Journal Website

Article history:
Received 04 December 2025
Revised 07 April 2026
Accepted 15 April 2026
Initial Publication 20 June 2026
Final Publication 01 July 2026

Iranian Journal of Neurodevelopmental Disorders

Volume 5, Issue 4, pp 1-12

Journal of Neurodevelopmental Disorder

E-ISSN: 2980-9681

Comparison of the Effect of Intolerance of Ambiguity on the Tendency Toward Cigarette Smoking and Electronic Vaping in Bipolar Adolescents and Adolescents with Risky Behaviors

Fatemeh. Sohrabi[1], Negare. Shahbazi[2], Shahnaz. Nezami Rashid [3], Zahra. Shadfar[4], Fariba. Rezagholi[5*]

[1] M.A., Department of Counseling, NT.C., Islamic Azad University, Tehran, Iran
[2] M.A., Department of Counseling, Faculty of Education and Psychology, University of Mohaghegh Ardabili, Ardabil, Iran
[3] M.A., Department of Public Psychology, Payame Noor University, Ardabil, Iran
[4] M.A., Department of Clinical Psychology, Se.C., Islamic Azad University, Semnan, Iran
[5] M.A., Department of Educational Psychology, Payame Noor University, Tehran, Iran

*** Corresponding author email address**: faribarezagholi66@gmail.com

Article Info

Article type:
Original Research

How to cite this article:
Sohrabi, F., Shahbazi, N., Nezami Rashid, S., Shadfar, Z., & Rezagholi, F. (2026). Comparison of the Effect of Intolerance of Ambiguity on the Tendency Toward Cigarette Smoking and Electronic Vaping in Bipolar Adolescents and Adolescents with Risky Behaviors, Rasht. *Iranian Journal of Neurodevelopmental Disorders, 5*(4), 1-12.
https://doi.org/10.61838/kman.jndd.754

ABSTRACT

Purpose: The present study aimed to compare the effect of intolerance of ambiguity on the tendency toward cigarette smoking and electronic vaping in bipolar adolescents and adolescents with risky behaviors.
Materials and Methods: This study was descriptive–correlational and cross-sectional in design. Path analysis and multi-group analysis (MGA) were conducted using SmartPLS version 4 to examine the relationships within the model. The study population included all adolescent students in Tehran during November to December 2024. A purposive sampling method was employed, and the sample consisted of 68 participants (34 bipolar adolescents and 34 adolescents with risky behaviors). The research instruments included the "Multiple Stimulus Types Ambiguity Tolerance Scale" (MAT) and the "Adolescent Cigarette and E-Cigarette Susceptibility Tendency" (ACSV T) questionnaire. Data were analyzed using SPSS version 27 and the Mann–Whitney U test. The significance level was set at 0.05.
Findings: The overall model results indicated that intolerance of ambiguity had a significant negative effect on the tendency toward cigarette smoking ($\beta = -0.640$, $T = 7.628$, $p < 0.001$) and electronic vaping ($\beta = -0.846$, $T = 28.607$, $p < 0.001$). The MGA results revealed a significant difference between the two groups in the effect of intolerance of ambiguity on the tendency toward cigarette smoking ($p = 0.006$), with a stronger effect observed in adolescents with risky behaviors ($\beta = -0.894$, $p < 0.001$) compared to bipolar adolescents ($\beta = -0.535$, $p = 0.003$). However, no significant difference was found between the groups in the path from intolerance of ambiguity to the tendency toward electronic cigarette use ($p = 0.353$).
Conclusion: The findings indicate that intolerance of ambiguity plays a significant role in adolescents' tendency toward cigarette smoking and electronic vaping, with a stronger effect observed among adolescents with risky behaviors compared to bipolar adolescents. These results highlight the importance of addressing cognitive factors such as ambiguity tolerance in prevention programs, decision-making skills training, and the reduction of risky behaviors. It is recommended that educational and psychological interventions focusing on improving ambiguity tolerance be developed to reduce addictive behaviors among adolescents.

Keywords: *intolerance of ambiguity; tendency toward cigarette smoking; tendency toward electronic cigarette use; bipolar adolescents; adolescents with risky behaviors*

1. Introduction

Adolescence is a critical developmental period characterized by rapid biological, psychological, and social changes, during which individuals become particularly vulnerable to engaging in risky health behaviors such as cigarette smoking and electronic vaping. The increasing prevalence of nicotine use among adolescents has become a major public health concern worldwide, as early initiation of substance use is strongly associated with long-term dependence and adverse mental health outcomes (Becker et al., 2021; Looti & Abd-alazim, 2025). Contemporary research indicates that the transition from experimentation to habitual use is influenced not only by environmental and social factors but also by cognitive–emotional processes that shape adolescents' decision-making under conditions of uncertainty and stress (Rahmati et al., 2023; Ridenour et al., 2025). In this context, understanding the psychological mechanisms that predispose adolescents to substance use is essential for developing effective prevention and intervention strategies.

