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REVIEW

# Theory of planned behavior and smoking: meta-analysis and SEM model

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**Abstract:** To examine if the theory of planned behavior (TPB) predicts smoking behavior, 35 data sets (N = 267,977) have been synthesized, containing 219 effect sizes between the model variables, using a meta-analytic structural equation modeling approach (MASEM). Consistent with the TPB's predictions, 1) smoking behavior was related to smoking intentions (weighted mean $r = 0.30$), 2) intentions were based on attitudes (weighted mean $r = 0.16$), and subjective norms (weighted mean $r = 0.20$). Consistent with TPB's hypotheses, perceived behavioral control was related to smoking intentions (weighted mean $r = -0.24$) and behaviors (weighted mean $r = -0.20$) and it contributes significantly to cigarette consumption. The strength of the associations, however, was influenced by the characteristics of the studies and participants.

**Keywords:** theory of planned behavior, smoking, meta-analysis, structural equation modeling

Smoking remains the leading preventable cause of death and disease in Western countries. Despite the constant reduction in smoking prevalence among adults over the last 20 years in developed countries, smoking rates have not decreased among young people, and the highest youth smoking rates can be found in Central and Eastern Europe.

In an attempt to understand the psychosocial determinants of smoking initiation and maintenance, a variety of social cognitive models has been applied. One of the most influential theories predicting smoking behavior, the theory of planned behavior (TPB)[1] has been used both for conducting a wide range of empirical research on smoking behavior antecedents and for designing many theory-based intervention programs to reduce tobacco consumption. An increasing number of empirical studies have examined this model in relation to smoking and the variability of results suggests that a quantitative integration of this literature would prove valuable. To date, various quantitative reviews of the TPB have been performed but centered in other behavioral outcomes, such as exercise,[2] condom use,[3] and others. Hence, the purpose of this study was to evaluate the success of the TPB as a predictor of smoking behavior through meta-analytic structural equation modeling (MASEM), involving the techniques of synthesizing correlation matrices and fitting SEM as suggested by Viswesvaran and Ones.[4]

The TPB, an extension of the theory of reasoned action,[5] incorporates both social influences and personal factors as predictors, specifying a limited number of psychological variables that can influence a behavior, namely 1) intention; 2) attitude; 3) subjective norm (SN); and 4) perceived behavioral control (PBC).[1] First, subjective norms are conceptualized as the pressure that people perceive from important others

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to execute a behavior. Second, people's positive or negative evaluations of their performing a behavior are conceptualized as other predictors of intention (attitudes). Third, PBC represents one's evaluation about the ease or difficulty of adopting the behavior, and it is assumed to reflect the obstacles that one encountered in past behavioral performances. Finally, attitudes, SN, and PBC are proposed to influence behavior through their influence on intentions, which "summarize a person's motivation to act in a particular manner and indicate how hard the person is willing to try and how much time and effort he or she is willing to devote in order to perform a behavior" as Rivis and Sheeran defined.[6]

The TPB has been applied through a relevant amount of primary studies and its predictive utility has been proved meta-analytically both for a wide range of behaviors[6,7] and for specific health-risky or health-protective behaviors.[2,3] These previous meta-analyses, however, have neither examined how useful the TPB is to predict smoking behavior, nor the overall structure of the model applied to tobacco consumption. Hence, some concerns remain about TPB and its utility to predict smoking behavior that deserve further examination through MASEM.

Firstly, a weakness of the SN–intention association has been found by previous meta-analysis[7] compared with attitude–intention and PBC–intention associations. It has been suggested that this lack of association indicates that intentions are influenced primarily by personal factors.[6] Some primary studies, such as Hanson,[8] found strong beta values ranging from 0.44 to 0.62 for attitude on smoking intention, but others found values near to 0.18 or 0.19.[9,10] At the same time, although researchers have theorized about the importance of PBC for health-risky behaviors in this domain, the correlation between PBC and behavior has sometimes been disappointing.[3] One possible explanation is that PBC may not capture actual control. Another explanation is that risky behaviors performed in social contexts may be determined more by risky-conducive circumstances than by personal factors.[11] Moreover, primary studies on smoking behavior have found contrasting results for PBC–behavior, such as $r = 0.55$[12] or $r = 0.06$.[13] Based on these discrepant findings, we proposed, as a first purpose of this review, to test the strength of relationships between TPB constructs applied to smoking behavior.

