Arch Health Sci Res. 2024
DOI: 10.5152/ArcHealthSciRes.2024.24109

Original Article

Endocrine Disruptors Attitude Scale: A Scale Development Study

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Cite this article as: Turan Miral M, Mamuk R, Dişsiz M, İşgüven SP. Endocrine disruptors attitude scale: a scale development study. *Arch Health Sci Res.* Published online November 8, 2024. doi: 10.5152/ArcHealthSciRes.2024.24109.

ABSTRACT

Objective: Endocrine disruptors are substances and mixtures that cause health problems in individuals and generations by affecting the endocrine system. There is no measurement tool for the assessment of people's attitudes toward endocrine disruptors. The development of a valid and reliable measurement tool for the measurement of the attitudes of adult individuals toward endocrine disruptors is the aim of this study.

Methods: This study with a methodological design was conducted with 366 participants who were at least 18 years old and literate in Turkish between December 01, 2021, and March 01, 2022, in İstanbul and Famagusta. To collect data, the "Participant Introduction Form" and "Endocrine Disruptors Attitude Scale" were used. Data were evaluated with descriptive statistics, exploratory and confirmatory factor analysis, dependent samples *t*-test, Cronbach's α internal consistency coefficient, and Pearson correlation analysis.

Results: When the item–total score correlations of 35 items in the draft scale were examined, 14 items with less than 0.30 and negative values were excluded from the scale. The correlation coefficient of all the remaining items was positive and significant ($P < .001$). The difference between test and retest mean scores was not statistically significant ($P > .05$). Cronbach's α reliability coefficient was determined as $\alpha = 0.81$ for the Consumer behavior sub-dimension, $\alpha = 0.80$ for Nutrition and hygiene, and $\alpha = 0.85$ for the whole scale.

Conclusion: The scale is concluded to be a reliable and valid tool and can be utilized for determining the determination of attitudes of adults toward endocrine disruptors.

Keywords: Attitude, endocrine disruptors, environment, community health, questionnaire

Introduction

Endocrine disruptors are substances and mixtures that cause health problems in individuals and generations by affecting the endocrine system.[1-3] Bisphenol A, phthalates, flame retardants, parabens, and pesticides are examples of endocrine disruptors. Bisphenol A, found in plastics, lotions, detergents, and many other places, causes health problems such as infertility, polycystic ovary syndrome, endometriosis, obesity, and type 2 diabetes.[1,4-6] Phthalates, found in plastics, perfumes, cosmetics, medical devices, and many other places, cause problems such as infertility, cardiovascular diseases, thyroid diseases, insulin resistance, cancer, and early puberty.[1,2,7] Flame retardants such as polybrominated diphenyl ethers (PBDEs) are used in many areas such as textiles, automobiles, and plastics and cause many problems such as early puberty, neurodevelopmental problems, and thyroid problems.[2,7] Parabens found in cosmetics can cause cancer.[2] Today, there are over a thousand substances known to be endocrine disruptors.[2,5] It has been reported that there are health effects such as miscarriage, preterm birth, intrauterine growth retardation, neurodevelopmental disorders, behavioral disorders, pubertal developmental disorders, thyroid problems, immune problems, diabetes, asthma, allergy, cancer, and infertility in individuals and their generations.[1,8-11]

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Received: June 26, 2024
Revision Requested: August 30, 2024
Last Revision Received: September 27, 2024
Accepted: October 1, 2024
Publication Date: November 8, 2024

Endocrine disruptors found in plastics, building materials, house dust, furniture, cosmetics, detergents, and even in the air, water, and soil are important public health problems.[1,5,11,12] Although endocrine disruptors are effective throughout life, the most susceptible periods are the fetal, childhood, and pubertal periods.[2] Studies aimed at reducing the exposure of society, especially risk groups, to endocrine disruptors have gained momentum in recent years. An organic diet intervention reduced the levels of organophosphate pesticide metabolites in the urine of adults.[13] Interventions to reduce the use of personal care products containing parabens, phthalates, and phenols reduced the levels of these chemicals in adolescents' urine.[14] Another study reported that information about endocrine disruptors and peer advice was effective in developing protective attitudes against endocrine disruptors in young women.[15] However, no measurement tool has been found in the literature that can be used in such intervention studies to measure attitudes toward endocrine disruptors.

