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The independent contribution of positive and negative metacognitions about smoking to urge to smoke, withdrawal symptoms, and dependence in smoking-dependent men

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Role of Funding

This article has been extracted from a research project supported by Shahid Beheshti University of Medical Sciences (SBUMS).

Author contribution

Methodology, supervision, clinical diagnosis, data curation, formal analysis, writing - original draft, review, and editing (VK and SMSA). Methodology, supervision, writing - original draft, review, and editing (MS and AN). Data curation, formal analysis, writing - original draft, review, and editing (MN).

Conflict of interest

There are no conflicts of interest to report.

Acknowledgements

The authors would like to thank the Behavioral Sciences Research Center, Shahid Beheshti University of Medical Sciences (SBUMS), Tehran, Iran for their support, cooperation, and assistance throughout the period of study.

Data availability: The data that support the findings of this study are available from the corresponding author on reasonable request.

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Abstract

Previous research has indicated that various factors, such as psychological distress, distress intolerance, anhedonia, impulsivity, and smoking metacognitions, have been individually linked to the urge to smoke, withdrawal symptoms, and dependence. However, these factors have not been collectively examined to determine whether smoking metacognitions independently and significantly contribute to these outcomes. Therefore, the aim of this study was to investigate the impact of distress intolerance, anhedonia, impulsivity, and smoking metacognitions on the urge to smoke, withdrawal symptoms, and dependency in men who are dependent on smoking. A total of 300 smoking-dependent men completed psychological scales and smoking-related measures. The findings of the study indicated that positive metacognitions about emotion regulation significantly predicted the urge to smoke, even when accounting for other significant predictors such as the number of daily cigarettes smoked, psychological distress, anhedonia, and impulsivity. Furthermore, positive metacognitions about cognitive regulation were found to be a significant predictor of withdrawal symptoms, independently of other significant predictors such as psychological distress and the urge to smoke. Smoking dependence was predicted by negative metacognitions about uncontrollability beyond other significant predictors, including number of daily cigarettes smoked and distress intolerance. These results highlight the role of metacognitions about smoking in both short and long-term clinical outcomes related to smoking. Consequently, addressing such beliefs during treatment for smoking dependence should be an important therapeutic goal.

Keywords: Distress intolerance, Anhedonia, Impulsivity, Smoking metacognitions, Urge to use smoke, Withdrawal symptoms

Key Practitioner Message

- Smoking metacognitions play a significant role in smoking-related behaviours and experiences and represent an important target of therapeutic intervention in smoking cessation
- Positive smoking metacognitions about emotion regulation are associated with the urge to smoke.
- Positive smoking metacognitions about cognitive regulation are related to withdrawal symptoms.
- Smoking dependence is related to negative metacognitions about uncontrollability of smoking and this is, independent from distress intolerance and daily cigarettes used

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1. Introduction

The phenomenon of the urge to smoke, also known as smoking craving, refers to a strong desire to resist smoking, particularly during the initial stages of nicotine withdrawal (Chandra et al., 2011; Nosen & Woody, 2014). This urge is closely associated with smoking dependence (Donny et al., 2008; Dunbar et al., 2014; Lechner et al., 2018) and is often accompanied by heightened withdrawal symptoms experienced by smokers (Chandra et al., 2011; Schnoll et al., 2016). Research has shown that smokers generally experience higher levels of the urge to smoke and withdrawal symptoms during active smoking phases compared to those who have abstained from smoking (Schnoll et al., 2016). The intensity of craving and withdrawal symptoms tend to increase when smokers are deprived of smoking (Bidwell et al., 2013), and psychological factors such as psychological distress, intolerance, anhedonia, and impulsivity may also contribute to these experiences.

Numerous studies have found a positive association between smoking and psychological distress (Boothby et al., 2017; Heffner et al., 2011; Liu et al., 2020; Schulte et al., 2017). Additionally, individuals who continue to smoke are twice as likely to persist in their smoking habit (Lawrence & Williams, 2016) and report more severe symptoms of nicotine withdrawal and stronger cravings, even when actively seeking treatment (Reid et al., 2016). Consequently, there is a consistent association between psychological distress and various aspects of smoking behavior, such as the urge to smoke, nicotine dependency, and withdrawal symptoms (Forman-Hoffman et al., 2017; Kilibarda et al., 2017; Kim-Mozeleski

et al., 2019; Kosiba et al., 2018; Lechner et al., 2018; Rosen et al., 2019), ultimately resulting in a reduced likelihood of successfully quitting smoking (Cosci et al., 2009).

