

Original Article



E-cigarette Attitude and Belief Scale in Adolescents: A Validity and Reliability Study

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Cite this article as: Can Oksay S, Alpar G, Bilgin G, et al. E-cigarette attitude and belief scale in adolescents: a validity and reliability study. *Thorac Res Pract.* [Epub Ahead of Print]

Abstract

OBJECTIVE: Electronic cigarette (e-cigarette) use has increased significantly since its appearance on the global market in the mid-2000s. International studies have indicated that substance use among children is as prevalent as 7.8% worldwide and 15.4% among high school students in Türkiye. To prevent this public health problem, it is necessary to understand why adolescents use e-cigarettes. This study aimed to develop an attitude and belief scale about adolescent e-cigarette use.

MATERIAL AND METHODS: Chronic disease-free adolescents aged 14-18 who applied to pediatric outpatient clinics were invited to the study. Three hundred forty eligible participants were recruited. The scale on e-cigarette use was developed in light of the existing literature and comprises a total of 31 questions, including 20 assessing beliefs and 11 assessing attitudes.

RESULTS: Following specialist reviews, the following exploratory factor analysis, internal consistency analysis, criterion validity analysis, discriminant validity analysis, confirmatory factor analysis, test-retest reliability analysis, and internal validity tests were conducted. The 18-item scale, which has been proven to measure attitudes and beliefs toward e-cigarettes, is sufficient, valid, and reliable.

CONCLUSION: The developed “E-cigarette Attitude and Belief Scale in Adolescents” scale can be a critical tool for future studies. Gaining insight into adolescents’ attitudes and beliefs toward e-cigarettes can contribute to creating targeted educational and awareness initiatives on this issue.

KEYWORDS: Electronic cigarette, adolescents, scale, validation, reliability

Received: 22.05.2025

Revision Requested: 22.05.2025

Last Revision Received: 30.07.2025

Accepted: 07.08.2025

Epub: 18.09.2025

INTRODUCTION

In response to the declining market share of conventional tobacco products, the tobacco industry introduced alternatives such as heated tobacco and electronic cigarettes (e-cigarettes), often targeting children and adolescents.¹⁻³ As a result, the consumption of e-cigarettes increased, posing a severe public health concern globally.²

E-cigarettes entered the global market in the mid-2000s. The industry has employed diverse marketing strategies to promote these products, including targeted media advertising, sponsorships, and film collaborations.¹ The National Youth Tobacco Survey reports that the prevalence of e-cigarette use among high school students in the United States (US) increased from 9.3% in 2014 to 27.5% in 2019.⁴ According to the analysis of national survey data obtained from 3,925 participants aged 8-20 in 69 countries and regions, the prevalence of electronic and non-electronic nicotine-carrying device use among children was 17.2%; and the prevalence of e-cigarette use in the last 30 days was 7.8%.⁵ E-cigarette sales are prohibited in Türkiye.⁶ However, these products remain accessible through online platforms and direct marketing channels.⁶ This ease of access poses a significant challenge to regulatory enforcement and contributes to the increasing prevalence of e-cigarette use, particularly among adolescents. Although no nationally representative

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study assesses the prevalence of e-cigarette use in Türkiye, a local survey of high school students reported a prevalence of 15.4%.⁷

The rationale for understanding adolescents' beliefs and attitudes toward e-cigarettes stems from well-established behavioral theories, such as the Theory of Planned Behavior and the Health Belief Model, which suggest that an individual's beliefs significantly influence health-related behaviors.^{8,9} Exploring adolescents' beliefs and attitudes allows us to identify cognitive and emotional factors that may predict or explain e-cigarette use. Behavior and expectancy scales regarding e-cigarette use have been developed and validated for adolescents.^{10,11} However, to date, only one such scale has been tailored to a specific racial or ethnic group.¹²

To address this gap, we aimed to develop a comprehensive and culturally adaptable tool - the "E-cigarette Attitude and Belief Scale in Adolescents (ECABA)". Our goal was to create a reliable and valid instrument capable of capturing the complex beliefs and perceptions that underlie adolescent e-cigarette use. Such a scale would not only provide insight into current attitudes but also serve as a valuable metric to evaluate the long-term effectiveness of preventive interventions.