Education is one of the first practices that come to mind to protect society, especially vulnerable groups. However, education alone is not enough for behavior change. In the study by Rouillon et al, the rate of pregnant women who find cosmetics and personal care products dangerous was 91.3%, while only 13% of these pregnant women agreed to reduce their use of cosmetics.[10] In another study, no difference was found in product use between the women who were informed about not using endocrine disruptors such as hair dye, during pregnancy and the women who were not informed about the use of these products.[16] If the aim is to change the behavior of the individual in education and similar interventions, an individual's perception of risk should be evaluated.[8,10,17,18] Interventions that change an individual's risk perceptions have also been shown to change health behaviors.[19] For interventions such as training to be provided on endocrine disrupters, it is recommended to assess the knowledge, skills, and attitudes of the individual prior to the intervention in order to assess risk perception.[8,10,17] However, the literature review was unable to locate a common measurement method that assesses people's opinions regarding endocrine disruptors.

The aim of this study was to create an "Endocrine Disruptors Attitude Scale (EDAS)" that could be used to examine adults' attitudes about endocrine disruptors.

Methods

Study Design

This methodological study design was conducted online between December 01, 2021 and March 01, 2022, in İstanbul and Famagusta. The study's population comprised the families of students from İstanbul Kültür University and the Faculty of Health Sciences, Nursing Department, at Eastern Mediterranean University. The main reason for the study universe to consist of student families was that the COVID-19 pandemic was continuing at full speed during the period when the study was planned. During this period, the number of individuals vaccinated was insufficient, so social distancing rules continued. In addition, only online studies were allowed by the Health Ministry due to the pandemic management rules. Therefore, the data could not be collected face-to-face. In addition, student families consisted of individuals with different cultural structures in different regions of the country. Student families were preferred as the study universe, anticipating that student families would provide participant diversity.

Sampling

The study included all volunteers who fulfilled the inclusion requirements and agreed to participate between the study dates. It is advisable to include cases 5-10 times the scale's item count in scale adaptation and development research.[20,21] Considering that the first draft of the EDAS had 35 items, a reliability and validity study was conducted with 366 participants. Individuals who were at least 18 years old, literate in Turkish, capable of using a mobile phone or computer, had an online social media account, and were willing to engage in the study were included in the sample.

Data Collection Tools

To collect data, the researchers used the Participant Introduction Form and the EDAS after reviewing the literature.

Participant Introduction Form

The researchers designed this form to evaluate the participants' sociodemographic characteristics. The form includes 11 questions about age, gender, number of children (if any), employment status, level of education, marital status, family type, income status, place of residence, and knowledge of endocrine disruptors.

Creating the EDAS Items Pool

At the stage of creating the scale items, the theoretical framework was determined by considering studies and publications on endocrine disruptors and the literature on scale development stages. A pool of 35 items was prepared by consulting experts on the subject.[1,4,7,8,10,12,15,17,19,22-26] A five-point Likert scale was also used, with 1 denoting "complete disagreement," 2 "disagreement," 3 "partial agreement," 4 "agreement," and 5 "complete agreement." There were no reverse items on the scale.

Data Collection

The data of the study were collected using a Participant Introduction Form and the EDAS when the individuals were informed and their consent was acquired. The COVID-19 pandemic was ongoing at the time the study was conducted. The number of individuals vaccinated against COVID-19 was low. The Ministry of Health and the Ethics Committee gave their approval for the online studies. Therefore, the data was collected online. The participants were provided with online surveys created in Google Forms until the predetermined sample size was met. Online questionnaires were to be filled out only once, and answering each question was mandatory. Thus, participants were prevented from completing more than one form. Moreover, possible data loss was prevented by making it obligatory to answer all questions. As a result, 366 volunteer participants filled out the forms completely.

Statistical Analysis

The Statistical Package for Social Sciences version 21.0 software (IBM Corp.; Armonk, NY, USA) and the SPSS Amos (Analysis of Moment Structures) 6.0 program were used to analyze the obtained data. The test–retest approach was used to obtain the Pearson correlation coefficient and assess the invariance with respect to time for the scale's reliability analysis. By calculating the Pearson product-moment correlation coefficient for the item–total correlation coefficient, internal consistency was assessed. The internal consistency coefficient was determined using Cronbach's α reliability coefficient. Confirmatory factor analysis (CFA) was used to analyze construct validity, and Lawshe's approach was used to assess expert judgments on the scale's content validity.

