

Uncovering the Multidimensional Nature of Climate Change Anxiety: Comprehensive Psychometric Evidence from Colombia

Ubaldo Enrique Rodríguez-de Avila

urodriguez@unimagdalena.edu.co

University of Magdalena

David Felipe Vega-Villa

University of Magdalena

Zuany Luz Paba-Argote

University of Magdalena

Research Article

Keywords: climate change anxiety, eco-anxiety, psychometric validation, confirmatory factor analysis, measurement invariance, Latin America

Posted Date: September 10th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10770988/v1>

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Additional Declarations: No competing interests reported.

Abstract

Climate change anxiety is an emerging phenomenon with significant implications for mental health, making the availability of valid and reliable instruments in Spanish-speaking contexts essential. The aim of this study was to comprehensively examine the psychometric properties of the Latin American Spanish version of the Climate Change Anxiety Scale (CCAS) in a Colombian sample of 2,212 participants. The sample was randomly divided for exploratory ($n = 884$) and confirmatory ($n = 1,328$) factor analysis on independent samples. The results supported a four-factor structure comprised of cognitive impairment, functional impairment, personal experience, and behavioral commitment. Confirmatory factor analysis showed a good fit of the model to the data ($CFI = 0.956$, $TLI = 0.950$, $RMSEA = 0.060$, $SRMR = 0.077$). Satisfactory levels of internal consistency, composite reliability, convergent validity, and discriminant validity were also observed. Correlations with a general anxiety measure supported the convergent validity of the instrument, while HTMT, Fornell-Larcker, and factor indistinguishability tests confirmed adequate differentiation between dimensions. Finally, evidence of metric invariance and additional support for scalar equivalence by sex and age were obtained. Taken together, the findings support the use of the CCAS as a valid and reliable measure for assessing climate change anxiety in Latin American populations, providing evidence on the multidimensional nature of the construct and strengthening mental health research related to climate change.

INTRODUCTION

Climate change is one of the most significant threats to global health in the 21st century due to its effects on ecosystems, living conditions, and human well-being (Abdul-Nabi et al., 2025; Ofremu et al., 2024). Beyond its physical consequences, the climate crisis has become an emerging determinant of mental health, increasing people's exposure to extreme events, environmental losses, and uncertainty about the future (Hartinger et al., 2024; Torales et al., 2026).

In Latin America, these impacts are particularly relevant due to the region's existing social and environmental vulnerabilities. Recent evidence shows a sustained increase in exposure to heat waves, droughts, and floods, along with high levels of public concern about climate change (Hartinger et al., 2024; Spektor et al., 2023). In Colombia, considered one of the nations most vulnerable to climate change, significant risks are projected for the health, natural resources, and quality of life of the population (Rozo López, 2020; World Bank Group, 2023a, 2023b).

The psychological consequences of this crisis have received increasing attention in recent years. Several studies have documented associations between climate change and symptoms of anxiety, stress, hopelessness, impaired subjective well-being, and other manifestations of emotional distress, even among people who have not directly experienced environmental disasters (Ogunbode et al., 2022; Tam et al., 2023; Torales et al., 2026).

In this context, the construct of eco-anxiety, or climate change anxiety, has emerged, understood as an emotional response characterized by worry, fear, and distress in the face of current and future

environmental threats (Clayton & Karazsia, 2020). Although not considered a mental disorder, high levels of eco-anxiety can be associated with cognitive impairment, functional difficulties, and negative impacts on psychological well-being (Clayton & Karazsia, 2020; Wullenkord et al., 2021). Growing cross-cultural evidence suggests that this is a global phenomenon with significant implications for mental health research and intervention, especially in regions highly exposed to the effects of climate change (Hoffmann-Ferrada, 2024; Ogunbode et al., 2022).

Despite the growing scientific interest in eco-anxiety, its conceptual definition remains a subject of debate. In general terms, eco-anxiety has been defined as an emotional response of worry, fear, or distress associated with present and future threats stemming from climate change (Clayton & Karazsia, 2020). However, several authors have pointed out that this phenomenon shares conceptual boundaries with related constructs, such as climate concern, ecological stress, environmental distress, and even some manifestations of generalized anxiety, making it difficult to establish a single, universally agreed-upon definition (Simon et al., 2022; Tam et al., 2023).

This lack of conceptual consensus is also reflected in the theoretical models proposed to explain the phenomenon. While some approaches consider eco-anxiety as an adaptive and potentially functional response to a real environmental threat, others emphasize its possible dysfunctional consequences when it interferes with psychological well-being or daily functioning (Clayton & Karazsia, 2020; Wullenkord et al., 2021). Consequently, the discussion persists as to whether eco-anxiety should be understood primarily as an emotional reaction, a cognitive process, or a multidimensional construct that integrates affective, behavioral, and experiential components.

