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Current Topic in Developing World: Are Early Adolescents Aware of Climate Change?

Gelişen Dünyada Güncel Sorun: Erken Ergenler İklim Değişikliğinin Farkında Mı?

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Abstract: Climate change is recognized by the World Economic Forum as one of the top ten global crises. Existing scales measure awareness in adults, but there is no scale specifically developed for early adolescents. To address this gap, the "Early Adolescent Climate Change Awareness Scale" (EACCAS) was developed. The study targeted individuals aged 10–14 in Edirne, Türkiye (N = 7133, 25 schools). A multi-stage stratified cluster sampling method was used to select (n=897, 6 schools). A 43-item pool was generated based on literature and educational materials, and content validity was evaluated by nine experts. Feedback from a pilot study involving 21 students was used to refine the items. Data collection proceeded after obtaining ethical approvals. Structural validity was assessed through Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) on two equal subsamples, while convergent and discriminant validity were tested. Reliability was measured using Cronbach's alpha coefficient. Analyses were conducted using SPSS 22 and R Studio's "lavaan" and "semTools" packages. The final scale consisted of 15 items across three subdimensions—causes, consequences, and measures—explaining 65.53% of the total variance. The Cronbach's alpha value was 0.92, and model fit indices indicated a good fit (CMIN/DF = 2.176, RMSEA = 0.051, CFI = 0.968, TLI= 0.961, SRMR= 0.041). The scale, scored on a 5-point Likert system (1 = strongly disagree, 5 = strongly agree), provides a range of 15–75 points. Higher scores indicate greater awareness. This scale is recommended for application in diverse populations following cultural adaptations.
Keywords: Climate change, Awareness, Early adolescence, Scale development, Reliability and validity.

Özet: İklim değişikliği, Dünya Ekonomik Forumu tarafından küresel ölçekte en önemli on krizden biri olarak belirtilir. Mevcut ölçekler, yetişkinlerdeki farkındalığı ölçerken, erken adölesanlar için geliştirilmiş bir ölçek bulunmamaktadır. Bu eksikliği gidermek amacıyla, "Erken Adölesan İklim Değişikliği Farkındalık Ölçeği" (EAİDFÖ) geliştirilmiştir. Araştırma, Türkiye'nin Edirne ilinde 10-14 yaş arasındaki bireyleri hedeflemiş (N = 7133, 25 okul) ve çok aşamalı tabakalı küme örnekleme yöntemi ile 6 okuldan 897 katılımcı seçilmiştir. Literatür ve eğitim materyalleri doğrultusunda 43 maddelik bir havuz oluşturulmuş ve içerik geçerliliği 9 uzmanın görüşleriyle değerlendirilmiştir. 21 öğrenciyle yapılan pilot çalışma, maddelerin düzenlenmesine yönelik geri bildirim sağlamıştır. Veri toplama süreci, gerekli etik onaylar alındıktan sonra gerçekleştirilmiştir. Yapısal geçerlilik, Açımlayıcı Faktör Analizi (AFA) ve Doğrulayıcı Faktör Analizi (DFA) ile iki eşit ayı grup üzerinde değerlendirilmiş, ayrıca benzeşme ve ayrışma geçerliliği test edilmiştir. Güvenilirlik, Cronbach alfa katsayısı ile ölçülmüştür. Analizler, SPSS 22 ve R Studio'nun "lavaan" ve "semTools" paketleriyle yapılmıştır. Nihai ölçek, üç alt boyuttan (nedenler, sonuçlar, önlemler) oluşan 15 maddeden oluşmuş olup, toplam varyansın %65,53'ünü açıklamaktadır. Cronbach alfa değeri 0,92 olarak hesaplanmış ve model uyum indeksleri iyi düzeyde bulunmuştur (CMIN/DF = 2.176, RMSEA = 0.051, CFI = 0.968, TLI= 0.961, SRMR= 0.041). Beşli Likert ölçeği (1 = kesinlikle katılmıyorum, 5 = kesinlikle katılıyorum) ile puanlanan bu ölçek, 15 ile 75 arasında puan aralığı sağlar. Daha yüksek puanlar, daha yüksek farkındalık anlamına gelmektedir. Ölçeğin kültürel uyarlamalar sonrasında kullanılması önerilmektedir.
Anahtar Kelimeler: İklim değişikliği, farkındalık, erken ergenlik, ölçek geliştirme, güvenilirlik ve geçerlilik.

