Clinical and Experimental Health Sciences

Validity and Reliability of Electronic Cigarette Dependence Scale (EDS-4) Among Nurses

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ABSTRACT

Objective: The aim of this study is to investigate the validity and reliability of the Turkish version of the short form of the Electronic Cigarette Dependence Scale (EDS-4).

Methods: This methodological study was conducted with 128 nurses in three public hospitals on the European side of Istanbul between June and November 2024. Data were collected using the Personal Information Form, Electronic Cigarette Questionnaire Form, and the Electronic Cigarette Dependence (EDS-4) Scale. To assess the validity of the EDS, which is a four-item, five-point Likert-type scale, construct and content validity were examined. To evaluate reliability, item-total correlations, internal consistency, and the split-half method were used.

Results: The content validity index of the scale was found to be .98; internal consistency was assessed using Cronbach's alpha and found to be .88; and split-half reliability, evaluated using the Spearman–Brown coefficient, was .92 ($p < .05$). Confirmatory factor analysis indicated excellent model fit indices (CFI=1.00, SRMR=.008, χ^2/df= .444, RMSEA=.000). The mean score of the Electronic Cigarette Dependence Scale (EDS-4) was 2.19±1.07.

Conclusion: The Turkish version of the Electronic Cigarette Dependence Scale was found to be valid and reliable.
Keywords: Electronic Cigarette, E-cigarette dependence, Reliability, Scale adaptation,

1. INTRODUCTION

Electronic cigarettes (e-cigarettes) were developed in China in 2003 as an alternative to traditional cigarettes and began to be used in the United States and many other countries in 2006 (1). Although many users consume both tobacco and e-cigarettes (dual use), the use of e-cigarettes alone has significantly increased among young adults and adolescents. This is concerning, as while tobacco use has declined globally over the past 50 years, e-cigarettes—with their appealing flavors and sleek designs—are creating a new generation addicted to nicotine (2). E-cigarettes allow users to vaporize a liquid solution (usually containing nicotine, flavoring, and other chemicals). These devices consist of three main components: a battery or power source, an atomizer that heats the liquid, and a mouthpiece for inhaling the vapor (3, 4, 5, 6,7). While the first designs were simpler, today there are various types such as pod systems, mod devices, and disposable e-cigarettes. This variety caters to different user preferences and facilitates the spread of addiction (8). Although the long-term health effects are not fully known, it is known that e-cigarettes produce toxic substances, some of which cause cancer and some of which increase the risk of heart and lung disorders (9). One of the harms attributed to e-cigarettes in the literature is EVALI (E-cigarette or Vaping product use-Associated Lung Injury), a serious lung disease officially recognized in 2019 (10). The most common symptoms in EVALI cases are respiratory-related symptoms such as shortness of breath, coughing, and chest pain. Additionally, gastrointestinal symptoms include nausea, vomiting, diarrhea, and abdominal pain.

Addictive substances such as nicotine, found in e-cigarette contents, carry a risk of developing addiction similar to tobacco cigarettes, giving rise to the concept of e – cigarette dependence. The addiction potential of e-cigarettes,

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particularly compared to tobacco cigarettes, remains a topic of debate. Self-report scales can be used to evaluate the addiction potential of a product. Many studies using these types of measurements show that e-cigarettes are addictive but at lower levels than tobacco cigarettes (11, 12, 13, 14). This situation has also been confirmed by the responses of e-cigarette users with different smoking histories to the same addiction measurement (15). However, two smaller-scale studies have reported opposite results, showing that e-cigarette dependence scores were higher than tobacco cigarette dependence scores in both exclusive e-cigarette users and dual users (16, 17). In one study, 41.3% of e-cigarette users reported positive signs of nicotine dependence within the past 30 days. Non-nicotine substance use and more frequent e-cigarette use were significantly associated with a higher likelihood of dependence and more severe symptoms (18). While various tools assess nicotine dependence, e-cigarette-specific scales remain limited. Globally, the Penn State Electronic Cigarette Dependence Index (19), E-cigarette Fagerström Test of Cigarette Dependence (20) and the E-cigarette Dependence Scale (EDS) (21) are the most widely recognized instruments. In Turkey, research has predominantly relied on adapted versions of traditional cigarette dependence scales. However, there is a clear need for psychometrically validated, short, and specialized tools like the EDS-4 that are specifically adapted for the Turkish population. The Electronic Cigarette Dependence Scale (EDS) has three versions: 22-item, 8-item, and 4-item. The short version with four items has been shown to assess dependence as effectively as the longer version while reducing participant burden.