The conceptual difficulties have extended to the realm of measurement. The Climate Change Anxiety Scale (CCAS), developed by Clayton and Karazsia (2020), is currently the most widely used instrument for assessing this construct; however, adaptation and validation studies conducted in different cultural contexts have reported divergent factor structures. While some research has confirmed the original proposal based on two main dimensions related to cognitive and functional decline (Clayton & Karazsia, 2020; Innocenti et al., 2021), others have identified alternative factor solutions that include additional components linked to personal experience or behavioral engagement with climate change (Cruz & High, 2022; Navarro-Carrillo et al., 2025).

International evidence shows considerable heterogeneity in the psychometric results obtained in different countries. Studies conducted in France, Poland, Korea, Slovenia, and Arab countries have found differences both in the number of factors and in the composition of the dimensions assessed (Fekih-Romdhane et al., 2024; Jang et al., 2023; Larionow et al., 2022; Mouguiama-Daouda et al., 2022; Plohl et al., 2023). These inconsistencies suggest that the structure of eco-anxiety may be influenced by cultural, contextual, and methodological factors, raising questions about the cross-cultural stability of the construct and the comparability of findings across populations.

Therefore, several specialists have emphasized the need to develop more rigorous psychometric studies that allow for a more precise understanding of the internal structure of eco-anxiety and the quality of its

measurement instruments (Boateng et al., 2018; Stefana et al., 2025). Current recommendations highlight the importance of combining exploratory and confirmatory factor analyses, evaluating evidence of convergent and discriminant validity, examining measurement invariance across groups, and employing statistical procedures appropriate for ordinal data (Brown, 2015; Cheung et al., 2024; Costello & Osborne, 2005; Kline, 2011). Taken together, these strategies are essential for strengthening the validity of the construct and advancing toward a more precise understanding of eco-anxiety in different sociocultural contexts.

Although eco-anxiety has sparked growing scientific interest internationally, the available evidence comes primarily from countries in Europe, North America, and some Asian nations. This geographic concentration of knowledge is problematic, given that Latin America is among the regions most exposed to the effects of climate change and associated ecological crises (Hartinger et al., 2024; Spektor et al., 2023). Social inequalities, dependence on natural resources, and the high frequency of extreme weather events increase the vulnerability of large segments of the population, which could significantly influence psychological responses to climate change.

The scarcity of regional research contrasts with the growing relevance that climate mental health has acquired on the international scientific agenda. Although some studies have explored beliefs and concerns related to climate change in Latin America (Spektor et al., 2023), research specifically analyzing eco-anxiety using psychometrically validated instruments remains limited. This situation makes it difficult to establish reliable estimates of the magnitude of the phenomenon, identify relevant sociocultural differences, and compare results with other regions of the world (Hoffmann Ferrada, 2024).

The need for Latin American evidence is particularly important because the manifestations of eco-anxiety can be conditioned by contextual, economic, and cultural factors. Findings obtained in developed countries are not necessarily generalizable to contexts characterized by higher levels of environmental vulnerability and social inequality. Therefore, several authors have highlighted the importance of conducting local studies that allow for examining the conceptual and psychometric relevance of the instruments used to assess this construct in different populations (Hoffmann Ferrada, 2024; Navarro-Carrillo et al., 2025).

Within this scenario, Colombia represents a particularly relevant context for research on eco-anxiety. The country has been identified as highly vulnerable to the effects of climate change due to its geographic diversity, exposure to extreme hydrometeorological events, and the sensitivity of its ecosystems to environmental alterations (Rozo-López, 2020; World Bank Group, 2023a, 2023b). Furthermore, there is evidence that these changes are already generating significant impacts on the health and well-being of the Colombian population (Rodríguez-Pacheco et al., 2019).

Despite this vulnerability, studies on eco-anxiety in Colombia remain scarce, particularly those focused on rigorously evaluating the psychometric properties of available instruments. This limitation hinders the generation of robust evidence for research, mental health monitoring, and the design of interventions targeting populations potentially affected by the climate crisis. Consequently, it is necessary to

strengthen regional research through studies that provide robust evidence on the validity and reliability of eco-anxiety measures in Latin American, and specifically Colombian, contexts.