Ethics Committee Approval: The study was approved by Trakya University Noninterventional Clinical Research Ethical Committee (Decision no: 16/14 -2023/396, Date: 23/10/2023).

Informed Consent: A written permission was obtained from Edirne Provincial Directorate of National Education.Verbal and written consent was obtained from both the students and their families.

Authorship Contributions: Concept: DHY, ÜÇ, GE. Design: DHY, ACY, ÜÇ, GE. Data Collection or Processing: STS, MÇ, HU. Analysis or Interpretation: DHY, ACY, HU. Literature Search: DHY. Writing: DHY, STS, MÇ, ACY.

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1. Introduction

Climate change, a phenomenon occurring at regular intervals, has been substantially exacerbated by human activities, particularly since the beginning of the industrial revolution (1). While natural factors such as solar radiation and volcanic activities play a role in climate change, the utilization of fossil fuels, deforestation, and widespread industrialization surged notably during the industrial revolution. These escalating human activities have significantly elevated the levels of natural greenhouse gases, including methane, ozone, carbon monoxide, and carbon dioxide, released into the atmosphere (2). This increase in greenhouse gas emissions has led to global warming by destroying the Earth's natural greenhouse effect, which has maintained the balance of the planet and nurtured life historically (3). As a result, the Earth's surface temperature has risen by 1.1 degrees Celsius compared to the pre-industrial period (4). The Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) stresses that the climate is altering as a result of human activities and that nineteen out of the twenty warmest years on record took place after the year 2001(5). The World Economic Forum's Global Risks Report 2023 emphasizes that six of the top 10 risks are related to environmental challenges resulting from global climate change, including biodiversity decline, as well as natural disasters and extreme weather events (6). Regarding the damages caused by climate change, it is estimated that climate change affects approximately 3.6 billion people by means of emergencies such as forest fires and floods. Between the years 2030 and 2050, 250,000 additional deaths per year are projected due various conditions such as malnutrition, malaria and heat stroke (7). From the Paris Agreement to the Kyoto Protocol, the main focus of international efforts to combat climate change has been on reducing carbon emissions (8). Combatting climate change requires not only government activities but also societal engagement. The issue of achieving intergenerational climate justice is actually coming to the forefront here. The concept of climate justice is not just a scientific or financial matter but also involves highlighting how people are disproportionately affected and addressing the resulting injustices in a fair manner (9). However, in the current scenario, as climate change-related issues (such as global warming of 1.5°C) persist, it is reported that a generation born in 2020 faces a 2 to 7 times higher risk of experiencing extreme weather events, particularly heatwaves, compared to an individual born in 1960 (10). In combating this disproportionate impact, it is important to raise awareness in society and mobilize every age group on the importance of the environment, environmental problems, and possible solutions (11).

Recently, a study conducted in Mexico assessing adolescents' risk perceptions indicated that while they are aware of issues such as air pollution, earthquakes, and fires, there is a mention of low awareness regarding climate impacts (12). However, global young climate activists have managed to create an agenda by drawing the world's attention with their actions. The awareness raised in Sheffield by a 21-year-old, questioning governments with 'What will you do to protect the future of your children and grandchildren?' (13), is actually aimed at spreading to all youth.

Children are more vulnerable to climate change due to their ongoing development and social factors and adolescence is characterized by many physical, psychosocial and intellectual changes affecting adolescents' feelings, decisions and the way they perceive the World (14, 15). Evaluating adolescents with more limited age group helps to understand how their thoughts and knowledge alter as they age and also according to World agenda. Therefore, framework for appropriate interventions can be determined according to their specific needs (16).

The World Health Organization (WHO) defines adolescence as a phase between the ages of 10 and 19, characterized by various pre-adulthood transitions. It consists of three stages and the early adolescence is defined as the period between the ages of 10 and 14, which is called the "middle school years" in Türkiye and covers the years from fifth grade to eighth grade (17). The early adolescence is a very important group about understanding and developing awareness about some critical subjects regarding Earth's future. These children will grow up and become in important administrative positions in future. So their consciousness about climae change is critical for future policy development. In Türkiye, although there are studies measuring knowledge, attitudes and awareness of climate change among university students and high school age groups, limited study has been conducted to assess the climate change awareness of individuals in early adolescence (18, 19). The aim of this study is to develop a valid and reliable scale that can be used to measure climate change awareness among in early adolescence.