With the increasing prevalence of e-cigarette use, its usage has also been observed to rise among nurses in clinical settings. Nurses act as health role models and are on the front lines of patient education for nicotine cessation. Therefore, assessing e-cigarette dependence among nurses is crucial, as their own dependence status can directly influence their attitudes toward counseling patients and the effectiveness of health promotion programs. This study aimed to examine the Turkish validity and reliability of the short version of the Electronic Cigarette Dependence Scale (EDS-4), which was developed in English by Morean and colleagues in 2019.

Research Questions:

Does the EDS-T demonstrate acceptable content validity?

Do the fit indices derived from the construct validity analysis of the EDS-T indicate an acceptable model fit?

Is the EDS-T a reliable instrument for the assessment of e-cigarette dependence?

2. METHODS

2.1. Ethical Considerations

Permission to use the Electronic Cigarette Dependence Scale (EDS-4) for the validity and reliability study was obtained via email from Meghan Morean. Prior to the implementation of the study, ethical approval was obtained from the Marmara University Ethics Committee (19.12.2023-122), as well as written permissions from the Istanbul Provincial Health Directorate and three public hospitals located on the European side of Istanbul.

2.2. Research Design and Sample

This study is of methodological design. It was conducted between June and November 2024 with nurses working in three public hospitals on the European side of Istanbul. The study sample consisted of 128 nurses who voluntarily agreed to participate. Data were collected through self-report.

The sample size of 128 was deemed sufficient for Confirmatory Factor Analysis (CFA), as it significantly exceeds the recommended ratio of 5 to 10 participants per item (22, 23). For a 4-item scale, our sample provides a high ratio of 32:1, ensuring the stability of parameter estimates (24). This sample size is also consistent with recent international studies (25, 26) using similar psychometric designs.

The inclusion criteria were: (1) being a registered nurse, (2) being an electronic cigarette user, and (3) volunteering to participate. Incomplete forms were excluded from the analysis based on the exclusion criteria.

2.3. Data Collection Tools

The data collection instruments included a Personal Information Form, an Electronic Cigarette Questionnaire, and the Electronic Cigarette Dependence Scale.

2.3.1. Personal Information Form

This form included questions regarding the participants' age, gender, chronic diseases, and health complaints.

2.3.2. Electronic Cigarette Dependence Scale (EDS)

The short form of the Electronic Cigarette Dependence Scale consists of four items using a Likert-type scale. Participants rate their dependence on e-cigarettes on a five-point scale ranging from 0 to 4. The total possible score ranges from 0 to 16. An example item from the scale is: "When I haven't been able to vape for a few hours, the craving gets intolerable." The scale was developed by Morean and colleagues and was administered to adults who reported using e-cigarettes at least once a week. In the original study, the internal consistency coefficient was $\alpha = .86$. Higher scores on the scale indicate higher levels of dependence.

2.4. Study Process

2.4.1. Language Equivalence, Cultural Adaptation, and Content Validity

The Turkish adaptation and content validity assessment of the Electronic Cigarette Dependence Scale followed these steps:

- The original English version of the scale was translated into Turkish by two independent experts fluent in both languages.
- The researchers reviewed the items and combined the most appropriate expressions to create a single Turkish version.
- This Turkish version was then back-translated into English by two different linguists, distinct from those who did the initial translation.
- The back-translated English version was reviewed by an independent linguist to ensure accuracy and a final English form was created.
- To assess the accuracy of translation and content validity, 13 experts were consulted. They rated each item on a scale from 1 to 4 [1 = Not appropriate, 4 = Very appropriate] for suitability and clarity. Based on the experts' feedback, necessary revisions were made, and the final Turkish version of the EDS (EDS-T) was finalized.

2.4.2. Pilot Study

The pilot study for the Turkish version of the EDS-T was conducted with 20 nurses. No issues with item clarity were reported, and the Cronbach's alpha was found to be .94.

2.5. Data Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) 20.0 and Analysis of Moment Structures (AMOS) 23.0 software. Content validity of the EDS-T was assessed using the Content Validity Index (CVI), and construct validity was assessed via Confirmatory Factor Analysis (CFA). CFA was first used to test how well the theoretical model explained the observed relationships in the dataset, followed by analysis of alternative models. Fit indices evaluated in CFA included chi-square (χ^2), degrees of freedom (df), Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), and Comparative Fit Index (CFI).

Reliability of the EDS-T was evaluated using Cronbach's alpha, item-total correlations, and the Split-Half (Spearman-Brown) method. Cronbach's alpha values were interpreted as follows: $\alpha > .60$ indicates acceptable (modest) reliability and $\alpha > .70$ indicates good reliability (27). Spearman-Brown coefficients were interpreted as: < .49 = insufficient, .50 –.59 = weak, .60 –.69 = moderate, .70 –.79 = acceptable, .80 –.89 = high, and .90–1.00 = very high reliability (28).