Prior research has established a connection between low distress tolerance and smoking behavior (Veilleux et al., 2019). Additionally, dependence and craving have been found to be associated with low distress tolerance in smokers (Farris et al., 2016a; Trujillo et al., 2017). Individuals with elevated levels of distress intolerance may be more susceptible to engaging in tobacco use, which can serve as an additional emotional risk factor that hinders their attempts to quit smoking (Schlam et al., 2020). This is due to the fact that these individuals experience heightened negative emotions (Abrantes et al., 2008) and encounter challenges when trying to quit smoking (Kraemer et al., 2013). Consequently, distress intolerance plays a significant role in the perpetuation of smoking behavior (Farris et al., 2016b).

In addition to the aforementioned findings, it has been observed that individuals who engage in smoking display elevated levels of anhedonia, particularly when they are experiencing significant psychological distress (Liverant, et al., 2014). Moreover, in smokers who experience pronounced anhedonia, this state of reduced pleasure further contributes to the inclination to smoke (Stone et al., 2017) and the engagement in more frequent smoking behaviors (Leventhal et al., 2009, 2014). Increased levels of anhedonia have also found to be linked to withdrawal symptoms (Cook et al., 2015) and serve as a risk factor for unsuccessful attempts to quit smoking (Powers et al., 2016).

As another psychological factor affecting smoking, impulsivity refers to the inclination to engage in rapid and unplanned responses to both internal and external stimuli, without adequately considering the potential negative consequences of these actions (Chivers et al.,

2016; Lee et al., 2015; Moeller et al., 2001). Several studies have highlighted the prevalence of impulsivity among heavy smokers and its association with increased smoking behavior (Granö et al., 2004; Kale et al., 2018; Skinner et al., 2004). Additionally, impulsivity has been linked to the maintenance of smoking habits, heightened cravings, withdrawal symptoms, and relapse (Bidwell et al., 2017; Dvorak et al., 2011; Pitts & Leventhal, 2012; VanderVeen et al., 2008a, 2008b). Moreover, research has shown that individuals with high levels of impulsivity are less likely to make efforts to quit smoking (Skinner et al., 2004).

In recent years it has been suggested that metacognitions play a significant role in smoking, with both positive and negative metacognitions influencing individuals' smoking-related behaviours. Positive metacognitions refer to the belief in the positive effects of smoking for emotional and cognitive self-regulation, while negative metacognitions encompass thoughts of uncontrollability and the harmful impact of smoking, such as cognitive interference (Nikčević et al., 2015; Nikčević & Spada, 2008). Positive metacognitions are seen to be important in the initiation of smoking, while negative metacognitions contribute to the continuation of smoking and therefore smoking dependence. The role of metacognitions in smoking has been supported by various studies (Alma et al., 2018; Izadpanah et al., 2021; Hamonniere & Varescon, 2018; Najafi et al., 2018; Nikčević et al., 2015, 2017; Nikčević & Spada, 2008; Poormahdy et al., 2022; Spada et al., 2007).

Psychological factors that induce distress, such as impulsivity, anhedonia and distress intolerance, have been found to increase the desire and motivation to smoke (Billieux et al., 2007; Mathew et al., 2015; Niezabitowska et al., 2022; Peraza et al., 2019; Roys et al., 2016; Trujillo et al., 2017). From the metacognitive perspective, smoking is a strategy for cognitive-

affective regulation (Nikčević & Spada, 2008). Several studies have demonstrated that metacognitive beliefs about smoking, both positive and negative are a significant predictor of nicotine dependence controlling for distress (Alma et al., 2018; Izadpanah et al., 2021; Najafi et al., 2018; Nikčević et al., 2017; Poormahdy et al., 2022). It is however not known whether metacognitions about smoking play a unique role in predicting smoking-related outcomes, independently of other dysfunctional and distressing factors such as distress intolerance, anhedonia, and impulsivity. This evaluation is particularly important in clinical settings and during the treatment of nicotine dependence.

Given the above extant literature, the current study aimed to examine the role of positive and negative metacognitions about smoking in relation to the smoking urges, withdrawal symptoms, and nicotine dependence, while controlling for the effects of psychological distress, distress intolerance, anhedonia, and impulsivity. Based on the existing literature underscoring the relevance of metacognitions about smoking in smoking behaviours and experiences (Alma et al., 2018; Izadpanah et al., 2021; Najafi et al., 2018; Nikčević et al., 2015, 2017; Nikčević & Spada, 2010; Poormahdy et al., 2022), we hypothesized that, taking into account the aforementioned personality and distress-related factors, a) positive metacognitions about smoking would predict the urge to smoke and withdrawal symptoms, and b) negative metacognitions about smoking would predict smoking dependence. Although our study was open to both women and men, due to the very small number of female smokers referred to the treatment clinics where recruitment took place, female participants were excluded from the final study sample. Such exclusion makes the results of this study relevant to male smokers and should be viewed with caution in generalizing to women smokers.