Although the Climate Change Anxiety Scale (CCAS) has been validated in several countries, evidence shows that its factor structure is not entirely stable across cultural contexts, with differences observed in studies conducted in Spain, Italy, France, Poland, Korea, Slovenia, and Arab countries (Cruz & High, 2022; Fekih-Romdhane et al., 2024; Innocenti et al., 2021; Jang et al., 2023; Larionow et al., 2022; Mouguiama-Daouda et al., 2022; Navarro-Carrillo et al., 2025; Plohl et al., 2023). These findings suggest that the measurement of eco-anxiety may be influenced by linguistic, cultural, and contextual factors.

This consideration is especially relevant in the Spanish-speaking world. Despite sharing a language, Spain and Latin America present sociocultural, environmental, and experiential differences that can affect the interpretation of the items and the expression of climate anxiety (Fenn et al., 2020; Hoffmann-Ferrada, 2024; Spektor et al., 2023). Therefore, directly extrapolating the results obtained in the Spanish adaptation of the Climate Anxiety Scale (CCAS) to Latin American populations lacks sufficient empirical support.

Contemporary psychometric guidelines indicate that validity and reliability must be demonstrated in each specific population where an instrument is intended to be used (Boateng et al., 2018; Stefana et al., 2025). Consequently, it is necessary to evaluate the internal structure, convergent and discriminant validity, internal consistency, and measurement invariance of the CCAS in Latin American contexts to ensure that its scores are interpretable and comparable (Brown, 2015; Cheung et al., 2024; Putnick & Bornstein, 2016). This need is particularly important in Colombia, given its high vulnerability to climate change and the scarcity of regional psychometric evidence on eco-anxiety.

In response to these limitations, the present study aimed to comprehensively examine the psychometric properties of the Latin American version of the Climate Change Anxiety Scale (CCAS) in a large Colombian sample, evaluating its internal structure, internal consistency, convergent validity, discriminant validity, and measurement invariance according to sex and age.

METHOD

Design

An instrumental psychometric validation study was conducted to examine the factor structure, reliability, validity based on internal structure, relationships with external variables, and measurement invariance of the Spanish version of the Climate Change Anxiety Scale (CCAS; Clayton & Karazsia, 2020). The study design followed contemporary recommendations for the evaluation of the psychometric properties of measurement instruments, incorporating both exploratory and confirmatory analyses in independent samples.

Participants

The total sample consisted of 2,212 participants. To minimize the risk of overfitting and provide a more rigorous evaluation of the internal structure, the dataset was randomly divided into two independent subsamples. The first subsample ($n = 884$) was used to conduct the exploratory factor analysis (EFA), whereas the second subsample ($n = 1,328$) was used for the confirmatory factor analysis (CFA), the assessment of convergent and discriminant validity, the estimation of composite reliability, and the analysis of measurement invariance.

Additionally, the association between the dimensions of the CCAS and general anxiety scores, measured using the short version of the Zung Self-Rating Anxiety Scale (SAS; Zung, 1971), was examined to provide evidence of convergent validity.

For the EFA subsample, women represented 57% of participants and men 43%. The mean age was 23 ± 8.9 years old. Most participants were students, accounting for 66% of the sample. Nineteen percent were exclusively employed, whereas 11% combined work and study. The remaining 4% reported other occupational situations.

For the CFA subsample, there was a higher proportion of women (54%) than men (46%). The mean age was 24 ± 9.8 years old. Regarding occupation, most participants were students (61%), while 20% were exclusively employed and 12% combined work and study. The remaining 7% reported other occupational situations.

Instruments

Climate Change Anxiety Scale (CCAS; Clayton & Karazsia, 2020). The CCAS is a 22-item instrument organized into four dimensions: cognitive impairment, functional impairment, behavioral engagement, and personal experience, the first two being the core dimensions of the original construct (Clayton & Karazsia, 2020). Although the scale was developed with a five-point Likert format, this study used a four-category version ("Never," "Sometimes," "Almost always," and "Always") to standardize the response formats with the other instrument used in this study and reduce the cognitive load for participants. This procedure has been previously used in psychometric research evaluating the functioning of measurement scales (Atienza et al., 2000). The full Spanish-language version of the 22 items, available in the supplementary materials, was administered. Previous studies have reported adequate levels of internal consistency for the CCAS, particularly for the cognitive and functional impairment dimensions, with alpha coefficients between 0.86 and 0.87 in the Spanish population (Navarro-Carrillo et al., 2025).