Secondly, in order to clarify the influence of moderator variables and to provide further explanation for the variability on the effect sizes (ES) between primary studies, some studies' and participants' characteristics may be taken into account. Ajzen and Fishbein[5] argued that intention and behavior should be measured as close in time as possible to the behavior. In spite of this, primary studies on smoking behavior[14,15] have found that beta values for intention–behavior association have been maintained during 6 months ($\beta = 0.38$), 9 months ($\beta = 0.35$), and 1 year ($\beta = 0.35$). Thus, it is important to quantitatively review the moderator effect of time interval on strength of TPB constructs.

It has been recognized that culture provides a social context that affects prevalence of certain behaviors. Moreover, some studies, such as Hanson,[8] have compared results of TPB applied to smoking behavior by using diverse ethnic groups in the United States, while a great amount of primary studies have expanded their applicability to different cultural contexts.[10,15,16] These studies have revealed contradictory results. For example in Puerto-Ricans and non-Hispanic whites SN was not a significant predictor of intention,[8] but was a significant predictor in African-American teenagers; and beta values for SN–behavior ranged from $\beta = 0.20$ for United Kingdom samples[17] to $\beta = 0.43$ for Netherlands students.[8] Hence, because of cultural differences in the SN–outcomes association, there is a need to meta-analytically examine the moderator effect of culture.

Ajzen and Fishbein[5] and Ajzen[19] also recommended scale correspondence of measures for intention to properly predict behavior. However, a meta-analysis on TPB applied to exercise behavior has found that only 50% of examined studies had scale correspondence,[20] and that ES was the strongest for the intention–behavior association when studies had scale correspondence.[2] Based on these previous findings, we contend that a thorough examination of moderator effect of scale correspondence on strength of smoking intention and behavior relationships is needed.

Research indicates that teenage years are associated with heightened sensitivity to SN[6] and differences have been found in previous meta-analyses between age groups on their intention–exercise behavior association.[2] At the same time, only 1 study has tested gender differences when applying TPB to cigarette smoking,[13] finding that the model fitted better among female students. Despite the fact that no consistent evidence has been found relating to the moderator effect of age and gender on the TPB constructs association, we consider that an exploratory analysis would be advisable.

Thirdly, while previous studies on TPB on smoking behavior had used stepwise regression analyses, more recent ones apply SEM or path-analyses. When all TPB relationships were tested simultaneously, the same patterns would change. For instance, after controlling the influence of intention, the PBC–behavior association would change to negligible values ($\beta = 0.05$), such as Albarracín et al[3] proved for condom use. Moreover, based on the fruitful results of meta-analyses obtained in many research domains,[3,21–25] it can be beneficial to use MASEM in testing causal models, such as some authors suggested.[4,26]

Based on these methodological and conceptual issues, this meta-analysis has 3 main objectives. The first objective was to test the strength of the relationships between the TPB constructs and smoking behavior. Specifically, we hypothesized: 1) large ES for intention–behavior, PBC–intention, PBC–behavior, and attitude–intention; 2) moderate ES for SN–intention; 3) larger ES for intention–behavior than for PBC–behavior; and 4) larger ES for PBC–intention and SN–intention than for attitude–intention. The second objective was to test the influence of moderator variables on the relationships between the TPB constructs. Specifically, we proposed 5) larger ES for attitude–behavior, PBC–behavior, SN–behavior, and intention–behavior when measures have been taken simultaneously; 6) larger ES when the time interval was shorter; 7) the largest ES for SN–intention and SN–behavior when participants belong to a collectivist culture, coded as *Others* into the category *origin of the sample*; 8) larger ES for attitude–intention, SN–intention, PBC–intention, and intention–behavior when constructs have been measured with scale correspondence; and 9) mean age of the sample, percentage of males, and year of publication would moderate the relationships among TPB constructs. The third objective was to test the predictive utility of TPB on smoking behavior through MASEM analyses. Specifically, we hypothesized that: 10) intention and PBC will predict smoking behavior; 11) attitude, PBC, and SN will predict intention, and 12) intention will be a stronger predictor of behavior than PBC.

# Method

## Literature search

In order to locate relevant studies, we conducted a computerized bibliographic search of the PsycInfo, MedLine, and ERIC, using the terms *smoke*, *smoking behavior*, *nicotine*, *tobacco consumption*, and *TPB* as keywords. We also conducted a manual search of journals that regularly publish smoking behavior research. Descendent searches have been conducted based on the references section of retrieved studies – specifically previous TPB meta-analyses including multiple behavioral outcomes – and some authors have been contacted to obtain unpublished papers. This processes resulted in 52 studies retrieved in full text for further screening.

