0.107]; SRMR = 0.091). The standardized loads of the first model (see Supplementary Fig. 1) range from 0.58 (Item 12, dimension Cue Exposure/Associative Processes) to 0.96 (Item 30, dimension Social/Environmental Goads).

3.4. Reliability of the scores and internal consistency

The corrected item-total correlations (see Table 4) showed values ranging from α = 0.137 (Item 27) to α = 0.773 (Item 33). Overall, reliability of the scale would not improve by deleting any of the items, as shown by Cronbach's alpha values. Moreover, internal consistency was satisfactory for the total scale (α = 0.950) and for its dimensions (values ranged from α = 0.657 in dimension 6, Cue Exposure/Associative Processes to α = 0.921 in dimension 7, Social/Environmental Goads).

3.5. Measurement invariance by gender

The eleven correlated factor solution fitting indicated that the values associated with CFI allowed the acceptance of factorial invariance of the Spanish version of B-WISDM across gender. FI was progressively tested at different levels: configural, weak, strong, and strict. Based on change in CFI value (ΔCFI $\leq$ 0.01), the factorial structure of scale showed strict invariance by gender [RMSEA = 0.049 (0.045, 0.053); CFI = 0.940]. Fit indices for the eleven correlated factor model are displayed in Supplementary Table 4.

3.6. Convergent validity

The total score of the scale significantly and positively correlated with FTND (r = 0.624; $p < 0.001$) and GN-SBQ (r = 0.785; $p < 0.001$) scores (see Supplementary Table 5). Furthermore, nearly all dimensions significantly ($p < 0.001$) and positively correlated with FTND scores, with results ranging between r = 0.253 (dimension 10, Weight control) and r = 0.814 (dimension 9, Tolerance). It should be noted that dimension 7 (Social/Environmental Goads) correlated negatively and not significantly with FTND scores (r = -0.027). Regarding the correlations between B-WISDM dimensions and the GN-SBQ, scores ranged from r = 0.14 (dimension 7, Social/Environmental Goads) to r = 0.707 (dimension 5, Craving).

4. Discussion

The aim of the present study was to analyze the psychometric properties of the Spanish version of the B-WISDM, including its factor structure and measurement invariance by gender, among a sample of Spanish smokers from the general population. Overall, results showed adequate psychometric properties of this scale within the Spanish

Table 2
Descriptive statistics of the B-WISDM's items (N = 480).