Zung Self-Rate Anxiety Scale –SAS. The SAS is used to measure subjective anxiety levels through self-reported somatic and cognitive aspects (Zung, 1971). It is a 4-point Likert scale, ranging from 1 (never) to 4 (always). The original 20-item version showed excellent internal properties (Dunstan & Scott, 2020; Zung, 1971), and the psychometric performance of a 15-item abbreviated version in Colombia showed

high internal consistency with a Cronbach's alpha of 0.81 (Rodríguez-de Ávila et al., 2020). This version was used for the study. Although the last item was omitted due to a database error, the scale maintained high internal consistency, with a Cronbach's alpha and McDonald's ω of 0.90 ($M = 1.75 \pm 0.53$), indicating excellent reliability for this population, and showed the expected patterns of association with related constructs. It is worth noting that Rodríguez-de Ávila et al. (2020) also provided evidence suggesting that this item contributes relatively little to the scale.

Data Analysis

The analyses were performed considering the ordinal nature of the data and the deviations from normality observed in several items. Initially, descriptive statistics (mean, standard deviation, skewness, and kurtosis), corrected item-total correlations, communalities, and internal consistency coefficients were calculated using Cronbach's alpha (α) and McDonald's omega (ω).

To investigate the underlying structure of the instrument, an exploratory factor analysis (EFA) was performed using the Unweighted Least Squares (ULS) method on the subsample designated for EFA. Subsequently, the resulting factor solution was tested using confirmatory factor analysis (CFA) on an independent sample. Model fit was assessed using the chi-square statistic and the robustness indices Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA) with 90% confidence intervals, and Standardized Root Mean Square Residual (SRMR). Construct reliability was assessed using α , ω , and composite reliability (CR). Convergent validity was examined using mean variance extracted (MVE) and correlations with the Zung Anxiety Scale. Additionally, Pearson correlations were estimated between the CCAS dimensions and the external measure of anxiety, applying the Benjamini-Hochberg correction to control for error associated with multiple comparisons.

Discriminant validity was examined using several complementary strategies. First, the Fornell-Larcker criterion was applied, comparing the shared variance between factors with their respective MVE estimates. Second, the heterotrait-monotrait ratio (HTMT) and maximum latent correlations between factors were calculated. Finally, tests of factorial indistinguishability were performed using restricted models that set the correlation between pairs of factors to unity. These models were compared with the original model using χ^2 differences and the w^2 effect size calculation. Measurement invariance was assessed between groups defined by sex and age using multigroup factor analysis. Configural and metric models were estimated, and their equivalence was assessed based on changes in CFI, RMSEA, and SRMR between nested models. Due to estimation difficulties associated with the threshold restrictions required for ordinal variables, scalar invariance could not be tested using conventional procedures. However, score tests based on Lagrange multipliers were performed using the `lavTestScore()` function from the `lavaan` package (Rosseel, 2012) to identify possible localized violations of equality restrictions. The absence of significant mismatch was interpreted as further evidence of intercept/threshold equivalence between groups.

A statistical significance level of $p < 0.05$ was adopted for all inferential tests. The analyses were performed in the R statistical environment, primarily using the lavaan package for factor modeling and invariance assessment.

RESULTS

In descriptive terms, item means ranged from 1.20 ± 0.53 to 3.01 ± 1.04 , with the lowest values observed in items belonging to the cognitive impairment and functional impairment dimensions, while the highest scores corresponded to the behavioral engagement dimension. Standard deviations ranged from 0.53 to 1.04, reflecting moderate variability in participant responses (Table 1).

Analysis of data distribution revealed different patterns of normality among the dimensions. Items related to cognitive impairment and functional impairment showed high positive skewness, and kurtosis values indicated leptokurtic distributions and a concentration of responses in the lower categories of the scale. In contrast, items related to personal experience showed distributions closer to normality. The behavioral engagement items, on the other hand, exhibited low skewness, including one case of moderate negative skewness and negative kurtosis values, suggesting relatively flatter and more balanced distributions. Taken together, these results demonstrate deviations from univariate normality in several items, particularly in the cognitive and functional impairment dimensions, supporting the use of robust estimation procedures for subsequent factor analyses (Table 1).

Regarding the EFA, the results showed moderate to high corrected item-total correlations, suggesting adequate item discrimination. Communalities indicated satisfactory representation of the items by the identified latent factors. Additionally, the α and ω_t coefficients demonstrated adequate internal consistency for all dimensions, with values ranging from 0.770 to 0.904. Taken together, these findings provide favorable initial evidence for the quality of the items and the internal functioning of the proposed factor structure (Table 1).