Among the various cognitive constructs associated with risk-taking behaviors, intolerance of ambiguity (or intolerance of uncertainty) has emerged as a key factor influencing emotional regulation, behavioral control, and vulnerability to maladaptive coping strategies. Intolerance of ambiguity refers to an individual's tendency to perceive uncertain or ambiguous situations as threatening, leading to heightened anxiety and avoidance behaviors (McLain, 1993). Empirical evidence suggests that individuals with low tolerance for ambiguity are more likely to engage in impulsive or risk-related behaviors as a means of reducing psychological discomfort (Wang et al., 2025). In adolescent populations, this construct has been linked to a wide range of maladaptive outcomes, including anxiety, depressive symptoms, and substance use tendencies, highlighting its importance as a transdiagnostic vulnerability factor (Di Vincenzo et al., 2025; Pontillo et al., 2025). Furthermore, interventions aimed at enhancing tolerance of ambiguity have demonstrated effectiveness in improving adaptive functioning and reducing risk behaviors, underscoring the potential clinical relevance of this construct (Bajaj et al., 2026; Ghaziasgar et al., 2022).

Substance use behaviors such as cigarette smoking and electronic vaping are increasingly conceptualized within cognitive–emotional frameworks that emphasize the role of expectancies, perceived benefits, and emotional regulation processes. The Nicotine Dependence Syndrome framework, for instance, highlights the multidimensional nature of nicotine dependence, including cognitive, affective, and behavioral components that reinforce continued use (Shiffman et al., 2004). Adolescents may perceive smoking or vaping as a means of coping with stress, enhancing social acceptance, or regulating negative emotions, particularly in contexts characterized by uncertainty or ambiguity (Rahmati et al., 2023; Zahrani et al., 2014). Moreover, recent studies have demonstrated bidirectional associations between electronic cigarette use and mental health outcomes, suggesting that vaping may both contribute to and result from psychological distress (Frewen, 2025; Looti & Abd-alazim, 2025). These findings highlight the importance of examining underlying cognitive vulnerabilities, such as intolerance of ambiguity, in relation to substance use tendencies among adolescents.

Adolescents with psychiatric conditions, particularly bipolar disorder, represent a high-risk group for engaging in substance use behaviors. Bipolar disorder is characterized by mood instability, impulsivity, and dysregulation of cognitive–emotional processes, which may increase susceptibility to risky behaviors (Dai et al., 2026; Huang, 2026). Research has shown that adolescents at familial or clinical risk for bipolar disorder often exhibit altered risk perception, impaired decision-making, and heightened sensitivity to environmental stressors (Ahmed et al., 2026; Layfield et al., 2026). These factors may interact with intolerance of ambiguity, leading to maladaptive coping strategies such as substance use. Additionally, neurobiological studies have identified functional dysregulation in brain networks associated with reward processing and executive control in adolescents with bipolar disorder, further contributing to their vulnerability (Dai et al., 2026). Consequently, examining the role of intolerance of ambiguity in this population is crucial for understanding the mechanisms underlying substance use behaviors.

In parallel, adolescents with risky behaviors, including those exhibiting externalizing tendencies, impulsivity, or exposure to adverse childhood experiences, also demonstrate elevated rates of substance use. The developmental trajectory of these behaviors is often influenced by a complex interplay of psychosocial and neurocognitive factors, including deficits in self-regulation,

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increased sensation seeking, and exposure to environmental stressors (Bandyopadhyay, 2026; Mattey-Mora et al., 2026). The Youth Risk Index and related frameworks emphasize the cumulative impact of multiple risk factors in predicting early initiation of substance use and the progression toward problematic patterns (Ridenour et al., 2025). Importantly, intolerance of ambiguity may exacerbate these vulnerabilities by intensifying emotional distress and promoting maladaptive coping strategies, thereby increasing the likelihood of engaging in substance use as a form of self-medication (Wang et al., 2025). This suggests that the relationship between intolerance of ambiguity and substance use may differ across adolescent subgroups, depending on their underlying risk profiles.

Recent advances in clinical and behavioral research have highlighted the importance of transdiagnostic approaches that integrate cognitive, emotional, and behavioral dimensions of psychopathology. Such approaches recognize that constructs like intolerance of ambiguity cut across traditional diagnostic categories and may serve as common underlying mechanisms for various maladaptive behaviors, including substance use (Di Vincenzo et al., 2025; Kansagara et al., 2026). Furthermore, interventions targeting cognitive–behavioral processes, such as cognitive-behavioral therapy (CBT), have demonstrated efficacy in reducing substance use and improving psychological functioning by enhancing coping skills and tolerance of uncertainty (Ullah et al., 2026; Wilson et al., 2026). These findings underscore the potential value of focusing on cognitive vulnerabilities in prevention and treatment programs for adolescents.

Methodologically, the examination of complex relationships between psychological variables and behavioral outcomes requires the use of advanced statistical techniques such as structural equation modeling and multi-group analysis. These approaches allow researchers to simultaneously assess direct and indirect effects, compare relationships across groups, and evaluate the robustness of measurement models (Hair et al., 2009; Kang, 2021). By employing such methods, it is possible to gain a more nuanced understanding of how intolerance of ambiguity influences substance use tendencies in different adolescent populations, thereby informing targeted interventions.

Despite the growing body of literature on adolescent substance use and cognitive vulnerabilities, there remains a gap in comparative research examining the differential role of intolerance of ambiguity across distinct clinical and behavioral groups. In particular, few studies have directly compared bipolar adolescents with adolescents exhibiting risky behaviors in terms of their susceptibility to cigarette smoking and electronic vaping. Given the unique cognitive–emotional profiles of these groups, it is plausible that the strength and nature of the relationship between intolerance of ambiguity and substance use may vary, necessitating a comparative approach. Addressing this gap is essential for developing tailored prevention strategies that account for the specific needs and risk factors of different adolescent populations.