Item	Min-Max	Mean	*SD*	Skewness	Kurtosis	Responses with a score of 1 (%)	Responses with a score of 7 (%)
1. I often smoke without thinking about it	1–7	4.20	2.05	−0.12	−1.16	15.6	21.0
2. Cigarettes control me	1–7	3.73	2.03	0.14	−1.22	20.4	12.7
3. I usually want to smoke right after I wake up	1–7	3.17	2.25	0.56	−1.22	38.1	14.0
4. It's hard to ignore an urge to smoke	1–7	4.45	1.93	−0.36	−0.97	11.5	18.1
5. The flavor of a cigarette is pleasing	1–7	4.00	1.94	−0.09	−1.12	15.8	12.1
6. I frequently smoke to keep my mind focused	1–7	2.57	1.84	0.88	−0.40	46.3	4.4
7. I rely upon smoking to control my hunger and eating	1–7	2.19	1.78	1.33	0.52	60.0	3.8
8. My life is full of reminders to smoke	1–7	3.48	1.97	0.30	−1.05	22.9	10.4
9. Smoking helps me feel better in seconds	1–7	3.47	1.91	0.25	−1.06	22.1	7.9
10. I smoke without deciding to	1–7	3.25	2.00	0.37	−1.09	31.0	8.3
11. Cigarettes keep me company, like a close friend	1–7	2.53	1.95	0.97	−0.44	51.0	4.8
12. There are particular sights and smells that trigger strong urges to smoke	1–7	3.54	1.02	0.25	−1.18	22.7	10.8
13. Smoking helps me stay focused	1–7	2.64	1.82	0.79	−0.58	43.3	3.3
14. I frequently light cigarettes without thinking about it	1–7	3.21	2.13	0.49	−1.17	34.0	11.0
15. Most of my daily cigarettes taste good	1–7	4.20	1.80	−0.18	−0.89	10.8	11.5
16. Sometimes I feel like cigarettes rule my life	1–7	3.23	2.13	0.46	−1.21	33.5	11.0
17. I frequently crave cigarettes	1–7	3.63	1.88	0.32	−0.96	14.2	11.3
18. Most of the people I spend time with are smokers	1–7	4.08	2.05	−0.08	−1.24	16.3	17.3
19. Weight control is a major reason that I smoke	1–7	1.85	1.57	1.90	2.69	69.6	3.5
20. Some of the cigarettes I smoke taste great	1–7	4.34	2.04	−0.24	−1.17	14.0	20.6
21. I'm really hooked on cigarettes	1–7	4.51	2.08	−0.36	−1.15	13.3	24.8
22. Sometimes I feel like cigarettes are my best friends	1–7	1.78	1.52	2.03	3.28	72.7	3.1
23. My urges to smoke keep getting stronger if I don't smoke	1–7	4.22	2.04	−0.16	−1.21	14.6	19.0
24. Seeing someone smoke makes me really want a cigarette	1–7	4.61	1.88	−0.47	−0.83	9.4	19.2
25. I find myself reaching for cigarettes without thinking about it	1–7	2.89	2.12	0.69	−1.01	43.8	8.3
26. I would feel alone without my cigarettes	1–7	2.00	1.66	1.70	1.87	63.5	4.0
27. A lot of my friends or family smoke	1–7	4.36	1.98	−0.23	−1.16	11.0	18.5
28. Other smokers would consider me a heavy smoker	1–7	3.16	2.02	0.57	−0.92	30.4	9.8
29. When I haven't been able to smoke for a few hours, the craving gets intolerable	1–7	3.07	1.93	0.57	−0.88	29.4	6.9
30. Most of my friends and acquaintances smoke	1–7	4.34	1.97	−0.23	−1.09	11.7	19.0
31. I smoke within the first 30 min of awakening in the morning	1–7	3.59	2.56	0.25	−1.69	40.4	25.0
32. Smoking helps me think better	1–7	2.59	1.82	0.91	−0.28	43.5	4.6
33. Smoking really helps me feel better if I've been feeling down	1–7	3.21	1.95	0.44	−0.99	28.7	7.9
34. Smoking keeps me from overeating	1–7	2.36	1.85	1.18	0.22	54.4	5.8
35. My smoking is out of control	1–7	2.84	2.01	0.70	−0.86	42.5	7.1
36. I consider myself a heavy smoker	1–7	3.83	2.20	0.05	−1.43	24.8	16.7
37. Even when I feel good, smoking helps me feel better	1–7	3.20	2.02	0.50	−0.99	30.0	10.0

Note. SD: Standard Deviation; %: Percentage.

culture indicating that the eleven correlated factors solution had the best fit for the data, being such structure invariant across gender.

Firstly, descriptive analysis regarding B-WISDM scores showed that the overall and the dimensions' scores were in the mid-range, with the lowest ones in the Affiliative Attachment dimension and, conversely, the highest ones in the Social/ Environmental Goads dimension (in line with Smith et al., 2010; Vajer et al., 2011). Regarding these outcomes, precedent literature (Piper et al., 2004,2006; Smith et al., 2010) has already demonstrated that emotional attachment to smoking appears to exert lower influence on motivational processes leading to ND (Piper et al., 2004,2006; Smith et al., 2010). On contrast, some basic learning processes (Niaura et al., 1988; Piper et al., 2004,2006) seem more likely to shape smoking motivation, such as associating the observation of someone smoking with the reported desire to smoke or linking certain social stimuli to smoking behavior (Bandura, 1997; Piper et al., 2004,2006; Smith et al., 2010).

Regarding the dimensionality of the Spanish B-WISDM, three different factor models were tested, finding that the eleven correlated factors solution had the best fit for the data (as reported in Ma et al., 2012; Mauduy et al., 2023; Pancani et al., 2015; Vajer et al., 2011). Consequently, the results of the original model proposed by Smith et al. (2010) were replicated in this study (without error covariances). Fit indices obtained for this model revealed the highest CFI (0.943) and NNFI (0.934) values, indicating an acceptable fit (McDonald & Ho, 2002) and with scores closer to the most recommended values ($\geq$ 0.95) (Hu & Bentler, 1999). Besides, RMSEA and SRMR indices were lower than 0.05, revealing a good fit (Hu & Bentler, 1999). Nonetheless, as highlighted by Mauduy et al. (2023); Pancani et al. (2015) and Vajer et al. (2011) the two second-order factors model cannot be completely discarded due to its theoretical relevance and given the adequacy of its fit indices. In this regard, Adkison et al. (2016) found that this second-order model obtained the best fit for the data and due to this lack of consensus, further studies are needed to refine the model specification and its dimensions.