Ethical Considerations

The İstanbul Kültür University Clinical Research Ethics Committee approved the project to begin (Approval no: 2021/78, Date: November 25, 2021), and an online form created in accordance with the Declaration of Helsinki was used to gain the participants' consent.

Results

Findings Regarding the Participants' Introductory Characteristics

The participants' mean age was found to be 32.90 ± 10.40 (min: 18; max: 60), and 78.7% were female; over half (62.8%) had an

Table 1. Descriptive Characteristics of Participants (n = 366)

Descriptive Characteristics	Number (n)	Percentage (%)
Age		
<32 years below	181	49.5
>32 years and above	186	50.5
Gender		
Women	288	78.7
Men	78	21.3
Marital status		
Married	189	51.6
Single	177	48.4
Education level		
<11 years and below	136	37.2
>11 years above	230	62.8
Employment status		
Working	233	63.7
Not working	133	36.3
Income level		
Income is less than expenses	89	26.3
Income is equal to expenses	223	60.9
Income is to expenses	54	14.8
Place of residence		
City center	243	66.4
District center	102	27.9
Village-town	21	5.7
Having a child		
Yes	186	50.8
No	180	49.2
Knowledge about endocrine disruptors		
Yes	185	50.5
No	181	49.5

undergraduate degree or higher. The participants' mean age was found to be 32.90 ± 10.40 (min: 18; max: 60), and over half (62.8%) had an undergraduate degree or higher. It was determined that over half (63.7%) of the participants were employed, and in 60.9% of cases, their income matched their expenses. According to the survey, over half of the participants (66.4%) resided in a city center, 51.6% were married, and 50.8% had at least one child. A total of 50.5% of the participants reported having knowledge of endocrine disruptors (Table 1).

Providing Content and Scope Validity Analysis

The clarity, quality, directiveness, usefulness, appropriateness, and manner of response of the scale items were evaluated by 11 experts (pediatric endocrinology, pharmaceutical toxicology, nutrition and dietetics, and nursing and midwifery specialists), 2 Turkish language experts, and 3 evaluation and assessment experts. Thorough assessments of the item pool's scale items were gathered. Participants scored the items between 1 and 5 (1 point: not at all appropriate; 2 points: somewhat appropriate; 3 points: undecided; 4 points: appropriate; and 5 points: very appropriate) to evaluate each item's measurement level. Using Lawshe's method, the divergences between expert opinions were investigated, and the content validity index (CVI) was used to assess the experts' data. Accordingly, the items' CVI was determined to be 94%. A total of 35 items developed in the item pool based on the CVI evaluations of the experts were adjusted once more due to similar expressions and unclear understandings. Using the scale, a decision was made based on expert assessments that 39 participants who were not part of the research sample and were chosen at random from the research universe would participate in a pilot study to evaluate the scale with any necessary modifications.

Item Analysis

A total of 14 items (items 1, 3, 7, 10, 12, 15, 17, 20, 21, 22, 23, 25, 26, and 31) with a negative value and an item–total correlation coefficient of less than 0.30 were eliminated from the scale when the item–total score correlations in the original 35-item version of the EDAS were assessed.

Table 2 provides the EDAS's 21-item item–total correlations. The item and overall scale scores were positively and significantly correlated ($P < .001$), and the reliability coefficient was determined to be between 0.36 and 0.61 (Table 2). The reliability coefficients (Pearson correlation) of 11 items in the consumer behavior subdimension were between $r = 0.49$ and 0.65, according to the component analysis of the item–subdimension total score correlations of each of the EDAS subdimensions. The reliability coefficients of 10 items in the subdimension of diet and hygiene ranged from $r = 0.45$ to 0.69, and all items' correlation coefficients were significant and positive ($P < .001$) (Table 2).

Internal Consistency Confidence Coefficient

Cronbach's α reliability coefficient was $\alpha = 0.81$ for the consumer behavior subdimension, $\alpha = 0.77$ for the nutrition and hygiene subdimension, and $\alpha = 0.85$ for the scale, according to the analysis of the internal consistency of the reliability research of the EDAS (Table 2).