Therefore, the aim of the present study was to compare the effect of intolerance of ambiguity on the tendency toward cigarette smoking and electronic vaping in bipolar adolescents and adolescents with risky behaviors.

2. Methods and Materials

2.1. Study Design and Participants

This study employed a descriptive–correlational design with a cross-sectional approach, and data analysis was conducted using structural equation modeling (SEM) and multi-group analysis (MGA). In this study, intolerance of ambiguity was considered the independent variable, and the tendency toward cigarette smoking and electronic vaping in adolescents was considered the dependent variable. The statistical population consisted of all adolescent students in Tehran during November to December 2024, and purposive sampling was applied. The sample size was determined based on power analysis using G*Power software, considering a significance level of 0.05, an effect size of 0.80, and a statistical power of 0.90, which suggested a sample size of 68 participants (Kang, 2021). Additionally, according to rules of thumb in structural equation modeling, the sample size should be approximately 2.5 to 5 times the number of measurement items (Hair et al., 2009), which, given 25 items, indicated a minimum of 62 participants. However, after excluding incomplete questionnaires, intentionally erroneous responses, and outliers, a total of 51 participants were included in the final analysis; 24 participants (47.1%) were in the bipolar adolescent group and 27 participants (52.9%) were in the group of adolescents with risky behaviors.

Inclusion criteria comprised being aged between 13 and 17 years, enrollment in schools in Tehran in 2024, obtaining informed parental consent and adolescent assent, the ability to read and respond independently, a diagnosis of bipolar disorder confirmed by a psychiatrist or clinical psychologist for the relevant group, identification of risky behaviors

E-ISSN: 2980-9681

based on reports from counseling centers or schools, and no use of illicit substances other than cigarettes and electronic vaping. Exclusion criteria included the presence of psychotic disorders or severe neurodevelopmental disorders, physical or neurological conditions affecting cognitive–emotional functioning, unstable psychiatric medication dosage, incomplete questionnaires, random or invalid response patterns, significant missing data or outliers, lack of sustained cooperation, and withdrawal from the study at any stage.

Ethical approval was obtained from the researcher's affiliated university, and sampling was conducted through visits to two adolescent psychology clinics in Tehran selected via convenience sampling. Adolescents with bipolar disorder were selected from existing clinical records, and adolescents with risky behaviors were identified based on referrals from psychological service centers. Initial contact with parents was established via telephone, and questionnaire completion was conducted online over a one-month period. The average time required to complete the questionnaires ranged from 30 to 35 minutes. Ethical principles, including confidentiality, the right to withdraw at any time, absence of coercion, and obtaining written informed consent from all participants, were strictly ensured.

2.2. Measures

Measuring Tolerance of Ambiguity (MAT): The Multiple Stimulus Types Ambiguity Tolerance Scale (MAT) was developed by McLain in 1993 to assess individuals' tolerance of ambiguity (McLain, 1993). The questionnaire consists of 13 items, each rated on a five-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5). The minimum possible score is 13 and the maximum is 60. Scores ranging from 13 to 30 indicate low tolerance of ambiguity, scores from 30 to 40 indicate moderate tolerance, and scores above 45 indicate high tolerance of ambiguity. In Iran, Ghazi Asgar et al. (2022) reported a Cronbach's alpha coefficient of 0.82 for this scale (Ghaziasgar et al., 2022).

Adolescent Cigarette Smoking and Electronic Vaping Tendency Questionnaire (ACSV-T): The Adolescent Cigarette Smoking and Electronic Vaping Tendency Questionnaire (ACSV-T) was developed by the researcher to assess adolescents' cognitive–emotional tendency toward cigarette smoking and electronic vaping. The instrument was designed based on a review of the literature related to adolescent risky behaviors, nicotine use, and cognitive–emotional models of substance use tendency, including the Nicotine Dependence Syndrome Scale (NDSS) (Shiffman et al., 2004). The NDSS includes 19 items and requires respondents to smoke between 11 and 40 cigarettes per day, making it unsuitable for adolescents (Zahrani et al., 2014). The present questionnaire consists of 12 items organized into two components: tendency toward cigarette smoking (6 items) and tendency toward electronic vaping (6 items). Responses are rated on a five-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5). The minimum score is 12 and the maximum score is 60, with higher scores indicating a greater tendency toward cigarette smoking and electronic vaping. Sample items include statements such as: "I sometimes think that smoking cigarettes can help me relax," "If my friends smoke, I may also be inclined to smoke," "I am curious about what smoking feels like," "In stressful situations, smoking may seem like an appealing option," "I think smoking can create a sense of maturity or acceptance," "I might try cigarettes in the future," "I consider electronic vaping less harmful than cigarettes," "If given the opportunity, I would like to try electronic vaping," "Using vaping devices seems attractive and exciting to me," "I think vaping is an accepted behavior among my peers," "Electronic vaping may help reduce my tension," and "I may use electronic vaping in the future." Items were also informed by instruments developed in Iran (Rahmati et al., 2023).