2. Methods

2.1. *Participants and Procedure*

The study sample included three hundred male individuals who were dependent on smoking and seeking help for smoking cessation from the Smoking Cessation Clinics. They ranged in age from 15 to 65 years with a mean age of 34.61 years. The inclusion criteria were as follows: 1) a diagnosis of smoking dependence, determined by achieving a score of 3 or higher on the Fagerstrom Test for Nicotine Dependence (FTND; Heatherton et al., 1991), which is considered indicative of smoking dependence; 2) being in the active phase of smoking; and 3) smoking a minimum of 10 cigarettes per day. In the present study, since the number of women smokers referred to the clinics was limited to only 8 women, we excluded them from the study. Among the participants, 64.3% ($n = 193$) had a history of attempting to reduce their smoking habits. On average, the participants smoked 18.28 cigarettes per day. The mean score on the FTND for the participants was 5.87, indicating a high level of smoking dependency. All participants provided informed consent to participate in the study, and the study was conducted in accordance with the 1989 revision of the Helsinki Declaration. The host institution's ethics committee (XXX) gave its ethical approval for the current study. Full clinical and demographic characteristics of the participants in our sample are presented in Table S1 (Supplementary Material).

2.2. *Self-report Measures*

Smoking Dependence. *The Fagerstrom Test for Nicotine Dependence (FTND; Heatherton et al., 1991)* was utilized as a means of assessing the level of smoking dependency among participants. The FTND consists of six items that measure various aspects of smoking dependence. Higher scores on the scale indicate a greater degree of dependency on smoking.

Specifically, scores of three or higher indicate moderate dependency, while scores of five or six indicate high dependency (Heatherton et al., 1991). Previous research has demonstrated the scale's satisfactory reliability (Cronbach's alpha = 0.71; Robabeh et al., 2017), and the current study also found the scale to have good reliability (Cronbach's alpha = 0.72).

Urge to Smoke. *The Brief Questionnaire of Smoking Urges (QSU-brief; Cox et al., 2001)* was used to assess the level of urge to smoke. The questionnaire consists of 10 items, each rated on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). The scale is composed of two factors, with the first factor measuring the desire to smoke and the second factor indicating the inclination to smoke as a means of alleviating negative emotions. Higher scores on the scale indicate a greater intensity of smoking urges. Previous research has demonstrated satisfactory internal consistency of the scale (Toll et al., 2006). In the current study, the Cronbach's alpha coefficient for the scale was calculated to be 0.91.

Withdrawal Symptoms. *The Minnesota Nicotine Withdrawal Scale (MNWS; Hughes & Hatsukami, 1986)* was employed to assess the presence and intensity of withdrawal symptoms experienced by individuals attempting to quit smoking. Comprising nine items, the MNWS employs a 4-point Likert scale ranging from 0 (indicating the absence of symptoms) to 4 (indicating severe symptoms). Research has confirmed the validity and reliability of this scale (Weinberger et al., 2007). In the current study, the internal consistency of the MNWS was found to be high, with a Cronbach's alpha coefficient of 0.89.

Psychological Distress. *The Psychological Distress Scale (PDS; Kessler et al., 2002)* was utilized to evaluate psychological distress among participants. The PDS consists of 10 items that assess distress, including symptoms of anxiety and depression experienced within the previous month. Each item is rated on a 5-point Likert scale, ranging from 0 (none of the

time) to 4 (all of the time) (Andrews and Slade, 2001). Higher scores on the scale indicate greater psychological distress. The scale demonstrated satisfactory reliability, with a Cronbach's alpha coefficient of 0.87 (Hajebi et al., 2018). Moreover, in the present study, Cronbach's alpha was found to be 0.89.

Distress Intolerance. *The Distress Intolerance Scale (DTS; Simons & Gaher, 2005)* is a commonly employed tool for evaluating psychological distress intolerance, consisting of 15 items. Each item is assessed on a five-point Likert scale, ranging from 1 (indicating complete disagreement) to 5 (indicating complete agreement). Higher scores denote a better ability to tolerate distress. Previous research by Leyro et al. (2011) has established the scale's validity and reliability. In the present study, the DTS demonstrated a Cronbach's alpha coefficient of 0.80, indicating satisfactory internal consistency.

Anhedonia. *The Snaith-Hamilton Pleasure Scale (SHAPS; Snaith et al., 1995)* was utilized as a measure of anhedonia. The SHAPS comprises 14 items, each rated on a four-point Likert scale ranging from 0 (complete agreement) to 4 (complete disagreement). Previous research has demonstrated the reliability and validity of this scale in assessing anhedonia (Langvik & Borgen Austad, 2019). In the current study, the internal consistency of the SHAPS was found to be high, with a Cronbach's alpha coefficient of 0.93.