Test and Retest

Pearson's product-moment correlation and a *t*-test evaluated test–retest data taken from 39 participants at 20-day intervals to test the invariance of the EDAS scale over time. The reliability coefficient between the 2 measurement scores of the scale and its 2 subdimensions ranged between −0.132 and 0.367, according to a Pearson correlation study of the scores obtained from the first and second applications of the EDAS scale and its subdimensions. No correlation

Table 2. Endocrine Disruptors Attitude Scale Item-Subscale Total Score Correlations (n = 366)

Scale Subscales and Items	Item–Subscale Total Score Correlation Coefficients		Item–Total Score Correlation Coefficients		Cronbach α
	r	*P*	*r*	*P*	α
Factor I					
Item 2	0.51	.001	0.45	.001	0.81
Item 4	0.63	.001	0.58	.001	
Item 11	0.61	.001	0.55	.001	
Item 13	0.54	.001	0.40	.001	
Item 14	0.59	.001	0.55	.001	
Item 16	0.55	.001	0.47	.001	
Item 18	0.65	.001	0.61	.001	
Item 19	0.59	.001	0.61	.001	
Item 24	0.49	.001	0.49	.001	
Item 32	0.65	.001	0.50	.001	
Item 33	0.60	.001	0.58	.001	
Factor II					
Item 5	0.55	.001	0.58	.001	0.77
Item6	0.46	.001	0.41	.001	
Item 8	0.49	.001	0.36	.001	
Item 9	0.54	.001	0.48	.001	
Item 27	0.54	.001	0.43	.001	
Item 28	0.63	.001	0.61	.001	
Item 30	0.61	.001	0.50	.001	
Item 34	0.69	.001	0.60	.001	
Item 35	0.58	.001	0.42	.001	

Factor I, Consumer Behavior Sub-Dimension; Factor II, Nutrition and Hygiene Sub-Dimension; *r*, Pearson correlation test.

Table 3. Endocrine Disruptors Attitude Scale Test and Retest Comparison Results (n = 39)

Scale Subscales	First Evaluation Mean ± SD	Second Evaluation Mean ± SD	*t*	*P*	*r*	*P*
Endocrine disruptors attitude scale (total)	83.74 ± 10.19	84.74 ± 10.85	0.546	.588	0.367	.046
1. Factor I	39.20 ± 6.60	38.66 ± 7.48	0.930	.647	−0.224	.170
2. Factor II	38.33 ± 6.19	38.46 ± 5.34	0.546	.588	−0.132	.425
Factor I, Consumer Behavior Sub-Dimension; Factor						

was found between the scale's overall scores and any of its subdimensions (Table 3). The *t*-test was used to compare the participants' mean test–retest scores in dependent groups, and the results revealed no statistically significant difference between the mean scores ($P > .05$, Table 3).

Exploratory Factor Analysis

The construct validity of the EDAS scale was first determined using exploratory factor analysis. In this study, the results on the construct validity of the EDAS scale, comprising 35 items, were acquired using 10 times as many items (n = 366), but factor analysis was performed for 21 items after 14 items were removed during item analysis. Additionally, the data's suitability for factor analysis was determined using the Kaiser–Meyer–Olkin (KMO) test. The significant and zero differences between the investigated variables were determined using Bartlett's test. The KMO coefficient was 0.85, and the chi-square value of Bartlett's test ($X^2 = 1856.127$; $df = 210$; $P = .001$) was significant ($P < .001$) at a high level. The data were considered sufficient and relevant for factor analysis. A maximum likelihood approach and the oblique (oblimin) rotation method were used for factor analysis. It was determined that no items had a factor load value below 0.30 or a load value difference of less than 0.10 for the 2 factors. A 2-factor structure with 21 items and an eigenvalue above 1.00, which accounted for 50.944% of the overall variance, was discovered using exploratory factor analysis (Table 4).

The scale consists of 2 sub-dimensions and is defined with the following names:

1. Consumer Behavior Subdimension: this factor group comprises 11 items, including items 2, 4, 11, 13, 14, 16, 18, 19, 24, 32, and 33.
2. Nutrition and Hygiene Subdimension: this factor group comprises 10 items in total, including items 5, 6, 8, 9, 27, 28, 29, 30, 34, and 35 (Table 4).

Confirmatory Factor Analysis

The EDAS was developed using 2-dimensional CFA, which was used to verify the fit of the factors for construct validity. Two-factor CFA resulted in fit indices chi-square = 506 700 ($P < .001$), Degrees of Freedom = 188 ($X^2 = 506{,}700$; $df = 188$, $X^2/df = 2.70$), root-mean-square error of approximation (RMSEA) = 0.070 ($P < .05$), standardized root-mean-square residual (SRMR) = 0.05, comparative fit index (CFI) = 0.92, non-normed fit index (NNFI) = 0.93, the goodness-of-fit index (GFI) = 0.93, and the adjusted goodness-of-fit index (AGFI) = 0.92. The CFA of all items revealed factor loads ranging from 0.37 to 0.67. The CFA diagram is shown in Figure 1.