2. Material and Methods

In this study, a methodological design was used for develop a scale. Developing a scale requires preliminary preparations and certain steps (20). In this study, we followed the steps that were recommended in the literature for scale development (21).

Theoretical framework and item development of the scale

Following the literature review, it was observed that there is a lack of a scale measuring climate change awareness, especially in the adolescent group (18, 19). Hence, a conceptual framework was first constructed and then potential sub-dimensions and items were identified. During the preparation of the items, it was ensured that each item was expressed in a clear way and that each item did not contain more than one statement (22). The items are designed to include various dimensions of climate change, including the causes, consequences and precautions. When creating the item pool, the content of science textbooks from 5th to 8th grades was taken into consideration, consistent with the literature on Climate Change Awareness Scale (18, 19, 23). Afterwards, a pool of 36 items was formed.

Following this, expert opinion was sought for view and content validity (24). We received 9 responses from 9 experts, 6 of whom were faculty members specialized in the field of Public Health and the remaining 3 had 10 years or more work experience in the Directorate of National Education. Based on the expert evaluation, some items were revised, some items were removed, and 7 new items were added, resulting in a scale consisting of 43 items in total. After the expert opinions were acquired, the final version of the questionnaire was formed by the researchers in accordance with the recommendations in the relevant literature (20). The preliminary scale (Table 1) was administered to a sample of early adolescents (n = 21) to assess item clarity and comprehensibility. Based on feedback, minor revisions were made to improve item wording and clarity.

Table 1. Climate change awareness preliminary scale for early adolescence.

	General Items
1.	I have heard of the concept of climate change.
2.	Climate refers to weather events observed over large regions and many years.
3.	Climate change is an environmental issue.
4.	Climate change negatively affects human health.
5.	Global warming does not have adverse effects on nature (plants, animals, other living beings).
	Causes
6.	Excessive population growth causes climate change.
7.	The destruction of forested areas is a cause of climate change.
8.	Climate refers to weather events observed over large regions and many years.
9.	Excessive and unplanned construction of buildings causes climate change.
10.	People buying more than they need (clothes, toys, shoes, etc.) leads to climate change.
11.	People traveling more than necessary causes climate change.
12.	People consuming more electricity than necessary (watching mobile phones or tablets, playing computer games, etc.) is a cause of climate change.
13.	Establishing industrial facilities and factories in unsuitable places is a cause of climate change.
14.	When people need transportation, using public transport instead of private vehicles positively contributes to climate change.
15.	Using solid fuels like coal and wood for heating in homes increases climate change.
16.	Climate change results from human activities.
17.	Air pollution leads to climate change.
18.	Emissions from home chimneys contribute to climate change.
19.	Emissions from factory chimneys contribute to climate change.
20.	Emissions from vehicle exhausts contribute to climate change
	Consequences
21.	Climate change does not lead to a decrease in species.
22.	I think severe weather events (extreme heat or cold) are related to climate change.
23.	I think extreme rainfall/floods are related to climate change.

24.	I think forest fires are related to climate change.
25.	I think water-related problems such as drought are associated with climate change.
26.	Glaciers melt due to climate change.
27.	Sea levels rise due to climate change.
28.	Climate change does not lead to a decrease in agricultural production.
29.	Climate change negatively affects children's health.
30.	Some health problems in humans are caused by climate change.
31.	Extreme weather events (extreme heat or cold) in a place can cause people to migrate
	Precautions
32.	All countries should take joint measures against climate change.
33.	Each country should take measures suitable for its conditions against climate change.
34.	Measures encouraging recycling should be taken for climate change.
35.	Forested areas should be increased to combat climate change.
36.	Energy needs should be met from sources like solar and wind energy.
37.	Filters should be installed in factory chimneys for polluting gases causing air pollution.
38.	Proper waste disposal is crucial to combat climate change.
39.	Water consumption should be avoided in waste.
40.	Energy saving should be practiced to combat climate change.
41.	The excessive and unnecessary use of plastics should be reduced in the fight against climate change.
42.	Students should be educated about climate change in schools.
43.	The public should be educated about climate change.