Impulsivity. *The Barratt Impulsiveness Scale-11 (BIS-11; Patton & Stanford, 1995)* was used to assess impulsivity. The BIS-11 consists of 30 items that measure three subscales of impulsivity: cognitive impulsivity, motor impulsivity, and non-planning. Participants rated each item on a 4-point Likert scale ranging from 1 (rarely/never) to 4 (almost always/always). Previous research has established the reliability of the BIS-11 (Cronbach's alpha = 0.85; Mohammadzadeh et al., 2018), and this current study also found high reliability (Cronbach's alpha = 0.83).

Metacognitions about smoking. *The Metacognitions about Smoking Questionnaire (MSQ; Nikčević et al., 2015)* was used to assess metacognitions about smoking. The MSQ consists of 20 items that assess both positive and negative metacognitions. Positive metacognitions are further divided into positive metacognitions about cognitive regulation (PM-CR; 5 items) and positive metacognitions about emotional regulation (PM-ER; 5 items). On the other hand, negative metacognitions include negative metacognitions about uncontrollability (NM-U; 5 items) and negative metacognitions about cognitive interference (NM-CI; 5 items). Participants rate each item on a 4-point Likert scale, ranging from 1 (do not agree) to 5 (agree very much). Previous studies have shown that the MSQ has good reliability, with ordinal alphas of 0.88 (Najafi et al., 2018). In the current study, Cronbach's alphas for the total scale, PM-CR, PM-ER, NM-U, and NM-CI were 0.86, 0.80, 0.75, 0.72, and 0.70, respectively.

2.3. Statistical Analysis

Following normality testing, the present study utilized Pearson correlation analysis in SPSS-22 software to examine the associations between various psychological variables, including psychological distress, distress intolerance, anhedonia, impulsivity, positive and negative metacognitions, urge to smoke, withdrawal symptoms, and smoking dependence in smoking -dependent men. Additionally, hierarchical regression analyses were conducted to investigate whether positive and negative metacognitions predict urge to smoke, withdrawal symptoms, and smoking dependence, while controlling for the effects of number of daily cigarettes smoked, psychological distress, distress intolerance, anhedonia, and impulsivity. The independent variables in these analyses were number of daily cigarettes smoked, psychological distress, distress intolerance, anhedonia, impulsivity, and positive and

negative metacognitions, while urge to smoke, withdrawal symptoms, and smoking dependence served as the outcome variables. Notably, in the context of dependency being the outcome variable, the urge to smoke was added to other potential predictors. Similarly, when predicting withdrawal symptoms, both the urge to smoke and dependency were included among other predictors. Prior to conducting the regression analyses, it was ensured that the assumption of multicollinearity, as indicated by a variance inflation factor (VIF) less than 10, was met. Furthermore, the skewness and kurtosis values of the data fell within the acceptable range of -1 to +1, as recommended by Byrne (2010) and Kline (2015), indicating that the data were normally distributed.

3. Results

3.1. Correlational Analyses

The results of the Pearson correlations are shown in Table 1. The findings indicate that the number of cigarettes smoked per day was positively and significantly associated with anhedonia, all smoking-related metacognitions (except negative metacognitions about uncontrollability), the urge to smoke, withdrawal symptoms, and smoking dependence ($p < 0.01$). Psychological distress and all smoking-related metacognitions were also significantly and positively associated with the urge to smoke, withdrawal symptoms, and smoking dependence ($p < 0.01$). Distress intolerance (negatively) and pleasure (positively) exhibited significant correlations with the urge to smoke, withdrawal symptoms, and smoking dependence ($p < 0.01$). Impulsivity demonstrated a significant and positive relationship with the urge to smoke and smoking dependence ($p < 0.05$). The urge to smoke was significantly and positively related to withdrawal symptoms and smoking dependence ($p < 0.01$).

Additionally, withdrawal symptoms and smoking dependence were significantly and positively correlated ($p < 0.01$).

3.2. Regression Analyses

Hierarchical regression analyses were conducted to ascertain the predictive factors for urge to smoke, withdrawal symptoms, and smoking dependence. The number of daily cigarettes smoked was included as a predictor in these regression models, as it exhibited a significant association with the dependent variables in the correlational analysis.