Descriptive findings were analyzed using percentages, means, and standard deviations. Since EDS-4 scores were normally distributed, group comparisons were made using independent samples t-tests.

3. RESULTS

The average age of the nurses was 31.85 ± 6.81 years, and 61.7% were female. Regarding chronic diseases and respiratory complaints, 10.9% had dyspnea, 6.3% had asthma, 5.5% had experienced wheezing or whistling in the chest at any time in the past 12 months, 3.9% had a persistent cough, 3.9% had diabetes, 1.6% had hypertension, and 0.8% had COPD. A total of 19.5% of participants believed they were addicted to e-cigarettes. (Table 1).

Table 1. *Sociodemographic characteristics and usage patterns of nurses using electronic cigarettes (n=128)*

Variables		Min-Max	Mean±SD
Age		21-51	31.85±6.81
		n	**%**
Gender	Female	79	61.7
	Male	49	38.3
Chronic Diseases and Complaints	None	85	66.4
	Dyspnea	14	10.9
	Asthma	8	6.3
	Wheezing or whistling in the chest at any time in the last 12 months	7	5.5
	Persistent cough	5	3.9
	Sputum production on most days during a three-month period	3	2.3
	Wheezing or whistling in the chest while breathing	0	0
	Diabetes	5	3.9
	Hypertension	2	1.6
	COPD	1	0.8
Do you consider yourself addicted to e-cigarettes?	Yes	25	19.5
	No	103	80.5

3.1. Validity Findings

The Content Validity Index was used to evaluate expert opinions based on the Davis method (29). Regarding content validity of the EDS-T, it was observed that all 13 experts scored each item with at least 3 points. The item-level mean scores ranged between 3.85 and 4.00, and the content validity index was calculated as .98.

In the first model of the CFA conducted to assess construct validity, the overall fit indices were CFI = .95, SRMR = .037, RMSEA = .225, and $\chi^2/df = 6.779$. In line with modification indices, an error covariance was added between item 3 and item 4. An error covariance was added between Item 3 and

Item 4 because these items exhibit semantic redundancy and conceptual overlap. Theoretically, correlating error terms is justified when items share similar wording or measure a specific sub-dimension of the construct (30). This modification improved the model fit without altering the scale's theoretical integrity. The revised model yielded excellent fit values: CFI = 1.00, SRMR = .008, χ^2/df = .444, RMSEA = .000 (Table 2).

Table 2. *Fit ındices obtained from the confirmatory factor analysis of the EDS-T*

Model	χ^2	p	sd	χ^2/sd	CFI	RMSEA	SRMR
Theoretical	13.559	.001	2	6.779	.954	.225 (.12 – .34)	.037
Proposed	**.444**	**.505**	**1**	**.444**	**1.00**	**.000 (.00-.21)**	**.008**
* Perfect Fit	-	>.05	-	χ2/sd<3	.97≤CFI≤1	.00< RMSEA<.05	.00≤SRMR≤ .05
*Acceptable Fit	-	>.05	-	χ2/sd<5	.95≤CFI≤ .97	.05< RMSEA<.10	.05≤ SRMR≤ .10

χ^2: Chi-square; df: Degrees of freedom; RMSEA: Root Mean Square Error of Approximation; SRMR: Standardized Root Mean Square Residual; CFI: Comparative Fit Index.
Source: Dursun & Kocagöz, 2010

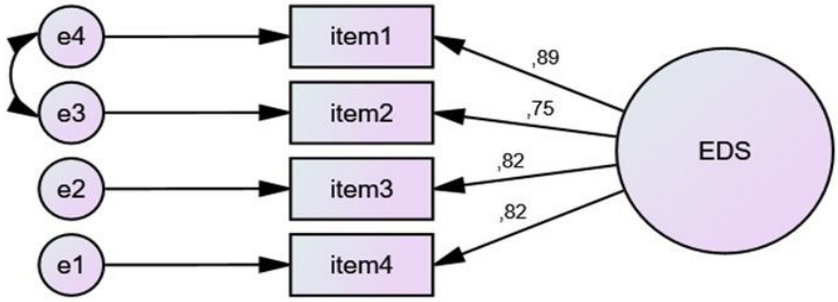

Figure 1. *EDS confirmatory factor analysis graphic*

Table 3. *Reliability and descriptive statistics of the ıtems in the electronic cigarette dependence scale (EDS) (n=128)*

Scale items	Mean	SD	Item-Total Correlation (r)	Spearman-Brown Coefficient	Mean ±SD	Cronbach's alfa
Item 1: I find myself reaching for my e-cigarette without thinking about it.	2.88	1.24	.74	.92	2.19±1.07	.88
Item 2: I drop everything to go out and buy e-cigarettes or e-juice.	1.50	1.33	.64			
Item 3: I vape more before going into a situation where vaping is not allowed.	2.35	1.30	.78			
Item 4: When I haven't been able to vape for a few hours, the craving gets intolerable.	2.04	1.17	.78			
EDS Total Score	8.77	4.32				

Mean = Average; SD = Standard Deviation; r = Item-total correlation.