To assess face and content validity, the initial version of the questionnaire was reviewed by eight experts in clinical psychology, child and adolescent psychiatry, and mental health. Based on expert feedback, revisions were made to improve clarity, simplicity, and cultural appropriateness of the items. The Content Validity Ratio (CVR) for all items exceeded the critical value of 0.62, and the Content Validity Index (CVI) was 0.86, indicating satisfactory content validity. To evaluate construct validity, exploratory factor analysis (EFA) using principal component analysis with varimax rotation was conducted. Prerequisites for factor analysis were assessed using the Kaiser–Meyer–Olkin (KMO) measure and Bartlett's test of sphericity. The KMO value was 0.88, and Bartlett's test was significant ($p < 0.001$). EFA results confirmed a two-factor structure explaining 65.4% of the total variance, with all factor loadings exceeding 0.50. Confirmatory factor analysis (CFA) was conducted using SmartPLS, and model fit indices indicated a good fit for the two-factor model, including $\chi^2/df = 2.41$, GFI = 0.91, CFI = 0.94, TLI = 0.93, RMSEA = 0.06, with standardized factor loadings ranging from 0.62 to 0.84, all statistically significant. Reliability was assessed using

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Cronbach's alpha and composite reliability (CR), yielding values of α = 0.87 and CR = 0.88 for cigarette smoking tendency, α = 0.85 and CR = 0.86 for electronic vaping tendency, and α = 0.89 for the total scale, indicating satisfactory reliability.

2.3. Data Analysis

Descriptive statistics were conducted using SPSS version 27, and path analysis along with multi-group analysis (MGA) was performed using SmartPLS version 4. The normality of variable distributions was assessed using the Shapiro–Wilk test, and since the test results were significant, the variables did not follow a normal distribution; therefore, partial least squares (PLS) was used for modeling. Additionally, the Mann–Whitney U test was employed to examine differences between groups. The significance level was set at 0.05.

3. Findings and Results

The results presented in Table 1 indicated that there were no statistically significant differences between bipolar adolescents and adolescents with risky behaviors in terms of demographic variables. Comparison of age distribution between the two groups using the Mann–Whitney U test showed no significant difference (U = 300.0, p = 0.629), with the highest proportion of participants in both groups falling within the 14–15 age range. Similarly, no significant differences were observed in fathers' employment status (U = 246.0, p = 0.079) or mothers' employment status (U = 286.0, p = 0.424). Regarding parental marital status, no significant difference was found (U = 283.5, p = 0.249), with most parents in both groups living together. In terms of gender, no significant difference was observed between the two groups (U = 261.0, p = 0.151), although the proportion of females was higher in the bipolar group. Furthermore, comparisons of fathers' education (U = 319.5, p = 0.927) and mothers' education (U = 314.5, p = 0.842) indicated that the two groups were homogeneous, with no statistically significant differences. Overall, these findings suggest that the two groups were comparable in terms of demographic characteristics, and these variables did not act as confounding factors in the study results.

Table 1

Demographic Characteristics

Variables	Categories	Bipolar Adolescents (N)	%	Adolescents with Risky Behaviors (N)	%	Mann–Whitney U	p-value
Age	13–14	8	33.3	10	37.0	300.0	0.629
	14–15	12	50.0	9	33.3		
	15–16	4	16.7	5	18.5		
	16–17	0	0.0	3	11.1		
Father's employment	Employee	12	50.0	7	25.9	246.0	0.079
	Freelance	12	50.0	20	74.1		
Mother's employment	Employee	2	8.3	6	22.2	286.0	0.424
	Freelance	8	33.3	7	25.9		
	Housewife	14	58.3	14	51.9		
Parental marital status	Living together	18	75.0	24	88.9	283.5	0.249
	Divorced	5	20.8	1	3.7		
	Death of a parent	1	4.2	2	7.4		
Gender	Male	6	25.0	12	44.4	261.0	0.151
	Female	18	75.0	15	55.6		
Father's education	Diploma/Associate	11	45.8	13	48.1	319.5	0.927
	Bachelor's	6	25.0	6	22.2		
	Master's	7	29.2	8	29.6		
Mother's education	Diploma/Associate	13	54.2	15	55.6	314.5	0.842
	Bachelor's	6	25.0	4	14.8		
	Master's	5	20.8	8	29.6		

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The mean and standard deviation of the research variables across the groups were examined in Table 2.

Table 2

Descriptive Statistics of Research Variables and Mann–Whitney U Test

Variable	Groups	Mean	SD	Skewness	Kurtosis	Shapiro–Wilk	p-value	U	p
Tolerance of ambiguity	Bipolar Adolescents	39.79	3.41	0.008	−1.193	0.948	0.247	288	0.495
	Adolescents with Risky Behaviors	40.55	3.89	0.055	−1.142	0.957	0.311		
Propensity for cigarette smoking	Bipolar Adolescents	17.04	2.61	−0.864	0.500	0.911	0.037	174.5	0.005
	Adolescents with Risky Behaviors	20.03	3.67	−0.580	−0.512	0.896	0.011		
Propensity for electronic vaping	Bipolar Adolescents	19.25	3.16	−0.358	−1.033	0.888	0.012	248	0.149
	Adolescents with Risky Behaviors	20.51	3.23	−0.073	−1.605	0.884	0.006		