MATERIAL AND METHODS

Study Design

The validation study was conducted in accordance with the principles outlined in the Declaration of Helsinki. Before commencing the study, it was approved by the the Ethics Committee of Koşuyolu High Specialization Training and Research Hospital (İstanbul, Türkiye) (decision no: 2024/16/920, approval date: 17.09.2024).

Participants and Settings

The participants were adolescents aged 14-18 who applied to the three pediatric outpatient clinics of İstanbul Medeniyet University Faculty of Medicine, between October and December 2024. All adolescents without chronic diseases who applied to the outpatient clinic were invited to participate in the study.

As this study involved both the development and validation of a new scale, the sample size was determined based on general recommendations suggesting a participant-to-item ratio of at least 5:1 to 10:1 for exploratory factor analysis.^{13,14} Since the initial draft scale had 31 items, we calculated the sample size

to be 310 participants. However, considering the possibility of non-respondents and missing data, it was decided to include 400 participants (Figure 1).

Demographic Information Form: To determine the demographic characteristics of the participants, information was collected regarding their ages, genders, parents' education levels, and whether they or others in their surrounding environment used packaged cigarettes or e-cigarettes. It consists of 16 questions.

Lifetime Substance Use: Participants' lifetime use of e-cigarettes and smoking was assessed (yes/no). The frequency of e-cigarette use or smoking in the last 1 month was also investigated.

Missing Data: Sixty participants, who either incompletely filled out the questionnaire or had no knowledge of e-cigarettes or tobacco, were excluded. Regarding demographic characteristics, participants with missing ECABA data did not differ significantly from participants with available ECABA data.

Smoking Decision Balance Scale: Youth Form

Initially developed by Velicer et al.,¹⁵ this scale assesses perceptions of the harms and benefits of smoking. Pallonen et al.¹⁶ adapted a 12-item version for children, later validated in Turkish by Bektaş et al.¹⁷ The five-point Likert scale comprises benefit and harm subscales. This scale is used with permission from the author.

Scale Development

The items in the initial draft scale, which measure attitude and belief regarding e-cigarette use, were developed in light of the existing literature.¹⁸⁻²¹

This initial scale comprised 31 items (20 belief questions and 11 attitude questions). Four specialists (three professors of pediatric pulmonology working on tobacco prevention and a psychologist working with adolescents with addiction) reviewed and revised the initial draft scale, and two items were excluded. The scale items were scored on a five-point Likert-type scale: "strongly disagree" (1), "disagree" (2), "undecided" (3), "agree" (4), and "strongly agree" (5).

Variables and Data Collection

Before beginning the questionnaire, participants and one of their parents read and reviewed the consent and were provided with comprehensive information about the study. The researcher provided adolescents with printed questionnaires, and an outpatient clinic room was designated for them to complete the questionnaires anonymously.

Validation and Reliability

Exploratory factor analysis with Varimax rotation, criterion validity analysis, discriminative validity analysis, confirmatory factor analysis, and test-retest reliability were conducted (Figure 2). The scale was reduced to 18 items in the final version.

Statistical Analysis

After collecting the data, all statistical analyses were performed using IBM Statistical Package for the Social Sciences (SPSS)

Main Points

- A novel scale was developed to assess adolescents' attitudes and beliefs regarding e-cigarette use.
- Comprehensive psychometric analyses, including factor analysis and reliability testing, validated an 18-item version of the scale.
- This validated scale can facilitate future research and targeted interventions aimed at preventing e-cigarette use among adolescents.