Concerning urge to smoke, findings revealed that number of daily cigarettes smoked ($p < 0.001$), psychological distress ($p < 0.001$), anhedonia ($p < 0.05$), and impulsivity ($p < 0.05$) were significant predictors. More importantly, positive metacognitions about emotion regulation were the only dimension of smoking metacognitions that significantly predicted the urge to smoke ($p < 0.001$), regardless of other predictors. The combined effect of these significant predictors accounted for 26% of the total variance in the urge to smoke. Distress tolerance, positive metacognitions about cognitive regulation, and negative metacognitions about uncontrollability and cognitive interference did not emerge as significant predictors ($p > 0.05$) (see Table 2).

The occurrence of withdrawal symptoms was predicted by urge to smoke and psychological distress, along with positive metacognitions about cognitive regulation ($p < 0.001$). These significant predictors accounted for 36% of the variance in withdrawal symptoms. Variables such as the number of cigarettes smoked per day, smoking dependence, distress intolerance, anhedonia, impulsivity, and specific smoking metacognitions related to emotion regulation, uncontrollability, and cognitive interference did not have a significant role in predicting withdrawal symptoms ($p > 0.05$) (see Table 3).

Lastly, negative metacognitions about uncontrollability were found to be a significant predictor of smoking dependence over and beyond other significant predictors, including number of daily cigarettes smoked ($p < 0.001$) and distress intolerance ($p < 0.05$). They accounted for 38% of the total variability in smoking dependence (see Table 4). Other factors, such as urge to smoke, psychological distress, anhedonia, impulsivity, and smoking-related metacognitions of emotion regulation, cognitive regulation, and cognitive interference were found to be non-significant predictors of smoking dependence ($p > 0.05$).

4. Discussion

The objective of this study was to determine the factors that contribute to various clinical manifestations of smoking, such as craving, dependence, and withdrawal symptoms. Specifically, the study aimed to examine the unique role of metacognitions about smoking in predicting these manifestations, while also considering the influence of the number of daily cigarettes smoked, psychological distress, distress intolerance, anhedonia, and impulsivity.

The results of the study indicated that several factors were found to predict the urge to smoke among participants, namely the number of cigarettes smoked per day, psychological distress, anhedonia, and impulsivity. Controlling for these significant predictors, it was found that positive metacognitions about emotion regulation were significantly related to the urge to smoke. Psychological distress and urge to smoke were significant predictors of withdrawal symptoms, with positive metacognitions about cognitive regulation independently contributing to the explanation of withdrawal symptoms. For smoking dependence, controlling for the number of daily cigarettes smoked and distress intolerance as significant predictors, negative metacognitions about uncontrollability were found to be a significant predictor.

The findings of our study which revealed the role of the number of cigarettes smoked per day, psychological distress, distress intolerance, anhedonia, and impulsivity, for both short- and long-term outcomes related to smoking, such as craving, withdrawal symptoms, and dependence are aligned with other studies that have highlighted the importance of these factors in the clinical manifestation of smoking (e.g., Bidwell et al., 2017; Cook et al., 2015; Dvorak et al., 2011; Farris et al., 2016a,b; Forman-Hoffman et al., 2017; Kilibarda et al., 2017; Kim-Mozeleski et al., 2019; Kosiba et al., 2018; Lechner et al., 2018; Pitts & Leventhal, 2012; Rosen et al., 2019; Stone et al., 2017; Trujillo et al., 2017; VanderVeen et al., 2008a, 2008b). These factors underscore the vulnerability of individuals with smoking dependence, which leads them to engage in smoking-related behaviors as a coping mechanism for these unpleasant states. For example, it has been observed that smokers with heightened levels of distress may smoke more frequently to manage negative mood, and they may have difficulty tolerating early withdrawal symptoms, particularly during the initial stages of a quit attempt (Brown et al., 2001). Consequently, the presence of distressing and unpleasant psychological states and the utilization of coping mechanisms, combined with greater relief derived from smoking, are more likely to predict an increase in craving (Watson et al., 2018). As our findings demonstrated, specific metacognitions about smoking such as positive meta-beliefs regarding emotion and cognitive regulation may contribute to individuals' inclination to smoke through the enhancement of the perceived urges and experience of deprivation (i.e. withdrawal symptoms) where then smoking is used as a mean of escaping from these distressing internal states (Izadpanah et al., 2021; Niezabitowska et al., 2022; Nikčević & Spada, 2010; Poormahdy et al., 2022).

As previous research (Alma et al., 2018; Izadpanah et al., 2021; Najafi et al., 2018; Nikčević et al., 2017; Poormahdy et al., 2022) has suggested, negative smoking metacognitions about uncontrollability were associated with long-term effects of smoking (e.g., dependence). Similar findings have also been observed in relation to alcohol-related outcomes (Clark et al., 2012; Dragan et al., 2018), even after controlling for the effects of distress intolerance and negative emotions in individuals with alcohol use disorder (Khosravani et al., 2021, 2020).