Examination of the normality of data distribution using skewness, kurtosis, and the Shapiro–Wilk test indicated that some variables did not follow a normal distribution ($p < 0.05$). Therefore, the nonparametric Mann–Whitney U test was used to compare the two groups. The results showed no statistically significant difference between the two groups in terms of tolerance of ambiguity ($U = 288$, $p = 0.495$), with similar mean scores observed in bipolar adolescents ($M = 39.79$, $SD = 3.41$) and adolescents with risky behaviors ($M = 40.56$, $SD = 3.89$). In contrast, a significant difference was found between the two groups in propensity for cigarette smoking ($U = 174.5$, $p = 0.005$), with adolescents with risky behaviors demonstrating higher mean scores ($M = 20.04$, $SD = 3.67$) compared to bipolar adolescents ($M = 17.04$, $SD = 2.61$). Additionally, the Mann–Whitney U test results for propensity toward electronic vaping indicated no statistically significant difference between the two groups ($U = 248$, $p = 0.149$), although the mean score was slightly higher in the risky behavior group ($M = 20.52$, $SD = 3.24$) than in the bipolar group ($M = 19.25$, $SD = 3.17$). Overall, these findings suggest that, in this study, only the variable of propensity for cigarette smoking significantly differentiated between bipolar adolescents and adolescents with risky behaviors.

In Table 3, measurement invariance across groups was assessed using the Multi-Group Analysis (MGA) approach through the MICOM procedure based on permutation testing.

Table 3

Results of the MICOM Procedure for Measurement Model Invariance

Variable	Configurational Invariance	Permutation p-value (Step 2)	Mean Difference (Step 3a)	p-value (Step 3a)	Variance Difference (Step 3b)	p-value (Step 3b)
Propensity for cigarette smoking	Yes	$p < 0.001$	0.858	0.003	0.687	0.055
Propensity for electronic vaping	Yes	0.723	0.396	0.197	0.050	0.837
Tolerance of ambiguity	Yes	0.370	0.211	0.448	0.269	0.344

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Figure 1

Path coefficients between variables and significance levels

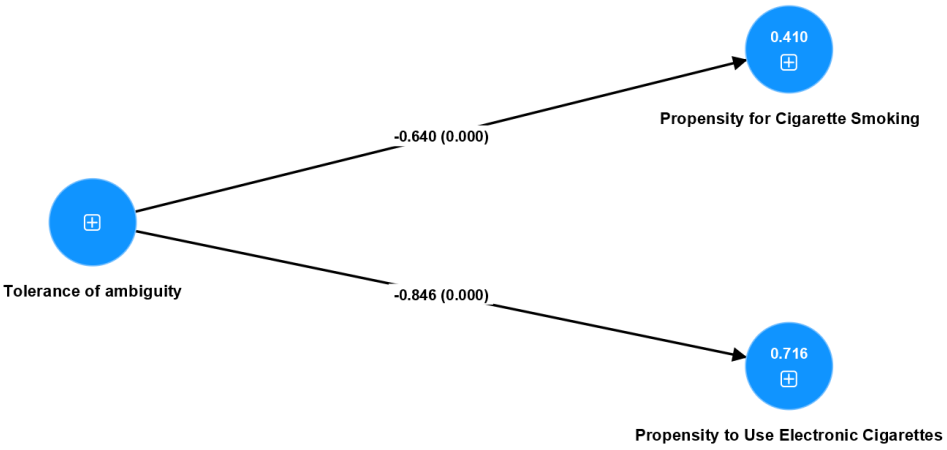


Figure 2

Path coefficients between variables and significance levels for adolescents with risky behaviors

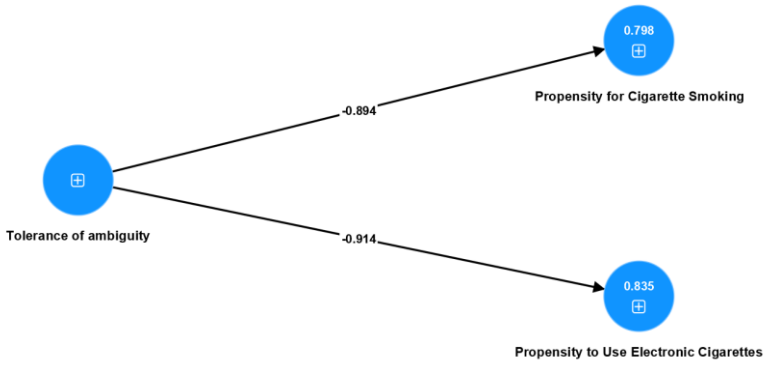
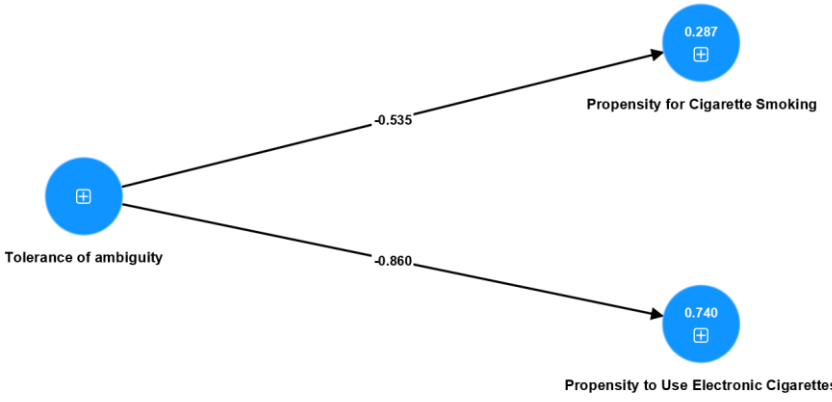