Table 1

Descriptive Statistics, Adjusted Item–Total Correlations by Subscale, Factor Loadings from Exploratory Factor Analysis (Unweighted Least Squares), and Item Communalities

	Items	Descriptive Analysis n = 2,212			Sample for EFA n = 884				Sample for CFA n = 1,328	
		M±	Sk	Kurt.	r	h ²	ai	af	af	wt
F1: Cognitive impairment	1	1.348 ± 0.607	1.875	3.727	0.61	0.46	0.354	0.89	0.903	0.904
	2	1.317 ± 0.626	2.118	4.354	0.67	0.49	0.564			
	3	1.214 ± 0.584	3.078	9.548	0.67	0.73	0.898			
	4	1.202 ± 0.526	2.915	8.888	0.75	0.65	0.753			
	5	1.379 ± 0.638	1.722	2.771	0.68	0.51	0.617			
	6	1.245 ± 0.578	2.628	7.072	0.78	0.70	0.691			
	7	1.215 ± 0.559	2.923	8.774	0.66	0.52	0.545			
	8	1.337 ± 0.627	1.943	3.524	0.61	0.49	0.448			
F2: Functional impairment	9	1.368 ± 0.716	2.082	3.852	0.66	0.52	0.576	0.77	0.857	0.860
	10	1.458 ± 0.691	1.525	2.056	0.51	0.33	0.505			
	11	1.315 ± 0.650	2.247	4.830	0.74	0.72	0.839			
	12	1.286 ± 0.616	2.366	5.530	0.76	0.70	0.834			

	13	1.205 ± 0.546	2.987	9.196	0.58	0.46	0.436			
F3: Personal experience	14	1.715 ± 0.838	1.088	0.587	0.68	0.65	0.750	0.86	0.785	0.788
	15	1.935 ± 0.932	0.743	-0.345	0.68	0.64	0.751			
	16	1.851 ± 0.923	0.870	-0.152	0.66	0.60	0.777			
F4: Behavioral engagement	17	2.360 ± 0.991	0.271	-0.951	0.45	0.34	0.438	0.82	0.770	0.773
	18	2.455 ± 0.977	0.134	-0.978	0.46	0.28	0.488			
	19	3.005 ± 1.039	-0.654	-0.820	0.55	0.46	0.652			
	20	2.373 ± 0.983	0.228	-0.953	0.59	0.47	0.673			
	21	2.203 ± 1.028	0.431	-0.950	0.50	0.34	0.583			
	22	2.192 ± 0.958	0.459	-0.701	0.51	0.36	0.589			

M: Mean. **±:** Standard Deviation. **Sk:** Skewness. **Kurt.:** Kurtosis. **r_{it}:** Correlation between an item and the total scale score. **h²:** *Communality*. **ai:** Cronbach's alpha of Item. **af:** Cronbach's alpha of factor. **wt:** McDonald's omega by factors. **EFA:** Exploratory Factor Analysis. **CFA:** Confirmatory Factor Analysis

The CFA provided favorable evidence for the proposed factor structure. Although the chi-square statistic was significant, $\chi^2(2023) = 1179.30, p < 0.001$, the robust fit indices indicated a good match between the model and the observed data (CFI = 0.956; TLI = 0.950; RMSEA = 0.060, 90% CI [0.057–0.063]; SRMR = 0.077). Taken together, these results support the suitability of the factor solution derived from the exploratory factor analysis and provide evidence of validity based on the instrument's internal structure.

Table 2 presents the correlations between the instrument's dimensions and an external measure of anxiety, along with the corresponding descriptive statistics. Interfactorial correlations were generally low to moderate, demonstrating consistent associations between dimensions without indicating conceptual

redundancy. Furthermore, all subscales showed positive associations with the Zung Anxiety Scale, in the theoretically expected direction. The correlation pattern was highly consistent between the samples used for the EFA and the CFA, providing favorable evidence of convergent and discriminant validity, as well as the stability of the instrument's internal structure.

Table 2
Convergent and discriminant Pearson correlation between subscales and external scale

Variable	M± (EFA)	F1	F4	F3	F2	Zung scale
F1	1.28 ± 0.39	—	0.61***	0.25***	0.08*	0.38***
F4	1.33 ± 0.46	0.64***	—	0.31***	0.04	0.40***
F3	1.85 ± 0.76	0.26***	0.29***	—	0.32***	0.26***
F2	2.46 ± 0.64	0.08*	0.07*	0.34***	—	0.15***
Anxiety(Zung scale)	1.76 ± 0.53	0.37***	0.36***	0.20***	0.09***	—
M± (CFA)		1.27 ± 0.39	1.32 ± 0.45	1.83 ± 0.70	2.44 ± 0.64	1.75 ± 0.52

M: Mean. **±:** Standard Deviation. * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$.

Note

Correlations above the diagonal correspond to Study 1 (EFA); correlations below the diagonal correspond to Study 2 (CFA). Corrected for multiple comparisons with Benjamini–Hochberg (BH).