Table 4. Exploratory Factor Analysis: Factor Loadings (n = 366)

Item	Scale	I	II
2. I use organic and natural cosmetic products.	A	**.532**	
4. I do not use printed clothes produced using harmful chemicals such as plastic.	A	**.638**	
11. When using products such as bleach and hydrochloric acid, which are harmful in terms of chemical content, I use protective equipment such as gloves, masks, etc.	A	**.591**	
13. I do not use furniture made of compressed and glued wood products (plywood, MDF, chipboard, etc.).	A	**.713**	
14. I use items made from natural materials such as cotton, glass, and wood in my home.	A	**.606**	
16. I wear gloves when dealing with vineyards, gardens, or pot works.	A	**.468**	
18. In my shopping, I buy national/international certified/labeled products such as TSE and CE.	A	**.609**	
19. While shopping, I check the content of the product I will buy.	A	**.455**	
24. When using a laptop computer, I make sure that there is a barrier between me and the computer, such as a desk and cushion.	A	**.336**	
32. I do not consume foods that come into contact with plastics marked with recycling codes 3, 6, and 7.	A	**.654**	
33. In the kitchen, instead of non-stick pans and pots, I use cast iron or stainless steel ones.	A	**.487**	
5. I avoid exposure to cosmetic products (nail polish, hair dye, hair spray, etc.) during pregnancy.	B		**.532**
6. In my daily life, I wash my hands frequently to avoid chemicals.	B		**.384**
8. I clean my house regularly.	B		**.654**
9. I ventilate my environment at intervals during the day.	B		**.618**
27. I prefer to consume fresh foods in season, rather than ready-to-eat foods whose shelf life has been extended by adding additives.	B		**.466**
28. I use glass, ceramic, porcelain, and steel products instead of plastic in water bottles and kitchenware.	B		**.457**
29. I store drinking water in plastic bottles away from the sun and high heat.	B		**.619**
3. I consume vegetables and fruits after washing them thoroughly.	B		**.813**
34. I do not heat food in a plastic container in the microwave.	B		**.439**
35. I do not use aluminum packaging materials and do not store food in the refrigerator with these materials.	B		**.387**
Percentage of Variance Explained by the Factors	**Eigenvalue**	**Total Variance Explained**	
1. Factor I: 36.722	4.302	50.9%	
2. Factor II: 14.222	1.607		
Bold, salient (>30) loading; A, Factor I: Consumer Behavior Sub-Dimension; B, Factor II: Nutrition and Hygiene Sub-Dimension.			