## Inclusion and exclusion criteria

A study was considered for this meta-analysis if it met the following inclusion criteria: 1) the study had to report quantitative research on TPB applied to smoking behavior; 2) the study had to report a Pearson correlation coefficient between TPB constructs or data that enabled us to calculate ES. Upon closer examination of the remaining 52 studies, a total of 27 studies were included which provided 35 independent samples (N = 267,977) and 219 ES. A total of 25 studies were excluded. Reasons for elimination were that TPB construct measures were not included (8 studies), ie,[27] or that the studies were focused on smoking cessation instead of on smoking behavior (17 studies), ie,[28,29]. Only 1 dissertation has been included and no unpublished papers have been obtained. The studies that focused on smoking cessation have been excluded because the outcome variable in the model – smoking behavior versus smoking cessation – differs substantially. These studies will be used to conduct a separate meta-analysis on smoking cessation. All the included studies are listed prior to the reference section.

## Coding of studies

The *study characteristics* coded were: year of publication, origin of the sample, scale correspondence, and time interval between TPB measures. The *subject characteristics* coded were: the number or participants, mean age of the sample, and gender (as percentage of men in the sample). We consider it relevant to code how smoking behavior was assessed (ie, objective vs self-report) but we could find only 1 study that used objective measures, such as CO (*carbon monoxide*) tests.[30] Following the procedures of Symons and Hausenblas,[2] the time interval between intention and behavior was examined by classifying the studies as: 1) short ($\leq$6 months), 2) medium ($>$6 months and $\leq$1 year), 3) large ($>$1 year). For scale correspondence, we examined the methods section of each study in search of detailed information. As Symons and Hausenblas suggested,[2] scale correspondence has been fulfilled when the same magnitude, frequencies, or response formats are used to assess the constructs. If intention and behavior were measured exactly with the same items, we considered that scale equivalence was present. If intention was measured with a broader selection (ie, *How certain are you that you could resist smoking this* *term?*) while behavior was assessed by a more detailed item (ie, *How many cigarettes did you smoke per day?*), or by asking participants to classify themselves as nonsmoker/current-smoker, we considered that scale correspondence had not been fulfilled.

In order to ensure accuracy, the studies were coded by 2 authors independently, reaching an intercoder agreement of 90%. The level of agreement reached was highly satisfactory and inconsistencies were solved by consensus. Some decisions about independence of the samples were taken. If the same study design was carried out in multiple but independent samples (ie, boys and girls, asthmatic and nonasthmatic students, African-American, Puerto Rican and non-Hispanic white teenagers) results were entered into the meta-analysis as independent samples.[8,13,18] In other cases, only 1 ES per study has been considered.

## Data analysis

We followed Hedges and Oldkin's[31] meta-analytic fixed effects procedures to estimate weighted mean correlations. In these procedures, correlations were converted using Fisher's $r$ to $z$ transformations and weighted by N – 3, the inverse of which is the variance of $z$, in analyses. Using Cohen's criteria,[32] ES values of 0.10, 0.30, and 0.50 were considered small, moderate, and large effects, respectively. Graphical procedures were used to explore the skewness of data. When an extreme value was detected, analyses were carried out both including and excluding the outlier. Next, we tested the homogeneity of the ES ($Q$ statistics) and we analyzed the influence of moderator variables using categorical model (ANOVA analogous) and weighted regression analyses (fixed-effect model). One problem in the interpretation of meta-analytic results is the potential bias of the mean ES due to sampling error or to systematic omission of studies that are hard to locate. According to Orwin,[33] the "tolerance index of null results" should be calculated and there must be more than 300 unpublished studies (and not recovered by the meta-analyst) for the results to be annulled. However, this statement should be qualified because the index by categories yields small values in some of these categories. Therefore, we can conclude that publication bias is unlikely to threaten the results severely.

## MASEM analyses

MASEM, which involves the techniques of synthesizing correlation matrices and fitting SEM, is usually done by applying meta-analytic techniques on a series of correlation matrices to create a pooled correlation matrix, which then can be analyzed using SEM, as suggested Viswesvaran and Ones.[4] However, these procedures have received criticism by Becker[34] and more recently by Cheung and Chan.[26] Despite some problems, the major advantage of these univariate approaches is their ease of application in applied contexts. Based on these recommendations, we used Viswesvaran and Ones' procedure to test the strength of the association among the TPB constructs with smoking behavior. The complete weighted correlation matrix was 5 × 5 and it was submitted to SEM analyses. The predicted model was fitted assuming the harmonic mean (N = 239) as sample size,[4] and it was estimated with unweighted least squares procedures. The proposed model, according to TPB literature, had 3 exogenous latent variables and 2 endogenous ones, such as depicted in Figure 1. Besides chi-square, we reported goodness of fit index (GFI), adjusted goodness of fit index (AGFI), normative fit index (NFI), and root mean squared residual (RMR) as fitness indices. It is typically assumed that GFI, AGFI, and NFI $\geq$ 0.90, and RMR values $\leq$0.06 are indicators of a good fit to the data (Figure 1).