Table 3 presents the composite reliability, convergent validity, and discriminant validity indicators for the instrument's dimensions. The results showed adequate levels of composite reliability for all factors, with confidence intervals supporting the stability of the estimates. Convergent validity was satisfactory for three of the four dimensions, whose mean variance extracted values exceeded the recommended criterion of .50; only dimension F2 showed a value below this threshold, suggesting a more moderate convergence of its indicators. Regarding discriminant validity, the HTMT indices and maximum latent correlations remained below the commonly accepted cut-off points, indicating adequate differentiation between the factors. Overall, these findings provide favorable evidence for the internal consistency and convergent and discriminant validity of the proposed factor structure.

Table 3
Composite reliability, convergent validity, and maximum correlations between factors

F	CR	AVE	C_L90	C_U90	A_L90	A_U90	HTMT	CLM
F1	0.83	0.53	0.817	0.856	0.503	0.566	0.824 (with F4)	0.809
F2	0.73	0.36	0.711	0.756	0.336	0.386	0.487 (with F3)	0.492
F3	0.71	0.53	0.679	0.734	0.495	0.561	0.487 (with F2)	0.492
F4	0.78	0.55	0.759	0.810	0.518	0.585	0.824 (with F1)	0.809

F: factor; CR: composite reliability; AVE: average extracted variance; C_L90 and C_U90: lower and upper limits of the 90% bootstrap CI for CR; A_L90 and A_U90: lower and upper limits of the 90% bootstrap CI for AVE; HTMT: heterotrait–monotrait ratio (with the factor at which it reaches its maximum value); CLM: maximum latent correlation (absolute value) of the factor with the other factors.

Table 4 presents further evidence of discriminant validity by examining latent correlations between factors, their bootstrap confidence intervals, the comparison between shared variance and average extracted variance (AVE), and the factorial indistinguishability test based on χ^2 differences. In general, latent correlations ranged from low to moderate, with the exception of the association between F1 and F4, which reached a high magnitude. However, in all comparisons, the shared variance between factors was lower than the AVE of the constructs involved, supporting the Fornell-Larcker criterion for factorial discrimination. Furthermore, the indistinguishability tests yielded statistically significant χ^2 differences in all factor pairs ($p < 0.001$), accompanied by substantial effect sizes, indicating that the dimensions represent empirically distinguishable constructs. Taken together, these results provide strong evidence of discriminant validity for the proposed factor structure.

Table 4
Latent correlations between factors, bootstrap confidence intervals, and comparison with AVE and χ^2 discrimination test

F(a)	F(b)	Lt	CI_L	CI_H	r²	AVE_F(a)	AVE_F(b)	$\Delta\chi^2$ (sys)	w²
F1	F2	0.095	0.018	0.165	0.009	0.534	0.360	4234.109*	3.191
F1	F3	0.395	0.327	0.452	0.156	0.534	0.529	2505.436*	1.888
F1	F4	0.811	0.767	0.852	0.658	0.534	0.551	1333.683*	1.005
F2	F3	0.494	0.425	0.557	0.244	0.360	0.529	2175.989*	1.640
F2	F4	0.076	0.000	0.148	0.006	0.360	0.551	4082.349*	3.077
F3	F4	0.461	0.398	0.522	0.212	0.529	0.551	2341.161*	1.764

F(a) and F(b): factors compared; **Lt**: standardized latent correlation between factors from CFA; **CI_L and CI_H**: lower and upper limits of the 90% bootstrap confidence interval for latent correlation; **r²**: variance shared between factors (r_{Lt}^2); **AVE_F(a) and AVE_F(b)**: average variance extracted from each factor; **$\Delta\chi^2$ (sys)**: χ^2 statistic from the systemic test of indistinguishability between factors, obtained by comparing the original model with a restricted model where the correlation between factors is set to 1 and their correlations with other factors are constrained to be equal; **w²**: effect size based on the χ^2 statistic, calculated as $\chi^2(\text{sys}) / N$ (equivalent to Cohen's effect size square for χ^2 tests, where **w**: $\sqrt{\chi^2 / N}$ see Abdul Rahman et al., 2025).

*All χ^2 differences were significant ($p < 0.001$). The difference in degrees of freedom was constant across all comparisons ($df = 206$).

Measurement invariance was examined using configural and metric models based on sex and age. For the comparison by sex, the observed variations between the configural and metric models were small ($\Delta CFI = 0.002$, $\Delta RMSEA = -0.003$, and $\Delta SRMR = 0.002$), supporting the equivalence of factor loadings between women and men. Similarly, in the comparison by age (18–24 years old vs. ≥ 25 years old), the changes in the fit indices were minimal ($\Delta CFI = 0.003$, $\Delta RMSEA = -0.003$, and $\Delta SRMR = 0.003$), providing further evidence of metric invariance. Consequently, the results suggest that the factor structure and the relationship between the items and the latent construct are comparable between the analyzed groups. Scalar invariance could not be assessed due to estimation problems related to threshold constraints in the context of ordinal variables.