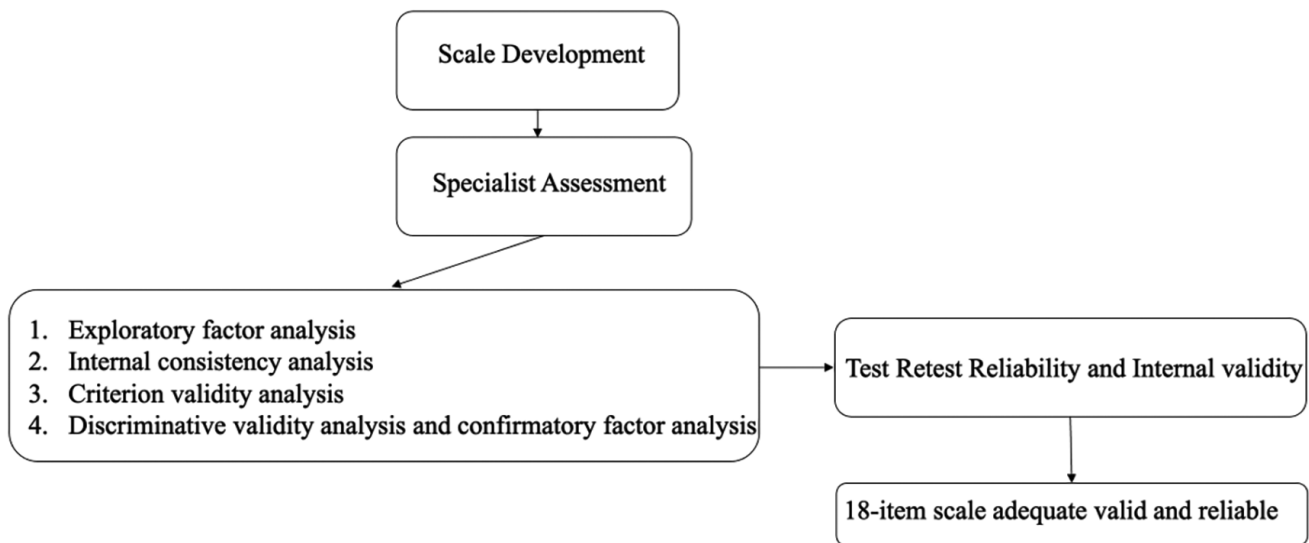


Figure 1. Flowchart

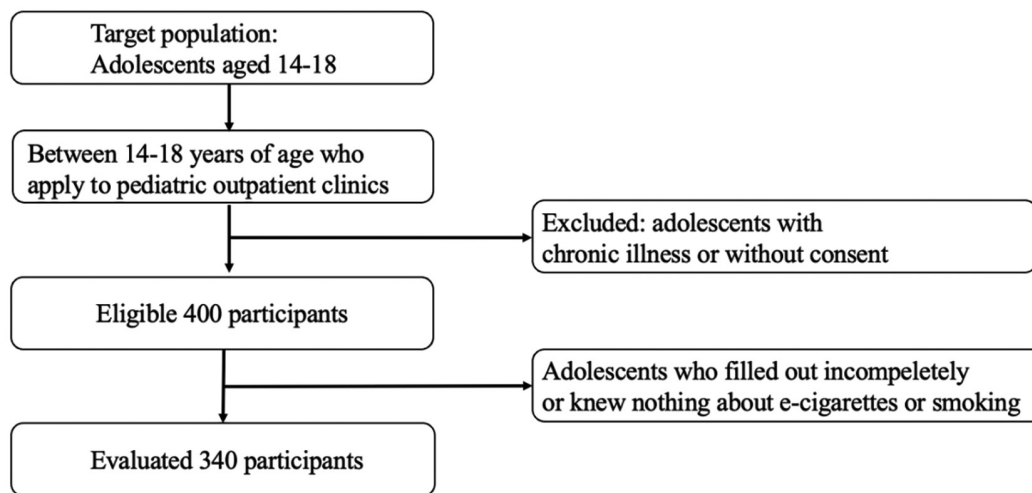


Figure 2. Flow diagram of the participants

statistics and IBM SPSS Amos, both for Windows, version 21.0 (IBM Corp., Armonk, NY, USA) to assess the validity and reliability of the ECABA scale. Exploratory factor analysis with Varimax rotation, internal consistency analysis, criterion validity analysis, discriminative validity analysis, and confirmatory factor analysis were conducted.

In the exploratory factor analysis, sampling adequacy and sphericity were assessed for the scale, as suggested by Kaiser. The Kaiser-Meyer-Olkin (KMO) sampling adequacy and Bartlett's test for sphericity were evaluated and reported accordingly.^{22,23} Principal component analysis was used as the extraction method. At the same time, Varimax with Kaiser normalization was applied as the rotation method.