# Results

## Description of studies

Most of the studies were conducted in the 2000s (n = 19), followed by the 1990s (n = 7), and the 1980s (n = 1). The majority of studies included European samples (n = 14), followed by United States' samples (n = 9), and other countries' samples (n = 4). The most common design was cross-sectional, with 16 studies having taken TPB measures simultaneously. Most of the other studies had a medium interval of time between measures (n = 5), followed by a large interval (n = 3), and a short interval (n = 3). The majority of the studies did not have scale correspondence (n = 18). A total of 267,977 participants were included in the 27 studies of this meta-analysis. Mean age of participants was 13.7 (SD = 2.4) and mean percentage of males in the samples was 43.2% (SD = 21%). All the studies were conducted with young participants (age range 10 to 21 years), whereas 1 study excluded the information of the participants' age.

Despite the fact that only 1 ES per study was considered, the multiple testing problem remained and could lead

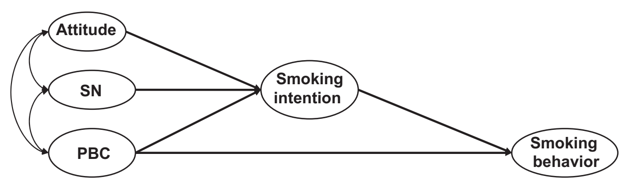


**Figure 1** Proposed MASEM model.
**Abbreviations:** MASEM, meta-analytic structural equation modeling approach; SN, subjective norm; PBC, perceived behavioral control.

to erroneous conclusions. We addressed the issue of multiple comparisons by focusing on lower $P$-values, such as $P < 0.01$. Another difficulty in understanding meta-analysis results is the nonintuitive nature of ES statistics. In order to properly interpret the ES, we recommend the rule of thumb established by Cohen:[32] a small ES means that the pair of variables under consideration is statistically independent, a medium ES means that the 2 variables covariate moderately, and a large ES represents 2 variables that covary perfectly or nearly perfectly. If the ES is positive, these variables vary closely together in the same direction, whereas if the ES is negative, they vary in opposite directions.

### First objective: Strength of the relationships between TPB constructs with smoking behavior

By examining global ES in Table 1, we could affirm that only partial support was found for hypotheses 1 to 4. Contrary to our hypothesis, medium ES was obtained for the intention–behavior association, while small ES was found for the attitude–intention, PBC–intention, and PBC–behavior relationships. Contrary to our second hypothesis, a small ES was obtained for the SN–intention association. For the third and fourth hypotheses, support was found. ES was larger for the intention–behavior association than for PBC–behavior association, confirming our prediction, and ES was larger for PBC–intention and SN–intention than for attitude–intention associations (Table 1).

### Second objective: Influence of moderator variables on the relationships between the TPB constructs

Examining $Q$ statistic values (Table 1), we concluded that variability of the ES was significant and results showed a clear heterogeneity of the ES. We therefore performed moderator variables analyses to test hypotheses 5 to 9.

Hypotheses 5 and 6 found support in the data (Table 2). ES were larger when TPB construct measures were taken simultaneously. Moreover, when the design implied a time interval between measures of TPB predictors and measures of smoking behavior, larger ES were found for those studies with a short interval than for those with a medium/long interval (Table 2).

We had hypothesized that the largest ES for the associations SN–intention and SN–behavior would be for participants from collectivist cultures, coded as *Others* in the category origin of the sample. Hypothesis 7 has not been supported because the largest ES were for European samples (Table 3).

Significant larger ES have been found for attitude–intention, SN–intention, PBC–intention, and intention–behavior when the study had scale correspondence, supporting hypothesis 8 (Table 4).

The moderating influence of quantitative variables – mean age of participants, percentage of males in the sample, and year of publication – on the TPB constructs association was examined to test hypothesis 9. For attitude–intention association, $R^2 = 0.44$ was reached and ES was higher with recent studies and/or younger participants. $R^2 = 0.34$ was found for intention–behavior association, and ES was higher for more recent studies and/or with older participants. Mean age was the better predictor for PBC–intention and PBC–behavior association, reaching $R^2 = 0.17$ and $R^2 = 0.25$, respectively, and ES was higher for studies with older participants. Finally, for SN–intention associations, percentage of males in the sample, and year of publication were the better predictors (Table 5).