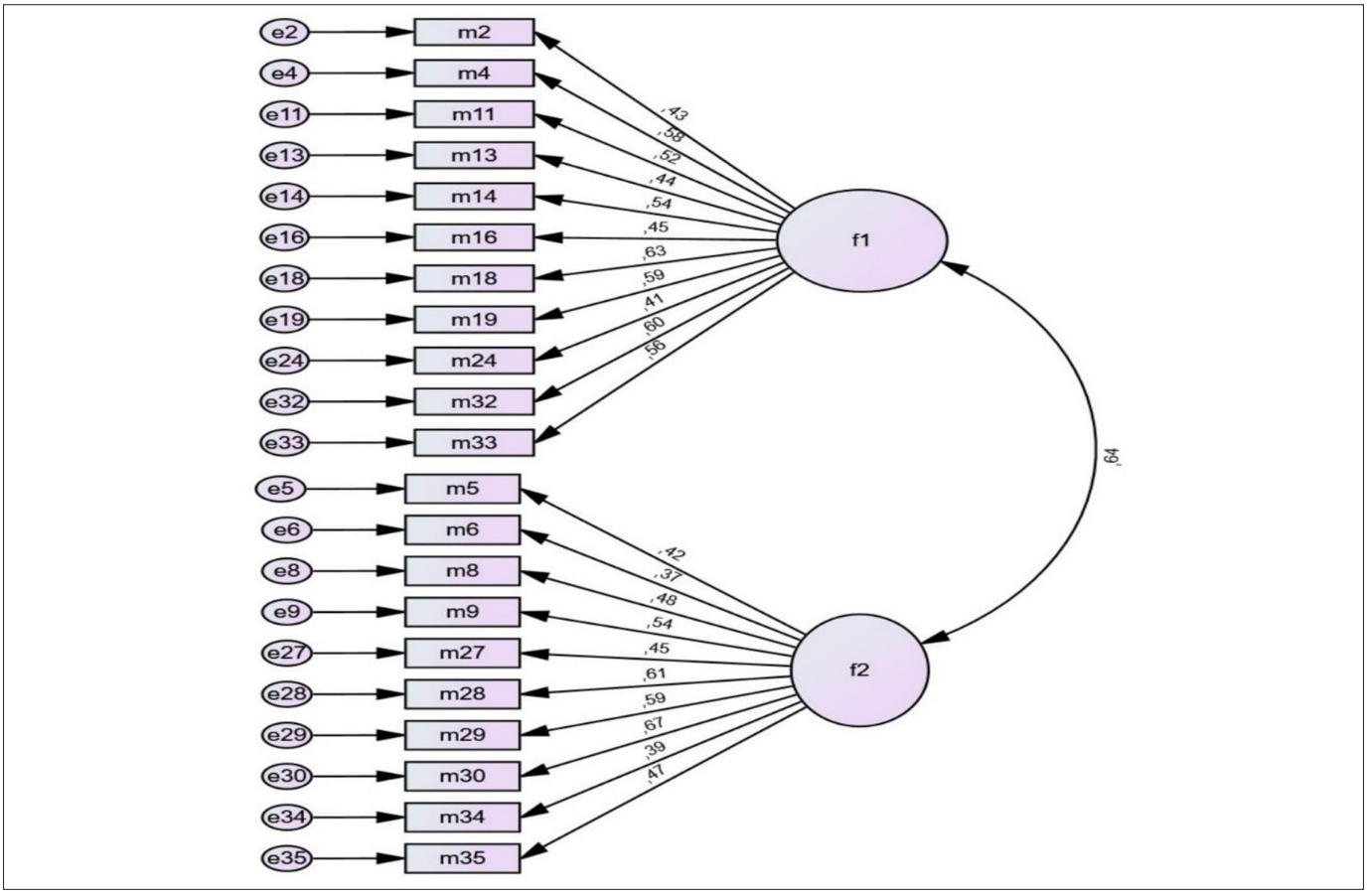

Figure 1. Confirmatory factor analysis diagram. M, Item no; e, residual covariance matrix; F1, consumer behavior sub-dimension; F2, nutrition and hygiene sub-dimension.

Discussion

To assess the reliability of the EDAS, internal consistency, item analysis, and test–retest procedures were used. The ability of a measurement tool to provide consistency across applications and to demonstrate invariance over time is shown by test–retest reliability. According to the results of the test–retest correlation study of the EDAS, no significant association was found between the subdimensions, but there was a strong relationship for the entire scale.[27,28] The group's mean scores, however, did not significantly change when paired with 20-day intervals. If the measured factor had a continuous structure, retest reliability was advised.[29] It was not time-dependent, as evidenced by the lack of a significant difference between the subdimensions in this investigation. The strong internal consistency coefficient was another encouraging discovery concerning the scale's reliability. The scale's internal consistency was assessed using the Likert-type scale-applicable Cronbach's α technique. It was expected that the scale's α coefficient would indicate how compatible its items were with one another and that it was composed of items that forecast the same feature's constituent parts. The α coefficient, calculated by adding the item variances to the overall variance and taking a number between 0 and 1, established whether the questions provided a comprehensive scale to represent a homogeneous structure.[21,27] According to the analysis conducted for the EDAS reliability study's internal consistency, the Cronbach's α's reliability coefficient was ideal for both dimensions and the entire scale.

It was assumed that the correlation coefficient between each item and the overall values would be high if the scale's items were equally weighted and treated as independent units. The stronger the link between that item and the quality to be measured, the greater the correlation coefficient.[21,27] The criteria under which the item–total score correlation coefficient would be declared insufficient for reliability were flexible; however, it was recommended that the correlations be positive and greater than 0.25 or 0.30.[30] The items' reliability increased with the coefficient of correlation.[21,27] The correlation of all items on the scale with the subdimension score and the scale's overall score was higher than the 0.30 value noted in the literature for the item analyses of the EDAS's item reliability. This outcome demonstrated that every item measured the same attitude.[30]

In terms of validity examinations, the experts found that the items were in strong agreement (94%) with the original scale when the content and scope validity were assessed. The high level of expert unanimity is a significant result for the scale's scope validity.[31] The scale appeared to have a distinct language structure and content.