4.1. Study Implications

From the theoretical perspective, this study examined the distinct roles of positive and negative metacognitions related to smoking in smoking-related outcomes, independently of other factors that contribute to smoking behaviors. This aligns with the metacognitive conceptualization of smoking dependence. Consequently, the findings offer further support for the metacognitive model of smoking dependency by highlighting the significance of metacognition about smoking in individuals who are dependent on smoking.

From the clinical perspective, our findings demonstrated that it is essential to evaluate and address both positive and negative metacognitions associated with smoking in clinical settings, particularly among smokers who display signs of impulsivity, distress intolerance, negative affect and anhedonia, as they may be more inclined to perceive smoking as an important mean of alleviating these negative emotions. Standard cognitive-behavioural treatment protocols for smoking cessation typically address negative affect, impulsivity and distress intolerance and train smokers to refrain from smoking and to consider more adaptive means of coping with negative emotions (Bradizza et al., 2017). Such protocols could be further enhanced by addressing the unhelpful metacognitions about smoking, both

positive and negative. A number of verbal reattribution methods and behavioural tasks have been described in Metacognitive Therapy (MCT; Wells, 2009) that can be utilised to challenge individuals' unhelpful metacognitions about smoking. These could include the direct re-structuring of both positive and negative metacognitions about smoking using Socratic dialogue techniques as well as experiential interventions aimed at questioning the validity of metacognitions such as the postponement of use, detached mindfulness and attention training (Spada et al. 2015, Nikčević et al., 2017).

4.2. Study Limitations

The present study possesses certain limitations that should be acknowledged. Firstly, the utilization of cross-sectional data restricts the ability to establish causal relationships and necessitates the implementation of longitudinal studies to elucidate the findings. Secondly, the exclusive reliance on self-report measures introduces the potential for participant bias, thus warranting the inclusion of behavioral tasks such as imaging instruments, visual analogue scales (VAS), and cue-induced craving tests to enhance data collection. Furthermore, the incorporation of laboratory tools such as urine samples could effectively assess dependency. Thirdly, the examination of withdrawal symptoms was limited to actively smoking individuals; therefore, caution should be exercised when interpreting the results of this variable during an actual abstinence phase in smokers.

Lastly and more importantly, the study sample consisted solely of smoking-dependent men, thereby precluding the generalization of the findings to women smokers. A number of gender-related differences in smoking behaviours and experiences have been reported in the literature especially with regards to the variables investigated in the present study. For example, it has been reported that female cigarettes smokers report a greater urge to smoke,

and are more reactive to the smoking cues, particularly for the positively reinforced aspects of smoking, compared to male smokers (Berlin & Singleton, 2008; Carpenter et al., 2014). In addition, nicotine-dependent women are less likely to initiate abstinence and are more likely to relapse compared to men (Pomerleau et al., 2005). It has been suggested that these phenomena may be due to more negative mood and the alleviating effects of smoking (Xu et al., 2008), lower distress tolerance (like pain) (Pulvers et al., 2012), and greater perceived stress associated with nicotine withdrawal symptoms (Lawless et al., 2015) in female compared to male smokers. Conversely, male gender is positively associated with impulsivity (Lee et al., 2015) which has implications for both initiation and maintenance of smoking and for the development of nicotine dependence (Fields et al., 2009). Further, although preliminary, research has highlighted that there might be gender-specific differences regarding metacognitions about smoking. In the study by Alma and colleagues (2018), male smokers reported higher levels of negative smoking metacognitions, while female smokers reported more positive smoking metacognitions (Alma et al., 2018). Given the above-described gender differences in smoking related behaviours and experiences highlighted by previous studies, it would be prudent to suggest that further research is needed before our study findings can be generalized to female smokers.

5. Conclusions

The current research suggests that endorsement of positive metacognitions about the role of smoking in emotion and cognitive regulation can predict immediate effects associated with smoking, such as the urge to smoke and withdrawal symptoms. Additionally, negative metacognitions about smoking (particularly those related to feeling unable to control one's smoking behavior) may contribute to long-term complications associated with smoking,

such as dependence. Importantly, these effects were observed even after accounting for factors such as the number of cigarettes smoked per day, psychological distress, distress intolerance, anhedonia, and impulsivity. Further research is needed to establish whether these findings, established with male smokers, can be generalized to female cigarette users.

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Table 1
Zero-order correlations among variables.