As noted above, there was no Spanish adaptation of the scale except for that carried out by Castro et al. (2014) among treatment-seeking U.S. Latino smokers. Contrary to our findings, these authors were not able to replicate the original structure of the B-WISDM, suggesting that the instrument did not appropriately measure ND among this subsample of Latino smokers. This could be caused by differences in the dialects of the Spanish language and the smoking behavior of Latino smokers, as well as the treatment-seeking profile of their sample. Also, Castro et al.

Table 3
Descriptive statistics of the B-WISDM's dimensions (N = 480).

Subscale	Min-Max	Mean	*SD*
Total sample (N = 480)			
1. Affiliative Attachment	1–7	2.10	1.49
2. Automaticity	1–7	3.39	1.80
3. Loss of Control	1–7	3.58	1.84
4. Cognitive Enhancement	1–7	2.60	1.64
5. Craving	1–7	3.85	1.63
6. Cue Exposure/Associative Processes	1–7	3.88	1.51
7. Social/Environmental Goads	1–7	4.26	1.86
8. Taste	1–7	4.18	1.70
9. Tolerance	1–7	3.43	1.87
10. Weight Control	1–7	2.14	1.52
11. Affective Enhancement	1–7	3.29	1.65
Primary Dependence Motives (PDM) scale	1–7	3.56	1.59
Secondary Dependence Motives (SDM) scale	1–6.71	3.21	1.04
Total Score	11–73.25	36.69	12.60
Females (n = 303)			
1. Affiliative Attachment	1–7	2.13	1.61
2. Automaticity	1–7	3.45	1.85
3. Loss of Control	1–7	3.56	1.88
4. Cognitive Enhancement	1–7	2.54	1.67
5. Craving	1–7	3.88	1.70
6. Cue Exposure/Associative Processes	1–7	3.98	1.52
7. Social/Environmental Goads	1–7	4.41	1.94
8. Taste	1–7	4.21	1.67
9. Tolerance	1–7	3.40	1.92
10. Weight Control	1–7	2.27	1.64
11. Affective Enhancement	1–7	3.37	1.73
Primary Dependence Motives (PDM) scale	1–7	3.57	1.64
Secondary Dependence Motives (SDM) scale	1–6.71	3.27	1.10
Total Score	11–73.25	37.22	13.28
Males (n = 177)			
1. Affiliative Attachment	1–6.67	2.05	1.24
2. Automaticity	1–7	3.28	1.70
3. Loss of Control	1–7	3.61	1.76
4. Cognitive Enhancement	1–7	2.70	1.60
5. Craving	1–7	3.78	1.51
6. Cue Exposure/Associative Processes	1–7	3.69	1.46
7. Social/Environmental Goads	1–7	4.01	1.69
8. Taste	1–7	4.11	1.69
9. Tolerance	1–7	3.49	1.78
10. Weight Control	1–7	1.90	1.25
11. Affective Enhancement	1–7	3.16	1.49
Primary Dependence Motives (PDM) scale	1–7	3.54	1.50
Secondary Dependence Motives (SDM) scale	1–5.67	3.09	0.92
Total Score	11–63.92	35.79	11.30

Note. SD: Standard Deviation.

(2014) highlight some shortcomings regarding their translation process, emphasizing the need of independent translations and the use of focus groups with smokers. In our study, we have attempted to overcome these limitations by following their recommendations as well as international guidelines (Hambleton & Zenisky, 2011; Muñiz et al., 2013; Vaughn et al., 1996).

Regarding measurement invariance by gender, the present study replicated the outcomes of the only studies addressing it (Mauduy et al., 2023; Vajer et al., 2011), demonstrating that the factorial structure of the scale remains invariant. Consequently, this version of B-WISDM represents a sensitive assessment instrument accounting for the existing gender differences in the underlying motives explaining ND. This emphasizes the clinical utility of the B-WISDM to tailor treatments to the real needs across genders.