Internal consistency analysis, a commonly used reliability measure, effectively assesses the homogeneity of the questions designed to evaluate a specific area, determining whether the questions appropriately target and measure only the intended concept.¹³

Cronbach's alpha coefficient is a reliability coefficient found by dividing the sum of the covariances of the k items in the scale by the overall variance.²⁴ Cronbach's alpha values were evaluated with a tiered approach: ≥ 0.90 excellent, ≥ 0.80 good, ≥ 0.70 acceptable, ≥ 0.60 questionable, ≥ 0.50 poor, and ≤ 0.50 unacceptable.²⁵

The internal consistency of the final version of the scale was analyzed by calculating Cronbach's alpha values. Cronbach's alpha values were evaluated with a tiered approach: ≥ 0.90 excellent, ≥ 0.80 good, ≥ 0.70 acceptable, ≥ 0.60 questionable, ≥ 0.50 poor, and ≤ 0.50 unacceptable.²⁵

The difference between the mean scores of the 27% lower-upper groups is expected to be significant, measuring the scale's discriminative validity. To evaluate the significance of the difference in mean scores between the groups with the highest and lowest 27% of total scale scores, an independent samples t-test was conducted.

Correlation coefficients between the scale and the 'Child Decision Balance Scale' were calculated to test the scale's criterion validity. Confirmatory factor analysis is a type of structural equation model application. It is used to test whether there is a significant relationship between the factors; whether the factors are independent of each other; which variables are related to which factors; and whether they are adequate to explain the model.¹⁴ First-level confirmatory factor analysis was conducted to determine whether the scale met the goodness-of-fit indices reported in the literature.²⁶

Test-retest Reliability and Internal Validity

The same baseline scale was administered to 30 participants at 2-week intervals. Table 1 shows the results of the paired sample t-test for the difference between the scale's test-retest averages. The mean scores obtained in the first test were compared with those obtained in the retest, which occurred fifteen days later.

Figure 1 presents the analysis algorithm.

RESULTS

Demographic Variables

Our study included 400 adolescents aged 14-18, however, after excluding those who provided incomplete responses, the final sample consisted of 340 adolescents aged 14-18 [mean age = 15.79; standard deviation (SD) = 1.204] (Figure 2), with 53.8%

females (n = 183; mean age = 15.78; SD = 1.216) and 46.2% males (n = 157; mean age = 15.79; SD = 1.193) participants. Sixty adolescents were unaware of e-cigarettes and had never been exposed to environments where e-cigarettes or smoking were used. They were excluded from the study to prevent potential bias and ensure the accuracy of the results. Of the participants, 19.4% had tried or used e-cigarettes, and 22.4% had tried or used packaged cigarettes.

Validity and Reliability of the E-cigarette Attitude and Belief Scale

Exploratory Factor Analysis

Factor analysis is a construct validity technique used to determine whether there is a particular order among participants' responses to the items in the measurement tool being developed.¹³ As a result of exploratory factor analysis, sub-dimensions, related to the concept to be measured by the scale, may be formed.¹³

In the exploratory factor analysis, all 29 items of the ECABA scale were subjected to principal component analysis with Varimax rotation (KMO = 0.875; Bartlett test₍₁₅₃₎ = 2681.429; $P < 0.001$). As a result of the study, a structure with 18 items and five factors was identified, each factor having an eigenvalue above one, explaining 66.63% of the variance (Table 2).