	1	2	3	4	5	6	7	8	9	10	11	12
1- Number of daily cigarettes smoked	-											
2- PDS	.05	-										
3- DTS	-.01	-.26**	-									
4- SHAPS	.15**	.07	-.04	-								
5- BIS-11	.07	.18**	-.22**	.11*	-							
6- MSQ PM-CR	.20**	.25**	-.09	.17**	.06	-						
7- MSQ PM-ER	.16**	.23**	-.11*	.07	.10	.64**	-					
8- MSQ NM-U	.09	.27**	-.22**	.06	.18**	.50**	.44**	-				
9- MSQ NM-CI	.14**	.16**	-.11*	.08	.08	.34**	.38**	.60**	-			
10- QSU-brief	.26**	.29**	-.16**	.17**	.11*	.33**	.37**	.29**	.23**	-		
11- MNWS	.18**	.40**	-.16**	.15**	.06	.44**	.32**	.37**	.29**	.42**	-	
12- FTND	.45**	.21**	-.21**	.18**	.12*	.21**	.24**	.22**	.20**	.30**	.24**	-

Note.

PDS: Psychological Distress Scale; DTS: Distress intolerance scale; SHAPS: Snaith–Hamilton Pleasure Scale; BIS-11: Barratt Impulsiveness Scale-11; MSQ: metacognitions about Smoking Questionnaire; PM-CR: positive metacognitions about cognitive regulation; PM-ER: positive metacognitions about emotional regulation; NM-U: negative metacognitions about uncontrollability; NM-CI: negative metacognitions about cognitive interference; QSU- brief:

brief questionnaire of smoking urges; MNWS: Minnesota Nicotine Withdrawal Scale; FTND: Fagerstrom Test for Nicotine Dependence.

* $p < .05$. ** $p < .01$.

Table 2
Predicting urge to smoke in smoking-dependent sample ($n = 300$).

Dependent variable	Step	Predictors	R^2	ΔR^2	F	β	p	95% <i>CI</i>	
QSU-brief	1	Number of daily cigarettes smoked	.07	.07	21.72	.26	<.001***	.23	.57
	2	Number of daily cigarettes smoked	.17	.16	12.35	.22	<.001***	.18	.50
		PDS				.25	<.001***	.24	.60
		DTS				-.12	.035*	-.28	-.01
		SHAPS				.14	.010**	.03	.23
		BIS-11				.09	.13	.02	-.18
		MSQ PM-CR				.03	.60	-.32	.55
	3	Number of daily cigarettes smoked	.26	.24	11.35	.17	<.001***	.10	.42
		PDS				.18	<.001***	.12	.48
		DTS				-.09	.089	-.24	.02
		SHAPS				.12	.020*	.02	.21
		BIS-11				.11	.038*	.02	.17
		MSQ PM-CR				.03	.60	-.32	.55

MSQ PM-ER	.22	<.001***	.33	1.32
MSQ NM-U	.10	.17	-.15	.85
MSQ PM-CI	.02	.80	-.41	.53

Note.

QSU- brief: brief questionnaire of smoking urges; PDS: Psychological Distress Scale; DTS: Distress intolerance scale; SHAPS: Snaith–Hamilton Pleasure Scale; BIS-11: Barratt Impulsiveness Scale-11; MSQ: metacognitions about Smoking Questionnaire; PM-CR: positive metacognitions about cognitive regulation; PM-ER: positive metacognitions about emotional regulation; NM-U: negative metacognitions about uncontrollability; NM-CI: negative metacognitions about cognitive interference.

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

Table 3
Predicting withdrawal symptoms in smoking-dependent sample ($n = 300$).

Dependent variable	Step	Predictors	R^2	ΔR^2	F	β	p	95% <i>CI</i>	
MNWS	1	Number of daily cigarettes smoked	.20	.19	23.88	.03	.66	-.09	.14
		QSU-brief				.38	<.001**	.18	.32
		FTND				.12	.048*	.01	.12
	2	Number of daily cigarettes smoked	.28	.26	16.08	.05	.35	-.06	.16
		QSU-brief				.30	<.001**	.12	.26
		FTND				.05	.38	-.24	.62
		PDS				.29	<.001**	.20	.43
		DTS				-.03	.56	-.11	.06
		SHAPS				.07	.20	-.02	.10
		BIS-11				.01	.92	-.06	.06
	3	Number of daily cigarettes smoked	.36	.33	14.66	.03	.59	-.08	.14
		QSU-brief				.22	<.001**	.07	.21
FTND					.03	.59	-.30	.52	

PDS	.24	<.001**	.15	.37
DTS	-.02	.70	-.10	.06
SHAPS	.04	.41	-.03	.08
BIS-11	.02	.69	-.07	.05
MSQ PM-CR	.26	<.001**	.26	.78
MSQ PM-ER	.07	.30	-.46	.14
MSQ NM-U	.09	.18	-.09	.51
MSQ PM-CI	.07	.23	-.11	.45

Note.