### Third objective: To test the predictive utility of TPB on smoking behavior

We performed SEM analysis based on the pooled correlation matrix and the model had acceptable fit indices

**Table 1** Mean weighted effect sizes for each meta-analysis

| TPB constructs association | *k* | Total N | Weighted *r* | CI 95% | | Q (*df*) | Tolerance index of null results |
|---|---|---|---|---|---|---|---|
| | | | | LI | UI | | |
| Attitude–intention | 27 | 27,965 | 0.16 | 0.15 | 0.17 | 3880.05 (26)*** | 32 |
| Attitude–behavior | 20 | 31,793 | 0.17 | 0.16 | 0.18 | 3734.13 (19)*** | 28 |
| SN–intention | 25 | 28,346 | 0.20 | 0.18 | 0.21 | 1730.29 (24)*** | 49 |
| SN–behavior | 19 | 29,633 | 0.15 | 0.14 | 0.16 | 1793.4 (18)*** | 17 |
| PBC–intention | 23 | 27,637 | –0.24 | –0.25 | –0.23 | 1836.64 (19)*** | 116 |
| PBC–behavior | 20 | 27,978 | –0.20 | –0.21 | –0.19 | 2804.88 (19)*** | 101 |
| Attitude–PBC | 22 | 24,223 | –0.34 | –0.35 | –0.33 | 2411.80 (21)*** | 77 |
| Attitude–SN | 23 | 24,646 | 0.37 | 0.36 | 0.38 | 497.85 (22)*** | 42 |
| PBC–SN | 22 | 24,294 | –0.13 | –0.14 | –0.12 | 1936.23 (21)*** | 29 |
| Intention–behavior | 18 | 21,462 | 0.30 | 0.28 | 0.31 | 864.52 (15)*** | 65 |

**Notes:** *$P < 0.05$; ** $P < 0.01$; ***$P < 0.001$.
**Abbreviations:** *k*, number of correlations; CI, confidence interval; LI, lower limit; UI, upper limit; SN, subjective norm; PBC, perceived behavioral control; TPB, theory of planned behavior.

**Table 2** Weighted analysis of variance as a function of the time interval

| TPB constructs association | Simultaneously vs not simultaneously | | | Short-medium-long interval | | | |
|---|---|---|---|---|---|---|---|
| | *Qb* (*df*)/*Qw* (*df*) | Effect size | | *Qb* (*df*)/*Qw* (*df*) | Effect size | | |
| | | Simultaneously | Not simultaneously | | Short | Medium | Long |
| Attitude–behavior | 789.6 (1)***/2944.5 (18)*** | 0.25 | 0.002 | 386.9 (2)***/169.5 (6)*** | 0.45 | 0.41 | −0.05 |
| SN–behavior[b] | 10.7 (1)***/1645.6 (15)*** | 0.16 | 0.13 | 82.3 (2)***/20.7 (5)** | 0.42 | 0.13 | 0.11 |
| PBC–behavior | 174.6 (1)***/2630.2 (18)*** | −0.24 | −0.11 | 150.9 (2)***/183.4 (5)*** | −0.33 | −0.27 | −0.10 |
| Intention–behavior[a] | 146.6 (1)***/393.6 (15)*** | 0.59 | 0.33 | 51.5 (2)***/93.3 (8)*** | 0.36 | 0.51 | 0.32 |

**Notes:** *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$. [a]Excluded Carvajal et al[42] as outlier; [b]Excluded Hill et al[47] as outlier.
**Abbreviations:** TPB, theory of planned behavior; SN, subjective norm; PBC, perceived behavioral control.

**Table 3** Weighted analysis of variance as a function of the sample origin

| TPB constructs association | *Qb* (*df*)/*Qw* (*df*) | Effect size | | |
|---|---|---|---|---|
| | | USA | EU | Others |
| SN–behavior[a] | 902.2 (2)***/770.7 (15)*** | −0.08 | 0.30 | 0.12 |
| SN–intention | 133.7 (2)***/408.8 (20)*** | 0.30 | 0.32 | 0.18 |

**Notes:** *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$. [a]Excluded Hill et al[47] as outlier.
**Abbreviations:** SN, subjective norm; PBC, perceived behavioral control; TPB, theory of planned behavior.