** The responses were collected using a 5-point Likert scale (Strongly Agree | Agree | Unsure | Disagree | Strongly Disagree).*

2.2.Research population and sample size

The population of the study consisted of early adolescent middle school students studying in a city center in Türkiye. The recommended sample size in scale development studies is at least 5 and ideally 20 participants per item (21). In this study, a scale consisting of 43 items was developed, and a minimum sample size of 43*5=215 and a maximum sample size of 43*20=860 was obtained. The sample was selected from schools in different socioeconomic regions using a multi-stage stratified cluster sampling method. Stratification was based on class and socioeconomic region. The distribution of the research population and sample is presented in Figure 1. Research data were collected from January 1st, 2024 to February 29th, 2024. The research inclusion criteria are attending 5th, 6th, 7th, or 8th grade, knowing how to read and write in Turkish, and consenting to participate in the study. A total of 897 participants were included in the study. The entire population was randomly stratified according to the socioeconomic region of the school, grade level and gender, and two separate sample groups were formed. The representation of both groups is provided in Figure 1. While the model created for the first sample group was included in the EFA analysis, it was further tested using CFA on the second sample group. No statistically significant difference was found between the two sample groups in terms of socioeconomic region, grade level and gender.

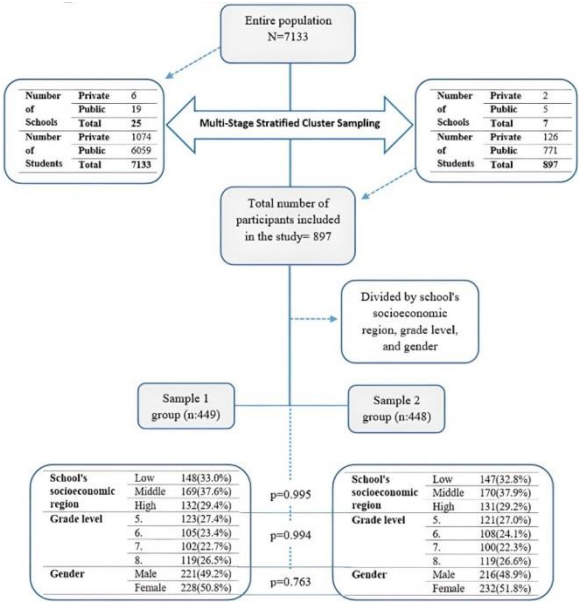

Figure 1. Distribution and comperative analysis of the divided sample groups.

2.3.Procedure

Trakya University Faculty of Medicine Research Ethics Approval for Non-Interventional Studies was obtained from the Scientific Research Ethics Committee on 23/10/2023 with reference number TÜTF-GOBAEK 2023/396. Permissions from the Governorship and the Directorate of National Education were obtained on 24/11/2023 with the reference number 90277863. Informed parental consent was also obtained for the students participating in the study. After obtaining the necessary permissions and approvals, data were collected from seven middle schools with the highest student population in the central district of Edirne. Data were collected through personal questionnaires distributed in the schools. Meetings were held with the administrators and teachers of the schools selected for data collection. Parental consents were sent to the families through their children. One week after the parental consents were obtained, the questionnaires were handed out face-to-face at the schools to the individuals who agreed to participate in the study. The average time to complete the questionnaires was 15 minutes.

Statistical analysis

While developing a scale, Exploratory Factor Analysis (EFA) should be preferred over Confirmatory Factor Analysis (CFA) due to the possibility of researchers making assumptions about the identified sub-dimensions (25). Moreover, CFA should be evaluated using a separate sample (21). Therefore, in this study, EFA was applied to half of the sample and CFA was applied to the other half of the sample to assess construct validity. Campbell and Fiske (26) proposed two ways to examine the construct validity of a test: convergent validity and discriminant validity. Reliability was also evaluated by using Cronbach's alpha.

Exploratory factor analysis (EFA): EFA was applied to the Group 1 sample. In this study, the principal components method was chosen for inference in EFA. Both scree test and parallel analysis were applied to determine the number of factors. For the rotation part, the oblique rotation method, especially the promax method, was used. In many studies, the orthogonal rotation method Varimax is used, where factors are analyzed when they are not correlated. However, in social sciences, especially when assessing behaviors and attitudes, factors are often correlated (20, 21). SPSS version 22 was used to conduct the EFA.

Confirmatory factor analysis (CFA): The model obtained via EFA was further analyzed by using group 2 sample through CFA. Model fit indices were evaluated using RMSEA (Root Mean Error of Approximation), CMIN/DF (Chi-Square/Degrees of freedom), CFI (Comperative Fit Index), TLI (Tucker Lewis Fit Index) and SRMR (Standard Root Mean Square Residuals). CFA was carried out using the "lavaan" package in R Studio (Vers.