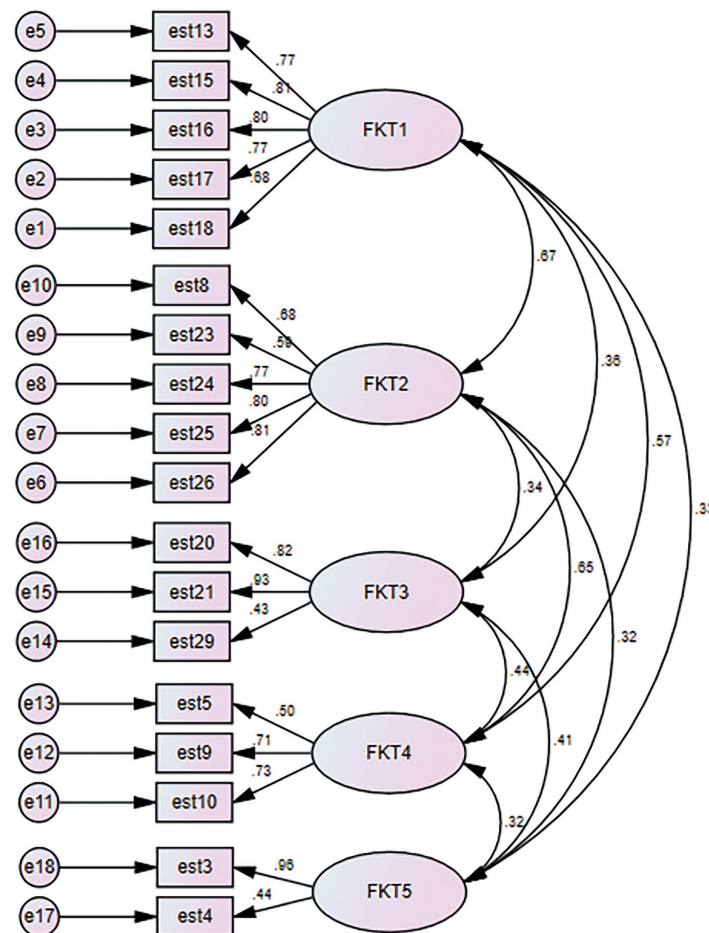


Figure 3. The five-dimensional latent structure established by the confirmatory factor analysis

Internal Consistency Analysis

After conducting an exploratory factor analysis, internal consistency coefficients were calculated based on the factor distributions of the 18 items that formed the scale. As a result of the internal consistency analysis, $\alpha=0.888$ for the total item, $\alpha=0.877$ for F1, $\alpha=0.847$ for F2, $\alpha=0.747$ for F3, $\alpha=0.657$ for F4, and $\alpha=0.591$ for F5 were found to be (Supplementary Table 1).

Criterion Validity

To determine the scale's criterion validity, the correlation coefficients between the scores obtained from the scale and its subscales, and the scores obtained from the "Benefits of smoking" and "Harms of smoking" subscales of the Decisional Balance Scale for Children were calculated. The calculation was done using Pearson correlation analysis, as detailed in Supplementary Table 2.

Table 1. Paired sample t-test findings regarding the difference between the test-retest averages of the scale

	Test		Re-test		t	P
	Mean	SD	Mean	SD		
Total	34.94	10.904	34.88	10.444	0.387	0.701
Physical consequences of e-cigarette	10.09	4.129	9.97	3.786	0.941	0.353
E-cigarettes versus packs of cigarettes	10.47	3.871	10.44	3.735	0.329	0.744
Identification	5.03	2.747	4.97	2.634	1.436	0.160
E-cigarette addiction	6.12	2.422	6.21	2.384	-1.787	0.083
Socialization	3.24	1.458	3.29	1.508	-1.436	0.160

* $P < 0.05$.

SD: standard deviation

Table 2. Exploratory factor analysis results

	F1	F2	F3	F4	F5
Physical consequences of e-cigarette: eigenvalue 6.511; variance explained: 36.171%					
18. E-cigarettes do not cause infertility (inability to have children).	0.796				
16. E-cigarettes do not cause loss of concentration.	0.789				
17. E-cigarettes do not cause nausea.	0.759				
15. E-cigarettes do not cause stroke.	0.752				
13. E-cigarettes do not cause headache.	0.713				
E-cigarette vs. packed cigarettes: eigenvalue 1.848; explained variance: 10.266%					
24. E-cigarettes are less harmful than packed cigarettes.		0.801			
26. E-cigarette use is less harmful than packed cigarette smoke.		0.785			
25. E-cigarettes are less addictive than packed cigarettes.		0.782			
8. E-cigarettes are less harmful and safer than packed cigarettes.		0.658			
23. E-cigarettes are tools that helps people quit smoking.		0.617			
Establishing identification: eigenvalue 1.450; explained variance: 8.057%					
20. Influencers using e-cigarettes makes me think positively about e-cigarettes.			0.899		
21. Celebrities/athletes using e-cigarettes makes me think positively about e-cigarettes.			0.896		
29. There is no problem in using e-cigarettes to avoid being excluded from your circle of friends.			0.451		
E-cigarette addiction: eigenvalue 1.134; explained variance: 6.300%					
10. E-cigarettes do not contain harmful or addictive substances.				0.786	
5. E-cigarette use is not addictive.				0.696	
9. E-cigarettes do not contain nicotine, unlike classic cigarettes.				0.628	
Socialization: eigenvalue 1.050; variance explained: 5.835%					
4. Refusing an e-cigarette when offered causes social exclusion.					0.850
3. E-cigarettes contribute to socialization.					0.744

There was a positive and significant relationship at a medium effect level between the total scores obtained from the ECABA Scale and the “Benefits of Smoking” subscale of the Child Decisional Balance Scale ($r = 0.477$; $P = 0.000$), while there was a negative and significant relationship at a low effect level between the “Harms of Smoking” subscale and the “Harms of Smoking” subscale ($r = -0.130$; $P = 0.017$).