[$\chi^2$ (*df*) = 0.63 (13), GFI = 0.997, AGFI = 0.98, RMR = 0.014, NFI = 0.97]. According to the goodness-of-fit statistics, the TPB was an adequate model to predict smoking behavior. Intention and PBC predicted smoking behavior, and attitude–SN–PBC predicted intention, as shown by squared multiple correlations ($R^2 = 0.12$ and $R^2 = 0.13$, respectively), providing support for hypotheses 10 and 11.

Finally, for hypothesis 12, standardized regression coefficients showed that intention was a stronger predictor of behavior than PBC (Figure 2).

If one wishes to know what provokes the behavior of smoking, the clear intention of performing the behavior seems to be the best predictor. But this intention, in turn, has antecedents. The variable SN has the most impact on the intention, whereas PBC reduces this intention, as well as the performance of the behavior, but the strength of its determination is lower than that of SN. Lastly, attitudes seem to have a weak impact on the intention of smoking.

## Discussion

The aim of this meta-analysis was 3-fold. The first objective was to examine the strength of the relationships between TPB constructs and smoking behavior. The second was to test the influence of moderator variables on the relationships between TPB constructs. The third objective was to examine the predictive utility of TPB on smoking behavior. We can affirm that the predictive validity of TPB on smoking has been proved, based on our findings obtained through meta-analysis and SEM. A thorough inspection of our results deserves further discussion.

The first set of hypotheses has been partially confirmed. On the one hand, we found that ES among TPB constructs were only moderate or small, contrary to our hypothesis. On the other hand, and supporting our hypothesis, we found that the best predictor of intention was PBC, followed by SN and attitude. These findings were consistent with previous meta-analytical research suggesting that health-risky behaviors may be determined more by what the person is willing to do

**Table 4** Weighted analysis of variance as a function of the scale correspondence

| TPB constructs association | *Qb* (*df*)/*Qw* (*df*) | Effect size | |
|---|---|---|---|
| | | With scale correspondence | Without scale correspondence |
| Attitude–intention | 251.9 (1)***/3628.2 (25)*** | 0.31 | 0.10 |
| SN–intention[a] | 10.03 (1)**/1660.1 (22)*** | 0.23 | 0.19 |
| PBC–intention | 145.4 (1)***/1691.3 (18)*** | –0.36 | –0.20 |
| Intention–behavior | 25.6 (1)***/837.9 (16)*** | 0.35 | 0.28 |

**Notes:** *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$. [a]Excluded Godin et al[45] as outlier.
**Abbreviations:** SN, subjective norm; PBC, perceived behavioral control; TPB, theory of planned behavior.

in risk-conducive circumstances than by personal attitudes.[11] In relation to this point, we suggest that a thorough examination of empirical findings is necessary, considering that a different set of results would be obtained as a function of the *health status* of the behavior. Despite the fact that TPB has proved its predictive effectiveness both for health-protective and health-risky behavior, a divergent pattern of relationships between TPB constructs would emerge for each group of outcomes. As suggested by the prototype–willingness model,[35] in the context of those healthy-risky behaviors that are performed in social contexts (smoking cigarettes, drinking alcohol), the social settings can afford opportunities to engage in risky behaviors that might overwhelm people's good intentions.

The second set of hypotheses obtained mixed support. Study characteristics were the first category of moderator variables that influenced the TPB constructs relationships. Our meta-analysis supported the idea that temporal contiguity affects how well SN–attitude, PBC, and intentions predict behavior. These results were consistent with previous meta-analyses[11,36] using a wide range of behavioral outcomes.

Cultural influences could affect the strength of SN–intention and SN–behavior associations, but results deserve closer scrutiny. We hypothesized that ES might be larger when participants belong to a collectivist culture but it has not been confirmed by results. Perhaps, as Guo et al[15] suggested, smoking prevention and cessation programs have been implemented, reducing smoking prevalence rates in Asian societies – coded as *Others* in this review – during the 2000s. Therefore, for Asian samples, normative influences against tobacco consumption are powerful, being partially responsible for shorter ES for SN–intention and SN–behavior.