2023.12.1+402). The "SemPlot" package was used for creating the graphics (27).

Convergent and discriminant validity: AVE (Average variance extracted) and CR (Composite Reliability) for convergent validity; Fornel-Larcker Test and HTMT (Heterotrait-Monotrait ratio of correlations) for discriminant validity were calculated using "lavaan" and "semTools" packages in R studio (27, 28).

3. Results

Exploratory Factor Analysis (EFA) was performed to determine the construct validity and factor structure of the Early Adolescent Climate Change Awareness Scale (EACCAS). The principal components method and oblique rotation (Promax) were used to perform EFA analysis. Defective items in the correlation matrix and items with low communality that contributed minimally to the total variance were identified and extracted one by one. As a result, 28 items were removed from the initial set of 43 items and a scale consisting of 15 items was formed after the EFA process.

Initially, Kaiser-Meyer-Olkin (KMO) Sampling Adequacy Measure was conducted and the result was calculated as 0.93, which indicates that the sample size provided excellent suitability for EFA. According to Field , a KMO value above 0.50 is accepted as adequate, whereas values between 0.9 and 1.0 are classified as excellent (29)]. Furthermore, Bartlett's test yielded a significant result of $X2=3680.54$; $p<0.05$, which indicates that there are strong correlations among the items selected for EFA.

EFA demonstrated that the 15-item EACCAS had a three-dimensional structure and that these three factors explained 65.54% of the total variance. Thus, it was concluded that EACCAC possesses valid qualifications. The first dimension accounted for 48.54% of the variance, the second dimension for 9.03%, and the third dimension for 7.97%. Table 2 and Figure 2 display the distribution of items in terms of factors and their factor loadings.

Table 2. Early adolescent climate change awareness scale EFA results.

Component Factors	Items	Factor 1	Component Factor 2	Factor 3
Factor 1	I34	0.528		
(Precautions)	I35	0.731		
	I37	0.824		
	I38	0.615		
	I39	0.853		
	I40	0.855		
	I41	0.706		
	I42	0.824		
Factor 2	I17		0.800	
(Causes)	I18		0.912	
	I19		0.913	
	I20		0.799	
Factor 3	I22			0.893
(Consequences)	I23			0.846
	I25			0.724
Eigenvalues		7.281	1.354	1.195
% of Variance		48.543	9.028	7.969
% Cumulative		48.543	57.571	**65.539**

KMO = 0.928, Significance of Barlett's test <0.001

As presented in Table 2 and Figure 2, the first dimension is composed of 8 items, the second dimension is composed of 4 items and the third dimension is composed of 3 items. Factor loadings of 0.30 and above were accepted to be ideal and indicated that the items made significant contributions to the factors. Moreover, the factors were titled as precautions, causes and consequences, respectively.

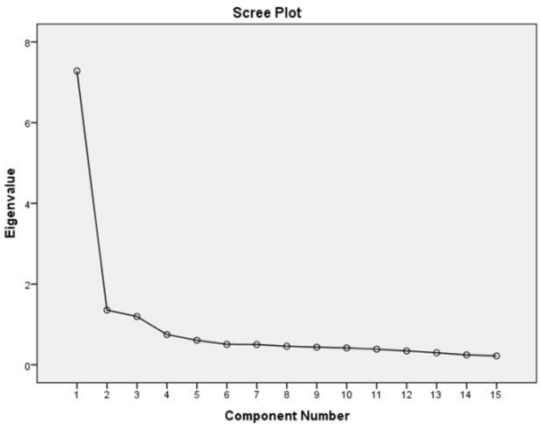

Figure 2. Scree plot of the EFA analysis.

The first step in testing structural validity was to conduct a CFA analysis on the model formed with EFA using the second group sample.

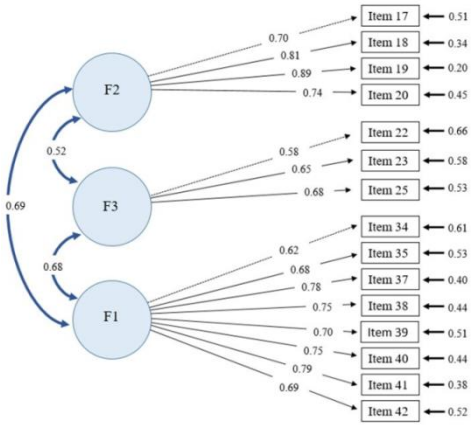

Figure 3. CFA path diagram.