The unidimensional structure of EDS-T was confirmed, with factor loadings (standardized weights) ranging between .75 and .89 (Figure 1).

3.2 .Reliability Findings

The Cronbach's alpha coefficient for EDS-T was found to be .88, and the Spearman-Brown coefficient was .92. The mean total score for the EDS was 2.19 ± 1.07 (Table 3).

4. DISCUSSION

This study found that the short form of EDS-T is a valid and reliable tool for assessing e-cigarette dependence. The content validity index of the EDS-T was calculated as .98, indicating a high level of expert agreement. CFA is recommended to assess construct validity in scale adaptation studies (31). CFA determines whether the items of a scale accurately and reliably represent the intended construct, thus minimizing measurement errors and

reinforcing the theoretical model (32). The model fit indices in this study showed excellent fit, with a χ^2/df value of .444. A value <3 is considered normal, and <5 is acceptable. The RMSEA was .000, indicating a very good fit (33). The CFI value of 1.00 reflects excellent model fit, as values between .97 and 1.00 are considered indicative of strong fit. The factor loadings in our study ranged from .75 to .89, similar to the range reported by Morean et al. (2019), which was between .71 and .89. These findings suggest that the EDS items had high factor loadings.

Cronbach's alpha coefficient was used to determine the internal consistency of the Likert-type scale, indicating the degree of inter-item reliability (34). In the literature, values of .70 and above are generally considered acceptable for reliability (35, 36). In the present study, the Cronbach's alpha coefficient for the EDS-T was found to be .88. This result indicates that the internal consistency of the scale is high and comparable to that of the original version, demonstrating good reliability.

In addition to other methods used to assess reliability in this study, the Split-half method divides the scale into two equal halves and evaluates the relationship between them using the Spearman-Brown correlation coefficient. A high and statistically significant correlation is expected between the two halves. In scale development and adaptation studies, reliability coefficients of .70 or above are considered acceptable (37, 38, 39). In our study, both the Spearman-Brown and Guttman reliability coefficients were found to be high at .92.

The reliability findings demonstrated that all coefficients—Cronbach's alpha, Spearman-Brown, and Guttman—were .70 or higher. Accordingly, the Turkish version of the Electronic Cigarette Dependence Scale (EDS-T) was determined to have sufficient internal consistency.

In our study, 19.5% of participants considered themselves addicted to e-cigarettes, while 80.5% did not consider themselves addicted. Although there is no established cut-off score for the EDS-4, participants who self-identified as addicted had significantly higher scores than those who did not. In Pienkowski's study, 31.5% of participants reported being highly dependent on e-cigarettes, and 42.7% reported being somewhat dependent (40). The lower dependence rate observed in our study may be related to the sample consisting of nurses and their tendency to underreport addictive behaviors.

The average dependency levels identified in our sample were similar to those reported in other studies using the same measurement tool. The mean EDS-4 score in our study (2.19) is consistent with the findings of Douglas et al (41), Douglas et al (26), Milstred et al (42), Morean et al (43) and, who reported average scores of 2.07, 2.20, 2.23, 2.24, respectively. These results demonstrate that the dependence levels identified in our sample align with global data using the same measure.

When evaluating chronic conditions and complaints, 28.9% of the sample reported lung-related complaints. This is noteworthy in terms of investigating possible health consequences related to e-cigarette use. The high prevalence of chronic complaints in a sample composed of nurses underscores the need for e-cigarette cessation programs specifically targeted toward healthcare professionals.

As the sample of this study was limited to nurses, it is recommended that future research with adult populations evaluate internal consistency for broader generalization. In our study, dual users (cigarette and e-cigarette users) and exclusive e-cigarette users were analyzed together, which may have limited the ability to perform a more detailed comparison between the addiction profiles of these two groups.

While EDS-4 scores range from 0 to 16, the scale currently lacks established cut-off points. Future research should focus on determining these thresholds to enable a more precise categorization of dependence levels. Defining such cut-off scores is essential for the scale's practical utility and for providing more personalized support.

5. CONCLUSION

The short form of the Electronic Cigarette Dependence Scale (EDS-4), originally developed in English by Morean et al., was found to be a valid and reliable instrument for use with Turkish nurses. The Turkish version of the scale is recommended for use in scientific studies evaluating e-cigarette dependence and in the assessment of e-cigarette cessation programs targeting e-cigarette use.

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