As part of the scalar invariance assessment, score tests (or Lagrange Multiplier tests) were performed using the `lavTestScore()` function from the `lavaan` package (Rosseel, 2012) to identify potential localized violations of the equality constraints imposed on the model. The results indicated no evidence of significant global mismatch for either sex or age. In the analysis by sex, the test yielded a $\chi^2(59) = 52.86$, $p = 0.7$, while for the age groups, the $\chi^2(59) = 70.66$, $p = 0.142$. No systematic violations of the scalar constraints were identified between the compared groups. These findings provide further evidence in favor of the scalar invariance of the instrument, suggesting that the items have equivalent intercepts between sex and age groups, which supports the comparability of the latent scores obtained in these subpopulations.

DISCUSSION

This study provides solid evidence on the psychometric properties of the Latin American Spanish version of the Climate Change Anxiety Scale (CCAS) in a large Colombian sample. The results support a four-factor structure comprised of cognitive impairment, functional impairment, personal experience, and behavioral commitment, showing adequate indicators of factor fit, internal consistency, convergent validity, discriminant validity, and measurement invariance across sex and age. These findings suggest that climate anxiety is a multidimensional phenomenon whose expression transcends the exclusively cognitive and functional manifestations proposed in the original model by Clayton and Karazsia (2020).

The identified factor structure partially coincides with the original CCAS proposal (Clayton & Karazsia, 2020), but is also consistent with more recent studies that have found expanded factor configurations incorporating components related to personal experience and behavioral commitment to climate change (Cruz & High, 2022; Navarro-Carrillo et al., 2025). These results contribute to the growing international evidence that questions the cross-cultural stability of a single two-dimensional structure and suggests that eco-anxiety can be expressed differently depending on the sociocultural, environmental, and linguistic context in which it is assessed (Fekih-Romdhane et al., 2024; Jang et al., 2023; Plohl et al., 2023).

Particularly relevant is the identification of the dimensions of personal experience and behavioral commitment as distinct factors. From a theoretical perspective, these findings support approaches that conceive of climate anxiety as a complex response integrating emotional, cognitive, experiential, and behavioral components, rather than a simple manifestation of worry or psychological distress (Simon et al., 2022; Tam et al., 2023). Furthermore, the high correlation observed between cognitive impairment and behavioral commitment suggests that climate concerns can coexist with action-oriented adaptive responses, which aligns with research that has documented associations between climate anxiety and pro-environmental behaviors (Ogunbode et al., 2022; Wullenkord et al., 2021).

Reliability analyses showed satisfactory levels of internal consistency and composite reliability across all dimensions. These results are consistent with those obtained in previous adaptations conducted in Italy, Germany, Poland, Korea, and Spain, where the CCAS has demonstrated adequate psychometric performance in diverse cultural contexts (Innocenti et al., 2021; Jang et al., 2023; Larionow et al., 2022; Navarro-Carrillo et al., 2025; Wullenkord et al., 2021). Taken together, these findings strengthen the growing body of evidence regarding the instrument's usefulness for assessing climate anxiety in different populations.

Convergent validity was supported by the positive associations between the CCAS dimensions and the general anxiety measure. Although the observed magnitudes were moderate, the correlations followed the theoretically expected direction, supporting the idea that eco-anxiety shares emotional mechanisms with other forms of anxiety without constituting a redundant or equivalent construct to generalized anxiety (Clayton & Karazsia, 2020; Tam et al., 2023). This pattern is consistent with cross-cultural studies that have found significant relationships between climate anxiety, psychological distress, and subjective well-being, while simultaneously maintaining sufficient conceptual specificity to differentiate it from other indicators of mental health (Ogunbode et al., 2022; Torales et al., 2026).

Furthermore, the results provided robust evidence of discriminant validity. Comparisons based on the Fornell-Larcker criterion, HTMT indices, and tests of factorial indistinguishability indicated that the dimensions represent related but empirically distinguishable constructs. This finding is particularly relevant considering that one of the main criticisms leveled at the literature on eco-anxiety has been the conceptual overlap between different emotional and cognitive components associated with climate change (Simon et al., 2022; Tam et al., 2023).