The results of the exploratory factor analysis used to assess the scale's construct validity indicated that no items had a factor load below 0.30, and none were included in more than one factor simultaneously. The difference between their loads on two factors was less than 0.10. The scale's final edition was eventually created with 21 components. Its component elements' factor loads ranged from 0.33 to 0.81. Based on the analysis, a 2-factor structure with eigenvalues greater than one was obtained using the items in the scale. Additionally, 51% of the total variance was explained by the 2 components. According to the literature, items are considered acceptable if the overall variance rate explained is greater than 50%.[32,33] The KMO value in exploratory factor analysis determines the sample's suitability.[30] The KMO value is rated

as excellent if it is between 0.90 and 1.00, very good if between 0.80 and 0.89, good if between 0.70 and 0.79, moderate if between 0.60 and 0.69, weak if between 0.50 and 0.59, and undesirable if below 0.50.[34] The KMO score of 0.85 in this study's exploratory factor analysis demonstrated that the sample was appropriate for factor analysis. The correlation matrix of the questionnaire items was adequate for factor analysis, according to the significance of Bartlett's test ($P = .001$).

In the literature, using EFA and CFA analysis on the same sample is still controversial. It has been found that if the sample size is adequate (>300), both EFA and CFA analysis can be performed on the same population.[35] Confirmatory factor analysis was used to examine the degree of item representation in the identified subdimensions and the sufficiency of the scale's explanation.[28,34] As commonly used for this purpose, goodness-of-fit tests, chi-square fit statistics, the RMSEA, the SRMR, the CFI, the NNFI, the GFI, and the AGFI were used.[28,34] The desired degree of goodness-of-fit statistics is required for CFA. The fit is good if the RMSEA is 0.08 or below, the *P*-value is less than .05 (statistically significant), and the fit is weak if it is less than or equal to 0.10. The RMSEA value in this study was significant in all dimensions, showing that the fit was good. Factor loads must be at least 0.30. A fit is indicated if an SRMR is less than 0.10, and CFI, GFI, and NNFI values are greater than or equal to 0.90, and AGFI is greater than or equal to 0.80.[28,34] The study determined that all of the produced scale's goodness-of-fit scores (X^2/df, SRMR, RMSEA, GFI, AGFI, NNFI, and CFI) were at or above the established limitations. The results show that the 5-factor model is suitable when viewed holistically.

The study is limited to the results garnered from the items in the item pool obtained through the literature review and the experts' experiences. Participants with limited internet access or lower digital literacy may be underrepresented.

Conclusions and Recommendations

The study results indicated that the developed EDAS had adequate reliability and validity. Validity values and internal consistency coefficients agree with the values reported in the literature. EDAS is understandable and can provide a quick response. These findings could be utilized to gauge attitudes toward the elements impacting the endocrine system across society or in different groups. The EDAS can be safely used to assess individuals' attitudes toward endocrine disruptors in public health interventions or educational programs. It is recommended that future research test the EDAS scale in different populations and conduct longitudinal studies to evaluate changes in attitudes over time.

Availability of Data and Materials: The data that support the findings of this study are available on request from the corresponding author.

Ethics Committee Approval: The study was approved and granted by the Ethics Committee of İstanbul Kültür University (Approval no: 2021/78, Date: November 25, 2021).

Informed Consent: Written informed consent was obtained from participants in this study.

Peer-review: Externally peer-reviewed.

Acknowledgments: The authors are grateful to the participants who willingly gave their time to participate in this study.

Author Contributions: Concept – M.T.M.; Design – M.T.M., R.M., M.D., Ş.P.İ.; Supervision – M.T.M., R.M., Ş.P.İ.; Resource – M.T.M., R.M.; Materials – M.T.M., R.M., M.D., Ş.P.İ.; Data Collection and/or Processing – M.T.M., R.M., M.D.; Analysis and/or Interpretation – M.D.; Literature Search – M.T.M., R.M., M.D., Ş.P.İ.; Writing – M.T.M., R.M., M.D.; Critical Review – M.T.M., R.M., M.D., Ş.P.İ.

Declaration of Interests: The authors have no conflict of interest to declare.

Funding: The authors declare that this study has received no financial support.

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