MNWS: Minnesota Nicotine Withdrawal Scale; QSU- brief: brief questionnaire of smoking urges; FTND: Fagerstrom Test for Nicotine Dependence; PDS: Psychological Distress Scale; DTS: Distress intolerance scale; SHAPS: Snaith–Hamilton Pleasure Scale; BIS-11: Barratt Impulsiveness Scale-11; MSQ: metacognitions about Smoking Questionnaire; PM-CR: positive metacognitions about cognitive regulation; PM-ER: positive metacognitions about emotional regulation; NM-U: negative metacognitions about uncontrollability; NM-CI: negative metacognitions about cognitive interference.

* $p < .05$. ** $p < .001$.

Table 4

Predicting smoking dependence in smoking-dependent sample ($n = 300$).

Dependent variable	Step	Predictors	R^2	ΔR^2	F	β	p	95% CI	
FTND	1	Number of daily cigarettes smoked	.24	.23	46.74	.40	<.001***	.08	.14
		QSU-brief				.20	<.001***	.02	.05
	2	Number of daily cigarettes smoked	.29	.28	20.23	.40	<.001***	.08	.14
		QSU-brief				.13	.016*	.01	.04
		PDS				.10	.069	-.01	.06
		DTS				-.14	.008**	-.05	-.01
		SHAPS				.08	.10	-.01	.03
		BIS-11				.08	.15	-.01	.03
	3	Number of daily cigarettes smoked	.38	.37	15.42	.40	<.001***	.08	.14
		QSU-brief				.10	.096	-.01	.04
		PDS				.08	.12	-.01	.06
		DTS				-.13	.013*	-.05	-.01
		SHAPS				.09	.09	-.01	.03

BIS-11	.06	.26	-.01	.03
MSQ PM-CR	.05	.47	-.10	.05
MSQ PM-ER	.09	.19	-.03	.14
MSQ NM-U	.30	<.001***	.30	.89
MSQ PM-CI	.04	.52	-.05	.11

Note.

FTND: Fagerstrom Test for Nicotine Dependence; QSU- brief: brief questionnaire of smoking urges; PDS: Psychological Distress Scale; DTS: Distress intolerance scale; SHAPS: Snaith-Hamilton Pleasure Scale; BIS-11: Barratt Impulsiveness Scale-11; MSQ: metacognitions about Smoking Questionnaire; PM-CR: positive metacognitions about cognitive regulation; PM-ER: positive metacognitions about emotional regulation; NM-U: negative metacognitions about uncontrollability; NM-CI: negative metacognitions about cognitive interference.

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

Table S1

Socio-demographic and clinical characteristics of smoking-dependent men ($n = 300$).

Characteristics	Mean \pm S.D or n (%)	Skewness	Kurtosis
Age, years	34.61 \pm 10.29	-	-
Education	10.36 \pm 3.20	-	-
Marital status		-	-
Single	139 (46.3%)	-	-
Married	149 (49.7%)	-	-
Divorced	12 (4%)	-	-
Age of onset of smoking use	18.71 \pm 6.06	-	-
Duration of smoking use	15.70 \pm 9.85	-	-
Number of daily cigarettes smoked	18.28 \pm 7.71	-	-
QSU-brief	46.18 \pm 11.80	-.18	-.07
FTND	5.87 \pm 2.06	-.08	-.28
MNWS	25.3 \pm 7.56	-.60	.14
PDS	32.22 \pm 7.06	-.18	.15
DTS	34.60 \pm 9.60	.24	.18
SHAPS	34.16 \pm 12.45	.78	.56
BIS-11	77.74 \pm 12.90	.15	.60
MSQ PM-CR	11.37 \pm 3.82	-.09	-.83
MSQ PM-ER	12.97 \pm 3.20	-.10	-.25

MSQ NM-U	12.86±3.28	-.03	-.39
MSQ NM-CI	12.79±3.19	-.29	-.22

Note.

QSU- brief: brief questionnaire of smoking urges; FTND: Fagerstrom Test for Nicotine Dependence; MNWS: Minnesota Nicotine Withdrawal Scale; PDS: Psychological Distress Scale; DTS: Distress intolerance scale; SHAPS: Snaith–Hamilton Pleasure Scale; BIS-11: Barratt Impulsiveness Scale-11; MSQ: metacognitions about Smoking Questionnaire; PM-CR: positive metacognitions about cognitive regulation; PM-ER: positive metacognitions about emotional regulation; NM-U: negative metacognitions about uncontrollability; NM-CI: negative metacognitions about cognitive interference.