Finally, the evidence of invariance across sex and age is a significant strength of the study. The stability of the factor structure across the evaluated groups supports the comparability of the scores obtained and expands the possibilities for using the scale in population-based and comparative research. These results are consistent with current recommendations on psychometric assessment and provide additional evidence for the use of the instrument in Latin American contexts, where there is still a significant need for valid tools for the study of mental health related to climate change (Boateng et al., 2018; Cheung et al., 2024; Putnick & Bornstein, 2016)

Recommendations

The results obtained support the use of the CCAS as an instrument for assessing climate anxiety in Colombian and Spanish-speaking Latin American populations. Its incorporation into epidemiological studies, research on environmental mental health, and psychosocial surveillance programs related to climate change is recommended. Furthermore, future research should examine the scale's temporal stability through test-retest reliability studies and evaluate its sensitivity to change in contexts of psychological intervention, environmental education, or climate adaptation promotion. It is also pertinent to explore validity based on external variables by including indicators of depression, stress, psychological well-being, resilience, and pro-environmental behavior, in order to broaden the understanding of the role of eco-anxiety within overall psychological functioning (Ogunbode et al., 2022; Tam et al., 2023).

Finally, it is recommended to replicate these analyses in representative samples from other Latin American countries to evaluate the cross-cultural stability of the identified factor structure and strengthen the regional comparability of the findings (Hoffmann-Ferrada, 2024; Spektor et al., 2023).

Limitations

This study has some limitations that should be considered when interpreting the results. First, a cross-sectional design was used, which prevents drawing conclusions about the temporal stability of the scores and limits the assessment of causal relationships between climate anxiety and other psychological variables. Second, the information was obtained using self-report instruments, which are susceptible to biases such as social desirability, memory, and subjective perception. Although this strategy is common in psychometric research, future studies could complement it with other sources of information.

Third, the sample consisted mainly of students and young adults, so the generalization of the findings to other age groups or populations with different sociodemographic characteristics should be approached with caution.

Additionally, although favorable evidence of metric invariance and indirect support for scalar invariance were obtained, the restrictions associated with the treatment of ordinal variables prevented the

conventional assessment of all levels of invariance, an aspect that should be explored using alternative procedures in future research (Putnick & Bornstein, 2016).

CONCLUSIONS

The findings contribute to strengthening the measurement of climate anxiety in Latin America and provide empirical evidence supporting the multidimensional nature of the construct. Furthermore, they offer a valid and reliable tool for research, mental health monitoring, and the development of intervention strategies in a regional context particularly vulnerable to the effects of climate change (Hartinger et al., 2024; Hoffmann-Ferrada, 2024; Rozo-López, 2020).

Overall, this study represents one of the most comprehensive psychometric analyses conducted on climate anxiety in Latin American populations and constitutes a significant step toward the consolidation of culturally appropriate instruments for assessing psychological responses associated with the climate crisis.

DECLARATIONS

Ethics Approval and Consent to Participate

The study was conducted in accordance with the principles of the Declaration of Helsinki and current Colombian ethical regulations. The study was reviewed and approved by the Research Ethics Committee (REC) of the University of Magdalena (Project Initiation Act signed: June 16, 2025). In accordance with Resolution 8430 of 1993, the research was classified as minimal risk, as it used institutional records and self-report questionnaires without any intervention in the biological, psychological, or social conditions of the participants. All participants provided informed consent before participating. Participation was voluntary and anonymous, and participants were informed about the study objectives, confidentiality procedures, and their right to withdraw at any time without consequence. Data handling complied with the provisions of Law 1581 of 2012 on the protection of personal data. Guidance and referrals were provided to participants who exhibited indicators of anxiety.

All participants provided informed consent prior to participation. Participation was voluntary and anonymous, and respondents were informed about the objectives of the study, confidentiality procedures, and their right to withdraw at any time without consequences.

Consent for Publication

Not applicable.

Availability of Data and Materials

The datasets generated and/or analyzed during the current study are not publicly available because they contain information collected from human participants and are subject to ethical and privacy

restrictions. Anonymized data may be made available by the corresponding author upon reasonable request and subject to approval by the relevant ethical and institutional authorities.

Competing Interests

The authors declare that they have no competing interests.

Funding

This work was supported by Universidad del Magdalena under institutional research project No. 16062025.

Authors' Contributions

UERD: Conceptualization, study design, data interpretation, manuscript writing, and supervision.

DFVV: Data curation, statistical analyses, results interpretation, and manuscript revision.

ZLPA: Literature review, manuscript revision, and critical review of intellectual content.

All authors read and approved the final manuscript.

Acknowledgements

The authors thank all participants for their voluntary participation in this study. The authors also acknowledge the support provided by Universidad del Magdalena during the development of this research.

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