Internal consistency rates were high for most of the subscales (α = 0.657– 0.921), and for the total scale (α = 0.950), in line with previous research (Ma et al., 2012; Mauduy et al., 2023; Pancani et al., 2015; Smith et al., 2010; Vajer et al., 2011). The dimension Cue exposure/Associative Processes showed the lowest internal consistency indexes, as shown in precedent studies (Ma et al., 2012; Mauduy et al., 2023; Pancani et al., 2015; Smith et al., 2010; Vajer et al., 2011), followed by the Affective Enhancement dimension, as reported by Mauduy et al. (2023) and Smith et al. (2010). In particular, the low reliability of the Cue exposure/Associative Processes dimension has been explained by cultural differences, the significant reduction in the number of items of the shorter version or even the poor stability of the SDM scales (which include this dimension) (Ma et al., 2012; Pancani et al., 2015). Despite this, our findings revealed that the Spanish B-WISDM will be useful to assess nonclinical samples of Spanish smokers in their own culture, as in the case of Hungarian (Vajer et al., 2011), African- and European-American (Ma et al., 2012), Italian (Pancani et al., 2015), French (Mauduy et al., 2023) and U.S. (Adkison et al., 2016) smokers.

Further convergent validity analysis showed that the total score of the B-WISDM and its dimensions significantly and positively correlated with FTND and GN-SBQ scores. On one hand, all dimensions included in the PDM scale showed higher correlations with FTND scores when compared to the SDM scale, as Adkison et al. (2016) have shown. This is not surprising since both the FTND and PDM dimensions measure physical dependence by addressing an automatic pattern of smoking, occurring due to high levels of craving, and not influenced by contextual cues (Adkison et al., 2016; Piper et al., 2008; Smith et al., 2010). The dimension Social/ Environmental Goads was the only one not correlating with the FTND scores, as previously reported with the WISDM-68 (Ma et al., 2012; Piper et al., 2004,2006). In this line, Vajer et al. (2011) also found no significant correlation between this dimension of the B-WISDM and the Tobacco Dependence Screener (Kawakami, Takatsuka, Inaba, & Shimizu, 1999) scores. This is not surprising either since this dimension focuses on the social features of ND. Finally, the B-WISDM showed even higher correlations with the GN-SBQ scores than with the FTND (except for the dimensions Loss of Control and Tolerance). Again, this result was expected given that the GN-SBQ focuses on the psychological, social, and gestural features characterizing ND (Glover et al., 2005), and is consequently more in accordance with the multidimensional conceptualization of ND in the B-WISDM.

Several limitations of our study merit consideration. Firstly, the cross-sectional nature of the study and the sample selection by convenience could reduce the generalizability of results and the representativeness of this sample. Due to this, some groups of population might be underrepresented, and further studies should explore this version of the B-WISDM with other populations as well as with representative samples of Spanish smokers. Nonetheless, it should be noted that our research was initially intended to use a non-probabilistic sampling method through online assessments and by using the snowball method, with the aim of reaching as many participants as possible from the Spanish general population. Besides, the final sample includes a broad number of Spanish smokers with different sociodemographic characteristics. The included smokers also had to meet several strict criteria to be considered for the study in order to obtain a typical profile of Spanish daily smokers. Using a non-clinical sample of smokers has also allowed us to overcome multiple limitations of previous research, i.e., the availability of the Spanish B-WISDM for non-clinical smokers is key given that ND assessments are usually applied for clinical purposes and validated instruments measuring ND in non-clinical populations are greatly needed (Adkison et al., 2016). Secondly, data was collected through self-report and due to this, further studies with biological verifications of tobacco use would provide valuable data. Thirdly, most participants reported only low-to-medium levels of ND and further studies might want to include smokers with high ND.

5. Conclusions

The Spanish version of the B-WISDM has optimal psychometric properties when used with a nonclinical sample of European Spanish smokers. The eleven correlated factors model has shown the best fit for

Table 4
Item-test correlations and Cronbach's alpha coefficients (N = 480).