Figure 3

Path coefficients between variables and significance levels for bipolar adolescents



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As shown in Table 3, in Step 1 (configurational invariance), the results indicated that the measurement model structure for all three variables—propensity for cigarette smoking, propensity for electronic vaping, and tolerance of ambiguity—was identical across both bipolar adolescents and adolescents with risky behaviors, confirming full configurational invariance. In Step 2 (compositional invariance), permutation test results showed that compositional invariance was significantly confirmed for the variable of propensity for cigarette smoking ($p < 0.001$), while for propensity for electronic vaping and tolerance of ambiguity, non-significant results ($p > 0.05$) also indicated that compositional invariance was established across groups. In Step 3, results for equality of composite means (Step 3a) indicated a significant difference between groups only for propensity for cigarette smoking ($p = 0.003$), whereas no significant differences were found for propensity for electronic vaping ($p = 0.197$) and tolerance of ambiguity ($p = 0.448$). Additionally, results for equality of composite variances (Step 3b) indicated no significant differences between groups for any of the variables ($p > 0.05$). These findings suggest that the model is not fully invariant across groups for the variable of propensity for cigarette smoking, indicating structural differences between the groups. Under such conditions, interpretation of MGA results should be conducted with caution, and alternative methods such as the Welch–Satterthwaite test were used to examine group-specific results. Path coefficients between research variables and their levels of significance are presented in Table 4, with bootstrap resampling set to 5,000 iterations.

Table 4

Standardized Path Coefficients and Multi-Group Analysis (MGA)

path between variables		Path	STDEV		P-value	T-value	Result
Tolerance of ambiguity -> Propensity for Cigarette Smoking		-0.640	0.084		p < 0.001	7.628	Confirmed
Tolerance of ambiguity -> Propensity to Use Electronic Cigarettes		-0.846	0.030		p < 0.001	28.607	Confirmed
Multi-Group Analysis (MGA)							
path between variables	Path (Adolescents with Risky Behaviors)	p value (Adolescents with Risky Behaviors)	Path (Bipolar Adolescents)	p value (Bipolar Adolescents)	Difference (Adolescents with Risky Behaviors-Bipolar Adolescents)	p value (Adolescents with Risky Behaviors vs Bipolar Adolescents)	Result
Tolerance of ambiguity -> Propensity for Cigarette Smoking	-0.894	p < 0.001	-0.535	0.003	-0.358	0.006	Confirmed
Tolerance of ambiguity -> Propensity to Use Electronic Cigarettes	-0.914	p < 0.001	-0.860	p < 0.001	-0.054	0.353	Rejected

In the overall model analysis and Figure 2, the results of the standardized path coefficients showed that tolerance of ambiguity had a significant negative effect on propensity for cigarette smoking ($\beta = -0.640$, $T = 7.628$, $p < .001$), indicating that as tolerance of ambiguity increases, adolescents' propensity for cigarette smoking decreases. Likewise, the effect of tolerance of ambiguity on propensity to use electronic cigarettes was also negative and significant ($\beta = -0.846$, $T = 28.607$, $p < .001$), indicating the strong protective role of tolerance of ambiguity in reducing the propensity for vaping.

In the multi-group analysis (MGA), the results comparing path coefficients between the two groups showed that the effect of tolerance of ambiguity on propensity for cigarette smoking differed significantly between the groups ($p = .006$). The path coefficient in the group of adolescents with risky behaviors ($\beta = -0.894$, $p < .001$) was significantly stronger than that in the bipolar adolescent group ($\beta = -0.535$, $p = .003$). This finding indicates that the protective role of tolerance of ambiguity in reducing propensity for cigarette smoking is more pronounced among adolescents with risky behaviors than among bipolar adolescents. In contrast, the MGA results for the path from tolerance of ambiguity to propensity to use electronic cigarettes indicated that there was no significant difference between the two groups ($p = .353$), although this path was confirmed as negative and significant in both groups (bipolar adolescents: $\beta = -0.860$, $p < .001$; adolescents with risky behaviors: $\beta = -0.914$, $p < .001$). This result indicates that the reducing effect of tolerance of ambiguity on propensity for vaping follows a

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similar pattern in both groups. Overall, the findings presented in Table 4 indicate that tolerance of ambiguity, as an important protective factor, plays a significant role in reducing adolescents' propensity for cigarette smoking and electronic cigarette use, with the difference that the magnitude of its effect on propensity for cigarette smoking is greater among adolescents with risky behaviors than among adolescents with bipolar disorder. The results related to model fit, reliability, and construct validity are presented in Table 5.