Relevant results were obtained on the influences of scale correspondence. ES were larger for the TPB predictors–intention relationships in studies with scale correspondence, and the same pattern was obtained for the intention–behavior association. These results are in line with previous meta-analytic findings,[2] supporting recommendations made by Ajzen.[19]

Finally, multiple regression analyses showed that age reached significant standardized coefficients. On the one hand, beta value was negative for the attitude–intention relationships, indicating that studies with younger participants exhibited a stronger ES compared with studies with older participants. On the other hand, beta values for age were positive in the PBC–intention, PBC–behavior, and intention–behavior associations, showing that studies with older participants reached larger ES than those with younger participants. At the same time, it has been proven to be related to other outcomes – exercise or condom use – older people have better volitional control.[2] This pattern of results is consistent with the notion that the more one has performed a behavior in the past, the more likely it is that one will perceive control over that behavior.[3] Evidence from life span developmental psychology has suggested that adolescents and young adults are

**Table 5** Weighted regression analyses

| TPB constructs association | Predictors: mean age, percentage of men in the sample year of publication | | | Standardized regression coefficients | | |
|---|---|---|---|---|---|---|
| | $Q_R$ (*df*) | $Q_E$ (*df*) | $R^2$ | Age | % of men | Year publication |
| Attitude–intention | 1669,13 (3)*** | 2152,67 (17)*** | 0.44 | –0.38*** | 0.00 | –0.45*** |
| SN–intention | 78,99 (3)*** | 1647,85 (19)*** | 0.05 | 0.03 | –0.08** | –0.20*** |
| PBC–intention | 319,70 (3)*** | 1525,69 (17)*** | 0.17 | 0.41*** | 0.13*** | –0.15*** |
| PBC–behavior | 481.42 (3)*** | 1412,78 (13)*** | 0.25 | 0.48*** | 0.06 | –0.23*** |
| Intention–behavior | 211,3 (3)**** | 411,11 (12)*** | 0.34 | 0.19*** | –0.23*** | –0.56*** |

**Notes:** *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.
**Abbreviations:** SN, subjective norm; PBC, perceived behavioral control; TPB, theory of planned behavior.

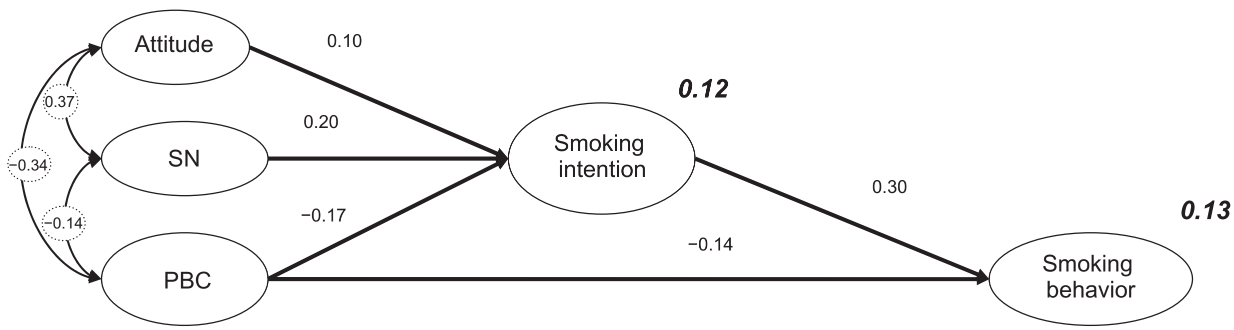


**Figure 2** MASEM analysis.
**Abbreviations:** MASEM, meta-analytic structural equation modeling approach; SN, subjective norm; PBC, perceived behavioral control.

particularly sensitive to the conformity pressures associated with real and perceived social norms.[6,37]

Year of publication reached negative beta values. In this sense, we argue that if methodological quality of studies has been improved over time, previous studies may use less rigorous procedures that produce larger ES compared with the ES in recent research. It seems likely that relationships between TPB predictors and criterion variables will differ significantly according to the methodological rigor of the studies included.

The third set of hypotheses has also been supported through MASEM analysis. Thus, people are more likely to smoke if they have previously formed the corresponding intentions; and these intentions appear to derive from attitudes, SN, and PBC. These results showed that TPB is a highly successful predictor of smoking behavior. An interesting finding was that attitudes showed the lowest standardized coefficient on intentions, compared with SN and PBC. Perhaps, elicited beliefs in included studies have tended to be cognitive and/or instrumental rather than affective, while for risky behaviors there is now growing evidence for the role of affect.[38] As Lowenstein and colleagues suggested,[39] when cognition and emotional reaction diverge, it is often the latter that drives behavior. In this sense, Ajzen and Fishbein[40] stressed affective components when measures of attitudes have been taken.