When the relationships of the ECABA subscales with the benefits of smoking and the harms of smoking subscales are examined, it is revealed that there is a significant positive small effect between the psychological consequences of smoking subscale and the benefits of smoking subscale ($r = 0.275$; $P = 0.000$). There was a significant positive small effect between findings that e-cigarettes are less harmful than classical cigarettes and the benefits of smoking subscale ($r = 0.333$; $P < 0.001$); significant adverse small effect between the identification subscale and the benefits of smoking subscale ($r = 0.481$; $P = 0.000$) and harms of smoking subscale ($r = -0.216$; $P = 0.000$); significant positive small effect between the e-cigarette addiction subscale and the benefits of smoking subscale ($r = 0.288$; $P = 0.000$); There is a significant positive medium effect between the socialization subscale and the benefits of smoking subscale ($r = 0.477$; $P < 0.001$) and a significant adverse small effect between the socialization subscale and the harms of smoking subscale ($r = -0.130$; $P = 0.017$).

Discriminative Validity Analysis

A 27% lower vs. upper group comparison was conducted to measure the discriminative validity of the E-cigarettes Attitude and Belief Scale. An independent sample t-test was conducted to determine whether there is a statistically significant difference between the mean scores of the lower 27% group (lowest scores) and the upper 27% group (highest scores) (Supplementary Table 3). As a result of the independent sample t-test, the differences between the mean scores of the 27% lower and upper groups from the scale and subscales were statistically significant ($P < 0.001$). Thus, it was determined that the scale had discriminative validity.

Confirmatory Factor Analysis

Confirmatory factor analysis was conducted for the five-factor structure of the ECABA Scale. According to the standard goodness-of-fit measures reported by Schermelleh-Engel et al.²⁶ (2003) (Supplementary Table 4).

When the obtained fit values were compared with the goodness-of-fit indexes accepted in the literature, the model for the five-factor structure of the ECABA Scale provided acceptable fit values (Figure 3).

Test Re-test Reliability and Internal Validity

The same baseline scale was administered at 2-week intervals to 30 participants. No significant difference was found between the mean scores of the first test and the retest conducted at 15-day intervals. Therefore, the scale was concluded to have retest reliability. Internal validity was evaluated with Cronbach's alpha (Table 1).

Supplementary Table 5 comprehensively presents the reasons for the retention or removal of all items initially evaluated in the statistical process. The complete, finalized version of the “Adolescent E-cigarette Attitude and Belief Scale (ECABA)” is available as Supplementary Tables 6 and 7 in both English and Turkish.

DISCUSSION

It is essential to understand why adolescents use e-cigarettes. The validated scale holds strong potential to serve as a key instrument in future research exploring adolescent perspectives on e-cigarette use. A thorough understanding of these beliefs and attitude systems is crucial for designing impactful, evidence-based, educational and policy interventions to curb both the initiation and persistence of e-cigarette use among youth. Therefore, we need concrete measurement tools to assess young people's attitudes and beliefs towards e-cigarette use. Behavior and expectancy scales about e-cigarette use have been developed and validated for adolescents.²⁷ To our knowledge, only one e-cigarette attitude scale has been developed for a specific group based on race/ethnicity.¹²

This study aims to develop a scale for measuring the attitudes and beliefs of adolescents related to e-cigarettes. It measures attitudes and beliefs about the Physical Consequences of E-cigarettes, E-cigarettes vs. Pack Cigarettes, Establishing Identification, E-cigarette Addiction, and Socialization. A valid and reliable attitude and belief scale can help assess the effectiveness of prevention studies and changes in them over time.

During the scale development process, several items were removed based on specialist review, semantic coherence, and statistical criteria. Initially, two items were excluded following specialist assessment as they reflected either self-assessed knowledge or external observations rather than personal attitudes. Subsequently, EFA led to the removal of additional items that either cross-loaded on multiple factors or did not logically fit within the emerging factor structure. Many of these items addressed misconceptions or general statements about the harms of e-cigarettes, suggesting they constitute a distinct dimension unrelated to the intended attitude construct. A final EFA, conducted after removing semantically inconsistent items, yielded a five-factor structure comprising 18 items, all demonstrating satisfactory factor loadings (>0.50) and strong internal consistency (Cronbach's $\alpha=0.88$). Detailed item-level decisions and exclusion criteria are provided in Supplementary Table 5.