Table 5

Model Fit, Reliability, and Validity

coefficient of determination of the model				
	Adolescents with Risky Behaviors		Bipolar Adolescents	
Variables	R-square	R-square adjusted	R-square	R-square adjusted
Propensity for Cigarette Smoking	0.798	0.790	0.287	0.254
Propensity to Use Electronic Cigarettes	0.835	0.828	0.740	0.728
Reliability and validity of the model				
Variables	Cronbach's Alpha	Composite Reliability	AVE	
Propensity for Cigarette Smoking	0.87	0.88	0.541	
Propensity to Use Electronic Cigarettes	0.85	0.86	0.501	
Tolerance of ambiguity	0.715	0.743	0.521	
model fit				
Model Fitting	SRMR		NFI	
Research Model	0.077		0.883	

Based on the values of the coefficient of determination (R^2 and adjusted R^2), the research model demonstrated adequate explanatory power for the endogenous variables. For the variable of propensity for cigarette smoking, the R^2 value in the bipolar adolescent group was 0.287 (adjusted R^2 = 0.254), whereas in the group of adolescents with risky behaviors it was 0.798 (adjusted R^2 = 0.790), indicating moderate explanatory power in the bipolar group and very high explanatory power in the risky behavior group. Likewise, for the variable of propensity to use electronic cigarettes, the R^2 value in bipolar adolescents was 0.740 (adjusted R^2 = 0.728), and in adolescents with risky behaviors it was 0.835 (adjusted R^2 = 0.828), indicating high explanatory power of the model in both groups. Examination of reliability and convergent validity indices showed that Cronbach's alpha and composite reliability (CR) values for all constructs exceeded the acceptable threshold of 0.70, indicating satisfactory reliability of the measurement instrument. In addition, the average variance extracted (AVE) values for propensity for cigarette smoking (0.542), propensity to use electronic cigarettes (0.501), and tolerance of ambiguity (0.521) were all above 0.50, confirming satisfactory convergent validity of the constructs. In evaluating the overall model fit, the SRMR value was 0.077 and the NFI value was 0.883. Given that the SRMR value was below 0.08 and the NFI value was close to 0.90, it can be concluded that the research model demonstrated acceptable and adequate fit.

4. Discussion and Conclusion

The present study aimed to examine the role of intolerance of ambiguity in predicting adolescents' propensity for cigarette smoking and electronic vaping, with a comparative focus on bipolar adolescents and adolescents with risky behaviors. The findings demonstrated that intolerance of ambiguity exerted a significant and negative effect on both cigarette smoking and electronic vaping tendencies, indicating that higher levels of ambiguity tolerance are associated with lower engagement in nicotine-related behaviors. Furthermore, the multi-group analysis revealed that the magnitude of this effect differed significantly between the two groups for cigarette smoking, with a stronger protective effect observed among adolescents with risky behaviors compared to bipolar adolescents. However, no significant between-group difference was found in the relationship between intolerance of ambiguity and electronic vaping, although the effect remained significant and negative in both groups.

The observed negative association between intolerance of ambiguity and substance use tendencies aligns with theoretical frameworks that conceptualize ambiguity tolerance as a critical cognitive–emotional resource for adaptive functioning. Individuals with higher tolerance for

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ambiguity are better equipped to manage uncertainty, regulate emotional responses, and avoid maladaptive coping strategies such as substance use (McLain, 1993; Wang et al., 2025). In contrast, adolescents with low tolerance of ambiguity may experience heightened anxiety and distress in uncertain situations, which can increase their reliance on external regulators, including nicotine, to alleviate discomfort. This interpretation is consistent with prior research demonstrating that intolerance of uncertainty is linked to increased impulsivity, emotional dysregulation, and vulnerability to addictive behaviors (Di Vincenzo et al., 2025; Pontillo et al., 2025). The current findings therefore reinforce the conceptualization of ambiguity tolerance as a protective cognitive factor in adolescent health behavior.

The significant effect of intolerance of ambiguity on cigarette smoking propensity is also consistent with existing literature emphasizing the role of cognitive–emotional expectancies in nicotine use. Adolescents often develop beliefs that smoking can reduce stress, enhance social acceptance, or provide emotional relief, particularly in ambiguous or stressful contexts (Rahmati et al., 2023; Shiffman et al., 2004). When ambiguity tolerance is low, these expectancies may become more salient, increasing the likelihood of smoking initiation. Additionally, empirical studies have shown that nicotine dependence is closely associated with mental health indicators, including anxiety and self-concept, further supporting the role of cognitive vulnerabilities in smoking behavior (Zahrani et al., 2014). The present results extend this body of research by demonstrating that ambiguity tolerance not only influences smoking behavior but does so differentially across adolescent subgroups.

The finding that the protective effect of ambiguity tolerance on cigarette smoking is stronger among adolescents with risky behaviors compared to bipolar adolescents provides important insights into the heterogeneity of risk mechanisms. Adolescents with risky behaviors often exhibit higher levels of impulsivity, sensation seeking, and exposure to adverse environmental factors, which may amplify the impact of cognitive vulnerabilities on behavior (Bandyopadhyay, 2026; Mattey-Mora et al., 2026). In such contexts, ambiguity tolerance may play a more central role in modulating behavioral responses to uncertainty, thereby exerting a stronger protective effect. This interpretation is supported by research indicating that cumulative psychosocial risk factors interact with neurocognitive processes to predict substance use outcomes (Ridenour et al., 2025). In contrast, bipolar adolescents may be influenced by additional factors, such as mood instability and neurobiological dysregulation, which may attenuate the relative impact of ambiguity tolerance on smoking behavior (Dai et al., 2026; Huang, 2026). Thus, while ambiguity tolerance remains a significant predictor, its effect may be moderated by disorder-specific mechanisms in bipolar populations.