Table 1 shows that PBC has the strongest ES both on intention and behavior. Despite this fact, when all the relationships were tested simultaneously through SEM, the latter impact of PBC was smaller compared with SN. These findings are consistent with data reported by Reinecke et al[41] in which bivariate correlations of PCB and outcomes ranged from 0.24 to 0.32, but the same associations became negligible after controlling for the influence of other TPB predictors. Moreover, a previous meta-analysis found a similar pattern of results.[3] Thus, PBC and actual control should be discrepant because environmental and personal constraints would exert their influence on behavior (ie, considering cigarette smoking, an environmental barrier might be that everyone at work smokes and a personal barrier might be nicotine dependence) such as Armitage and Conner suggested.[7] In this sense, we could suggest that future researchers deeply explore different conceptualization and operationalization of PBC (ie, behavioral intentions vs behavioral expectations), because it is reasonable to expect that the accuracy of self-reports will vary as a function of the TPB construct operationalization. While some alternatives have been used in TPB research, the reduced number of studies on smoking behavior did not enable us to compare ES among these categories.[42–44] As Albarracin et al recommended,[3] future research comparing many and diverse measures of PBC will provide some solutions to this problem. Moreover, PBC effects on risky-behavioral outcomes need to be analyzed deeply. It would provide us with a better understanding of the negative relationship between PBC and smoking and behavior, which remains unclear.[45–48]

## Limitations, suggestions for future research and practical implications

Several limitations of this study need to be discussed. First, the most important limitation of this review was that it included only a limited number of primary studies. We have tried to avoid this problem through an exhaustive bibliographic research, but fail-safe N[33] for some categories have been reduced. In spite of this fact, this review represents an initial effort to prove the TPB predictive utility on smoking behavior.[49–52] Second, the current conclusions assume that self-reported behaviors are accurate reflections of people's actions, and we acknowledge the limitations of correlational analyses, especially in the light of studies that manipulate smoking intentions. Nevertheless, based on differences found between percentage of variance explained by TPB in observed or self-reported behaviors,[7] it would be reasonable to expect that the accuracy of relationships will increase if smoking behavior is measured objectively, such as via saliva nicotine levels or other biochemical procedures.

For methodological considerations, first, we can state that a relevant amount of information was unavailable in primary studies, which implies that some useful moderator analyses could not be conducted due to this lack of information. Second, the correlations we summarized have a considerable variability across the 31 databases that provided ES. This wide heterogeneity indicates the presence of some measurement factors that have the potential to increase some correlations and decrease others (ie, a measurement factor related to the reliability of the measures used to assess the TPB variables). Unfortunately, such as we previously stated, studies infrequently provided this information, making comparisons difficult. Third, the use of the pooled correlation matrix as the input for adjusting a SEM assumes that the correlation matrices employed are homogeneous. However, this is not the case, as many of the joint estimates yield significant *Q* values, which indicate heterogeneity, so it would be considered threatening for our conclusions. Combining meta-analytic procedures with SEM proved to be a difficult task, given the large quantity of missing data in the pooled correlation matrix. To avoid this problem in future, primary studies should report the correlation matrix of all variables.

Lastly, we would like to note for future research that this meta-analysis has detected certain limitations in the empirical investigation approach to smoking behavior. This has led to a number of predictor variables of great interest from the psychosocial perspective that were not meta-analyzed in this review because only 1 or 2 empirical studies were included. Such variables include self-efficacy, social support, previous history of consumption, and peer identification. The explanatory limitation of these models of smoking behavior may lie in this aspect, as most of the models are mere replications of studies initiated by TPB research tradition and they have overlooked the importance of the interaction of personal variables with other contextual characteristics to determine tobacco consumption. We also call attention to the fact that the models reviewed in the empirical studies also tended to concentrate on classical TPB indicators, ignoring group variables explored in smoking cessation research, such as identification with peers, which could play mediating roles in the relation with tobacco addiction.

To conclude, we indicate some practical implications of our results. From the individual viewpoint, smokers should be aware that PBC exerts a powerful influence both on the intention and the behavior of smoking. In this sense, any attempt to cease smoking should seek to strengthen PBC, because this perception is a powerful personal tool in behavior modification.[53] From the viewpoint of smoking prevention, the strength of SN on the intention of smoking and on behavior is very important. Therefore, we suggest that as long as prevention campaigns do not change society's global appraisal of tobacco consumption, long-term individual behaviors will not be modified.[54–56] Lastly, from the viewpoint of public health, it is necessary to consider the cultural variations of the above-mentioned relationships. Our results are not conclusive but they reveal that the influence of SN on the intention to smoke and on smoking behavior is modified depending on whether the participants belong to countries with individualistic or collectivist cultures. From these results we recommend taking into consideration diverse national cultures when designing smoking prevention campaigns aimed at adolescents and youth.

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The following studies have been included in this meta-analysis: references.[8–10,12–18, 38, 42–54]

## Disclosure

The authors report no conflicts of interest in this work.

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