Upon examining the results of the internal consistency analysis, it was observed that the values generally aligned with those reported in the literature. The internal consistency coefficients for the subscales of e-cigarette addiction and socialization were found to be low but within acceptable limits. It was suggested that increasing the number of items loading on the subscales of socialization and e-cigarette addiction could enhance internal consistency. To test the criterion validity of the scale, its correlation with the reference test was assessed.¹⁷ As a result, it was found that as positive attitudes towards e-cigarettes increased, scores for these attitudes regarding the benefits of

smoking also rose moderately. In contrast, negative attitude scores towards the harms of tobacco decreased slightly. The correlation of the attitude and belief scale towards e-cigarettes, with the benefits of smoking subscale, demonstrated that the assumption of criterion validity was met. In contrast, the correlation between the initial scale and the harms of smoking subscale was low.

The scale's discriminant validity analysis revealed that it could distinguish between individuals with positive and negative attitudes and beliefs toward e-cigarettes. Therefore, the scale was assessed to measure participants' self-assessments in a way that differentiates them based on their attitudes and beliefs. A confirmatory factor analysis was conducted to test the model obtained from the exploratory factor analysis of the scale, and it was observed that the model met the goodness-of-fit values reported in the literature.²⁶ When evaluating the validity and reliability results of the E-cigarette Attitude and Belief Scale, it was evident that the scale items measured the intended characteristic and distinguished between individuals with and without the targeted attitude and belief. Expert opinions were utilized to determine the content validity of the scale. Exploratory and confirmatory factor analyses were used to assess the scale's construct validity. The scale's high and acceptable internal consistency coefficients indicate that the items within the subdimensions are consistent.

This study makes a significant contribution to the literature, but it also has some limitations. Although the study focuses on adolescents, the primary target group of the e-cigarette industry, conducting it in a hospital setting may have influenced responses due to social desirability bias. While previous studies and guidelines on e-cigarettes were utilized for item development, cognitive testing was not conducted with adolescents to ensure the items were meaningful and appropriate for this age group. Additionally, apart from pediatric pulmonology specialists specializing in e-cigarettes, and a psychologist specializing in substance abuse, no revision was obtained from other experts.

Although the study population was drawn from pediatric outpatient clinics, the sample demonstrated comparable socioeconomic, educational, and geographic diversity with that reported in national data by the Turkish Statistical Institute. This supports the generalisability of our findings to the broader Turkish adolescent population.

Despite these limitations, the current study offers a scientifically robust and original tool for measuring adolescents' attitudes and beliefs about e-cigarettes. By providing a reliable and valid scale to assess these attitudes and beliefs quantitatively, this study lays a strong foundation for future research and intervention programs. The responses can provide valuable insights for developing targeted educational initiatives and policy regulations to prevent e-cigarette use among adolescents.

CONCLUSION

In conclusion, e-cigarette use among adolescents represents a pressing public health concern that demands immediate attention. The ECABA Scale provides a valid and reliable tool for assessing adolescents' attitudes and beliefs, offering a foundation for identifying both risk factors that compromise

health and protective factors that support healthy behaviors. It can also inform the design of targeted educational and awareness programs to prevent e-cigarette use in this vulnerable population.

Ethics

Ethics Committee Approval: The Ethics Committee of Koşuyolu High Specialization Training and Research Hospital (İstanbul, Türkiye) (decision no: 2024/16/920, date: 17.09.2024) approved the application.

Informed Consent: Before beginning the questionnaire, participants and one of their parents read and reviewed the consent and were provided with comprehensive information about the study.

Acknowledgements

I would like to thank my daughter, Deniz Oksay, for her valuable contribution to the preparation of the visual materials.

Footnotes

Authorship Contributions

Surgical and Medical Practices: S.C.O., Concept: S.C.O., G.B., S.G., Design: S.C.O., G.B., Z.R.O., E.D., Data Collection or Processing: S.C.O., G.A., G.B., D.M.T., Z.R.O., E.G., S.G., Analysis or Interpretation: S.C.O., G.A., G.B., E.D., S.G., Literature Search: S.C.O., G.A., S.G., Writing: S.C.O., G.A.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

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