The absence of a significant between-group difference in the relationship between ambiguity tolerance and electronic vaping suggests that this behavior may be influenced by more universal mechanisms across adolescent groups. The consistent negative association observed in both groups indicates that ambiguity tolerance plays a broadly protective role in reducing vaping tendencies, regardless of clinical or behavioral status. This finding is in line with recent research highlighting the widespread appeal of electronic cigarettes among adolescents and their association with psychological factors such as stress, curiosity, and perceived safety (Becker et al., 2021; Looti & Abd-alazim, 2025). Unlike traditional cigarette smoking, which may be more strongly embedded in specific social or behavioral contexts, vaping may represent a more generalized coping strategy that is similarly influenced by cognitive vulnerabilities across populations. Moreover, evidence suggests that vaping is associated with both cognitive impairment and emotional dysregulation, further supporting the role of underlying psychological processes in its use (Frewen, 2025).

The high explanatory power of the model, particularly in the group of adolescents with risky behaviors, further underscores the importance of cognitive factors in understanding substance use tendencies. The substantial R^2 values indicate that intolerance of ambiguity accounts for a significant proportion of variance in smoking and vaping behaviors, especially among high-risk adolescents. This finding is consistent with the growing emphasis on cognitive–behavioral models of addiction, which highlight the role of maladaptive beliefs, emotional regulation deficits, and decision-making processes in substance use (Kansagara et al., 2026; Wilson et al., 2026). The robustness of the measurement model, as evidenced by satisfactory reliability and validity indices, further strengthens the credibility of these findings and supports the use of ambiguity tolerance as a key construct in future research.

From a clinical perspective, the present findings have important implications for intervention development. Cognitive-behavioral approaches that focus on enhancing tolerance of ambiguity and improving emotional regulation may be particularly effective in reducing substance use

E-ISSN: 2980-9681

behaviors among adolescents. Interventions such as cognitive-behavioral therapy have been shown to improve coping skills and reduce reliance on maladaptive behaviors, including substance use (Ullah et al., 2026). Additionally, preventive programs that target cognitive vulnerabilities and promote adaptive decision-making may help mitigate the risk of smoking and vaping initiation, particularly in high-risk populations. The differential findings across groups also suggest that interventions may need to be tailored to address the specific needs and characteristics of different adolescent populations.

The present study also contributes to the broader literature on adolescent mental health by highlighting the interplay between cognitive, emotional, and behavioral factors in shaping risk behaviors. The integration of transdiagnostic constructs such as ambiguity tolerance with group-specific analyses provides a more comprehensive understanding of the mechanisms underlying substance use. This approach is consistent with contemporary trends in psychological research that emphasize the importance of identifying common underlying processes across disorders while also accounting for contextual and individual differences (Di Vincenzo et al., 2025). By adopting such an approach, the study offers valuable insights into the complex dynamics of adolescent behavior and informs the development of more effective and targeted interventions.

One of the limitations of the present study is the relatively small sample size, which may limit the generalizability of the findings and reduce statistical power for detecting subtle group differences. Additionally, the use of a cross-sectional design precludes causal inferences regarding the relationship between intolerance of ambiguity and substance use behaviors. The reliance on self-report measures may also introduce response biases, including social desirability and recall bias. Furthermore, the sample was restricted to adolescents in a specific geographic region, which may limit the external validity of the findings. Finally, potential confounding variables, such as peer influence, socioeconomic status, and family dynamics, were not directly controlled for in the analysis.

Future research should aim to replicate these findings using larger and more diverse samples to enhance generalizability and statistical robustness. Longitudinal designs are recommended to examine the causal pathways between intolerance of ambiguity and substance use behaviors over time. Additionally, future studies could explore potential mediators and moderators of this relationship, such as emotional regulation, peer influence, and environmental stressors. Incorporating neurobiological and experimental approaches may also provide deeper insights into the mechanisms underlying these associations. Comparative studies across different clinical populations could further elucidate the role of ambiguity tolerance in diverse contexts.

From a practical standpoint, the findings highlight the importance of incorporating cognitive training and emotional regulation strategies into prevention and intervention programs for adolescents. Educational initiatives aimed at improving tolerance of ambiguity and decision-making skills may help reduce the likelihood of engaging in substance use behaviors. Schools and mental health professionals should consider integrating evidence-based approaches, such as cognitive-behavioral techniques, into their programs. Additionally, targeted interventions for high-risk groups, including adolescents with risky behaviors and those with psychiatric conditions, may enhance the effectiveness of prevention efforts and contribute to improved mental health outcomes.

Authors' Contributions

All authors significantly contributed to this study.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

Acknowledgments

We hereby thank all individuals for participating and cooperating us in this study.

Declaration of Interest

The authors report no conflict of interest.

Funding

According to the authors, this article has no financial support.

E-ISSN: 2980-9681

Ethical Considerations

In this study, to observe ethical considerations, participants were informed about the goals and importance of the research before the start of the study and participated in the research with informed consent.

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E-ISSN: 2980-9681