CFA results such as path diagram and goodnes of fit measures are represented in Figure 3 and Table 3.

Table 3. CFA model fit indices.

Measure	Threshold	Model fit indices
CMIN	-	189.324
CMIN/df	<3 good; <5 sometimes permissible	2.176
CFI	≥0.95 great; >0.90 traditional	0.968
TLI	≥0.90	0.961
SRMR	<0.09	0.041
RMSEA	<0.05 good; 0.50-0.10 moderate; >0.10 bad	0.051
PClose	<0.05	<0.001

CMIN: Chi-Square; df: Degrees of freedom; CFI: comperative fit index; TLI: Tucker Lewis fit index; SRMR: Standart root mean square residual; RMSEA: root mean square error of approximation; PClose: p-value for testing the null hypothesisof the close fit.

When the path diagram of the CFA is analyzed, the single-headed arrows directed from the factors to the variables (items) examined indicate a one-way linear relationship. These variables present indication about how well each item represents its latent variable. According to the calculated model fit indices, good fit was observed for all other indices. For determining the convergent validity of the variables, CR and AVE (Average Variance Extracted) values were calculated and shown in Table 4.

Table 4. Convergent and discriminant validity values.

Convergent Validity			**Discriminant validity Fornel-Larcker Test**		
CR	**AVE**				
			Factor 1	Factor 2	Factor 3
0.870	0.626	Factor 1	**0.791**		
0.666	0.505	Factor 2	0.273	**0.711**	
0.896	0.518	Factor 3	0.471	0.457	**0.719**
				HTMT	
		Factor 1			
		Factor 2	0.528		
		Factor 3	0.696	0.667	

CR: Composite reliability; AVE: Average variance extracted; HTMT: Heterotrait-Monotrait ratio of correlations. The HTMT ratio values in the provided table reveal the correlations among the constructs of the model, with a HTMT value below 0.90 indicating discriminant validity. For Fornel-Larcker test table diagonal elements (bolded) are the square root of average variance extracted (AVE). Off-diagonal elementes are the correlations among factors.

According to (30)] factor loadings and AVE values above 0.50 and CR values up to 0.70 indicate that the research model has reached convergent validity (31). Despite the fact that the CR value calculated for Factor 2 in our model is below the threshold value, it is seen that convergent validity is deemed acceptable when other CR and AVE values are evaluated together. Discriminant validity analysis was performed using Fornel-Larcker and HTMT analysis. According to Fornel-Larcker test, the correlation between a construct and any other construct must be smaller than the square root of the average variance retrieved by the construct. The threshold value for HTMT analysis is 0.90 (32). It was found that the proposed model meets the discriminant validity criteria via both Fornel-Larcker test and HTMT analysis. Cronbach's alpha was used for internal reliability, and the calculated value for the total scale was found to be 0.917. As a result of EFA and CFA analysis, the 3-factor, 15-item substructure is stated in the Table 5.

Table 5. Early adolescent climate change awareness scale

			Strongly Disagree	**Disagree**	**Undecided**	**Agree**	**Strongly Agree**
F2:Causes	17	Air pollution leads to climate change.	1	2	3	4	5
	18	Emissions from home chimneys contribute to climate change.	1	2	3	4	5
	19	Emissions from industrial chimneys contribute to climate change	1	2	3	4	5
	20	Emissions from vehicle exhausts contribute to climate change.	1	2	3	4	5
F3:Consequences	22	I think severe weather events (extreme heat or cold) are related to climate change.	1	2	3	4	5
	23	I think extreme rainfall/floods are related to climate change.	1	2	3	4	5
	25	I think water-related problems such as drought are associated with climate change.	1	2	3	4	5

F1: Precautions	34	Measures encouraging recycling should be taken for climate change.	1	2	3	4	5
	35	Forested areas should be increased to combat climate change.	1	2	3	4	5
	37	Filters should be installed in factory chimneys for polluting gases causing air pollution.	1	2	3	4	5
	38	Proper waste disposal is crucial to combat climate change.	1	2	3	4	5
	39	Water consumption should be avoided in waste.	1	2	3	4	5
	40	Energy saving should be practiced to combat climate change.	1	2	3	4	5
	41	Excessive and unnecessary plastic usage should be reduced to combat climate change.	1	2	3	4	5
	42	Schools should educate students about climate change.	1	2	3	4	5

Descriptive statistics for the items for both sample groups and the total population are presented in Table 6.