Item	Corrected item-total correlation	α when item was deleted
1. I often smoke without thinking about it	0.543	0.949
2. Cigarettes control me	0.766	0.947
3. I usually want to smoke right after I wake up	0.641	0.948
4. It's hard to ignore an urge to smoke	0.681	0.948
5. The flavor of a cigarette is pleasing	0.485	0.949
6. I frequently smoke to keep my mind focused	0.602	0.949
7. I rely upon smoking to control my hunger and eating	0.460	0.949
8. My life is full of reminders to smoke	0.519	0.949
9. Smoking helps me feel better in seconds	0.607	0.948
10. I smoke without deciding to	0.691	0.948
11. Cigarettes keep me company, like a close friend	0.599	0.949
12. There are particular sights and smells that trigger strong urges to smoke	0.470	0.949
13. Smoking helps me stay focused	0.621	0.948
14. I frequently light cigarettes without thinking about it	0.723	0.948
15. Most of my daily cigarettes taste good	0.390	0.950
16. Sometimes I feel like cigarettes rule my life	0.725	0.948
17. I frequently crave cigarettes	0.764	0.947
18. Most of the people I spend time with are smokers	0.166	0.952
19. Weight control is a major reason that I smoke	0.378	0.950
20. Some of the cigarettes I smoke taste great	0.453	0.950
21. I'm really hooked on cigarettes	0.757	0.947
22. Sometimes I feel like cigarettes are my best friends	0.556	0.949
23. My urges to smoke keep getting stronger if I don't smoke	0.657	0.948
24. Seeing someone smoke makes me really want a cigarette	0.518	0.949
25. I find myself reaching for cigarettes without thinking about it	0.711	0.948
26. I would feel alone without my cigarettes	0.571	0.949
27. A lot of my friends or family smoke	0.137	0.952
28. Other smokers would consider me a heavy smoker	0.672	0.948
29. When I haven't been able to smoke for a few hours, the craving gets intolerable	0.723	0.948
30. Most of my friends and acquaintances smoke	0.145	0.952
31. I smoke within the first 30 min of awakening in the morning	0.549	0.949
32. Smoking helps me think better	0.623	0.948
33. Smoking really helps me feel better if I've been feeling down	0.773	0.949
34. Smoking keeps me from overeating	0.450	0.950
35. My smoking is out of control	0.734	0.948
36. I consider myself a heavy smoker	0.701	0.948
37. Even when I feel good, smoking helps me feel better	0.675	0.948

B-WISDM subscale	Cronbach's alpha coefficient		
	Total (N = 480)	Male (n = 177)	Female (n = 303)
1. Affiliative Attachment	0.830	0.708	0.874
2. Automaticity	0.888	0.890	0.887
3. Loss of Control	0.912	0.916	0.910
4. Cognitive Enhancement	0.882	0.893	0.878
5. Craving	0.860	0.844	0.869
6. Cue Exposure/Associative Processes	0.657	0.661	0.659
7. Social/Environmental Goads	0.921	0.896	0.932
8. Taste	0.839	0.827	0.846
9. Tolerance	0.842	0.830	0.849
10. Weight Control	0.847	0.782	0.866
11. Affective Enhancement	0.790	0.765	0.801
Total	0.950	0.942	0.954

the data and preserves measurement invariance across gender. Moreover, the B-WISDM scores correlated with other traditional ND measures, confirming its utility to assess the motives driving tobacco use among Spanish smokers. Our findings are of great relevance given the need of validated tools to evaluate ND among nonclinical subsamples (Adkison et al., 2016) and in languages other than English (Castro et al., 2014). This version of the B-WISDM also represents the first validated instrument for the multidimensional assessment of ND within the Spanish culture. We believe that further analyses should explore its factor structure among other populations such as those with high ND or seeking treatment to shed light on the underlying motives that lead them to initiate and maintain their smoking behavior, as well as to relapse. Additionally, it would be interesting for further studies to evaluate invariance assessment across versions by conducting cross-cultural analysis. All this information will allow clinicians to tailor future smoking cessation treatments to the real needs of both male and female Spanish smokers.

CRediT authorship contribution statement

Carla López-Núñez: Conceptualization, Methodology, Supervision, Investigation, Data curation, Writing – original draft, Writing – review & editing. **Manuel J. Ruiz:** Methodology, Investigation, Writing – original draft, Writing – review & editing. **Sara Domínguez-Salas:** Visualization, Formal analysis, Software, Writing – original draft, Writing – review & editing. **Sergio Fernández-Artamendi:** Methodology, Investigation, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.addbeh.2023.107833.

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