Table 6. Descriptive statisitcs of items for both sample groups

	Item Number	**Mean±SD**		
		Group 1	**Group 2**	**Total**
F2: Causes	I-17	4.13±1.05	4.16±1.05	4.14±1.05
	I-18	3.97±1.08	4.04±1.05	4.01±1.07
	I-19	4.12±1.08	4.13±1.10	4.13±1.09
	I-20	4.14±1.02	4.15±1.06	4.15±1.04
F3: Consequences	I-22	3.90±1.05	3.88±1.15	3.89±1.10
	I-23	3.70±1.16	3.79±1.14	3.75±1.15
	I-25	3.90±1.12	4.06±1.07	3.98±1.10
F1: Precautions	I-34	3.96±1.10	3.95±1.12	3.96±1.11
	I-35	4.05±1.13	4.07±1.11	4.06±1.12
	I-37	4.37±1.02	4.35±1.06	4.36±1.04
	I-38	4.07±1.07	4.11±1.08	4.09±1.08
	I-39	4.34±1.01	4.26±1.13	4.30±1.07
	I-40	4.13±1.08	4.15±1.09	4.14±1.08
	I-41	4.18±1.05	4.21±1.04	4.19±1.04
	I-42	4.21±1.08	4.18±1.13	4.19±1.10
Scale Total	**Factor 1**	33.31±6.53	33.27±6.64	33.29±6.59
	Factor 2	16.36±3.64	16.48±3.59	16.42±3.62
	Factor 3	11.50±2.77	11.73±2.62	11.62±2.70
	Total	61.17±11.16	61.49±10.91	61.33±11.03

The distribution and difference analyses of sub-dimension (factor) and total scale scores by gender, school's socioeconomic region, and grade variables for the entire population are presented in Table 7.

Table 7. Comparing scale scores according to various variables.

		Mean scale points							
		Factor 1	**p**	**Factor 2**	**p**	**Factor 3**	**p**	**Total**	**p**
School's SER*	**Low**	30.82±6.95	**0.001**	15.54±3.98	**0.001**	12.01±2.88	**0.001**	57.46±11.57	**0.001**
	Middle	34.38±5.34		16.87±3.06		11.76±2.49		63.01±9.11	
	High	34.65±6.86		16.84±3.67		11.10±2.68		63.50±11.56	
Grade level	**5.**	32.45±6.65	**0.005**	16.26±3.48	0.076	11.47±2.61	0.435	60.18±10.77	**0.011**
	6.	33.35±6.77		16.25±3.95		11.63±2.55		61.23±11.34	
	7.	32.81±7.35		16.18±3.92		11.51±3.01		60.50±12.86	
	8.	34.47±5.46		16.95±3.13		11.84±2.63		63.50±12.86	
Gender	**Male**	32.78±7.23	**0.025**	16.32±3.87	0.314	11.33±2.90	**0.002**	60.43±12.06	**0.015**
	Female	33.78±5.81		16.56±3.30		11.89±2.41		62.23±9.71	

**SER: Socioeconomic Region.*

There were statistically significant differences observed between groups based on the socioeconomic regions of schools in terms of both factor mean scores and total scale scores. According to the post hoc pairwise analyses, the mean scores for factor 1, 2, 3, and the total score in the group with low socioeconomic region (SER) were found to be significantly lower compared to the groups with medium and high SER. Regarding the students' grade levels, statistically significant differences were found between groups in terms of factor 1 and total scale mean scores. Pairwise group comparisons revealed that the mean score for factor 1 of 8th-grade students was significantly higher than that of 5th and 7th-grade students (p=0.004 and p=0.041, respectively). Additionally, the total scale mean score of 8th-grade students was significantly higher than that of 5th-grade students (p=0.004). When evaluated by gender, the mean scores for factor 1, factor 3, and the total scale were significantly higher in females compared to males.

4. Discussion

The aim of this study was to develop a valid and reliable scale to evaluate climate change awareness among early adolescents. Based on our findings, the Early Adolescence Climate Change Awareness Scale emerged as a robust measurement tool for this age group. Construct validity analyses identified 15 items across three sub-dimensions: causes, precautions and consequences. Confirmatory Factor Analysis conducted on a separate sample confirmed the scale's adequancy (CMIN/DF: 2.17, RMSEA: 0.051, SRMR: 0.041, CFI: 0.968, TLI: 0.961). Scores on the 5-point Likert scale ranged from 15 to 75, with higher scores indicating grater awareness. A cut-off score was not computed since there is no reference that measures awareness for this age group in the literature.

In Türkiye, climate change topics are introduced in early adolescence science classes, yet there was previously no valid tool to assess understanding. The causes sub-dimension highlighted concepts like air pollution, while consequences focused on issues such as glacier melting and extreme weather. Precautions emphasized recycling, forest conservation, and education programs, but omitted factors like population growth or biodiversity loss, which are noted in international studies. Contrary to our findings, international research suggests young people feel governments are insufficiently addressing climate issues (33). Studies with younger age groups frequently cite air pollution as a primary climate concern (34), similar to our findings. Additionally, in the literature, this age group suggests afforestations efforts in the fight against global warming (35) and has recommendations for addressing transportation related pollutants (36). When devoloping scale items, provisions related to legistlation or legal regulations (such as the Kyoto Protocol and the Paris Agreement) were not included, as they might be beyond the knowledge level of the relevant age group.

This scale is the unique instrument to measure climate change awareness in early adolescent age groups. There are other studies conducted in Türkiye that measure climate change awareness in other age groups. One of the studies conducted in Türkiye in 2020 developed a 21-item scale with four subscales

to determine the climate change awareness among university students. The four subscales were classified as causes, impacts on the natural and human environment, energy consumption, and organizations and agreements (19). Similarly, in a study conducted with high school students in Türkiye in 2023, a 17-item, 2 subdimension climate change awareness scale was developed and the subdimensions were defined as reasons for climate change and act to climate change (18). Furthermore, studies investigating climate change awareness among youth and adolescents in the literature highlight the concerns about climate in this population by addressing them as young and vulnerable groups (37, 38). It is crucial to assess the awareness of young individuals on climate change, to provide appropriate information on the issue, and to raise the young population as environmentally conscious individuals. Detecting the awareness of the young population regarding climate change can also contribute to managing their concerns about this issue. A program aimed at rising climate change awareness was implemented for individuals aged 10-12 in the United States. Before the program, many children reported that they had not heard of the concept of climate change. By the end of the program, their awareness had increased, emphasizing the importance of education on climate change (39). Although most studies in the literature that assess climate change awareness focus on the adult age group, the literature on the awareness of young people and adolescents is more limited. One striking example is when Greta Thunberg, who was just 15 years old in 2018, started the climate change movement known as 'School Strike for Climate', which rapidly grew (40). The increasing concerns and resistance of young people regarding climate change and the future challenges they will face (41) can also influence governments and decision-makers. According to a recent comrehensive review, 51 international studies were examined, and it was found that research assessing young people's climate change awareness typically focuses on topics such as beliefs, concerns, causes, consequences, and measures related to the issue (42).

In this study, the climate change awareness scale scores were compared in terms of various sociodemographic characteristics. According to the research findings, schools in higher grade levels, female gender, and regions with high socioeconomic status had significantly higher scale scores. Literature on the effect of age on environmental behaviors presents mixed results. Some research findings suggest that older age is associated with more environmental behaviors (43); while other studies indicate that younger participants exhibit more environmental behaviors (44, 45). In this study, it was observed that the climate change awareness scale score increased with age, which might be due to the formal education received with increasing age.

Regarding the limitations of the study, it is accepted that the answers given by the participants in the questionnaires are accurate and representative of reality. Despite that, the strengths of the study include the choice of cluster sampling, which is a probability sampling method, and the inclusion of representation of schools with different socioeconomic status. Furthermore, the evaluation of CFA and discriminant validity analyses using the R program and the use of sound statistical methods constitute another strength of the study.

5. Conclusion

In conclusion, the items of the Early Adolescence Climate Change Awareness Scale devoleped in the present study are consistent with the topics indicated in the literature on climate change awareness studies for young age groups. Raising the younger generation as environmentally conscious individuals can support the future architects of green transformation technologies and developments. The initial pool of 43 items was reduced to 15 items after the CFA analysis. This is an expected outcome. It is necessary to prepare three to four times the number of items initially planned for the scale, if possible. Having a larger number of items increases the opportunity to select those that offer the desired level of comprehensiveness and discriminative power (46). As a result of the current research, a valid and reliable scale that addresses the awarenesses of early adolescents about climate change in three sub-dimensions (causes, consequences, and precautions), fifteen items has been developed. It is recommended that the current scale be used after different culturel adaptation studies.

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