Detecting and classifying eco-anxiety: development of clinical cut-off scores for the climate change anxiety scale

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Abstract

Background Climate change anxiety, that is worry and fear in relation to the awareness of the impacts of climate change, is widely observed around the world. Some evidence suggests that while climate change anxiety can, at times, be adaptive, a growing body of research has reported that climate change anxiety is also related to a range of negative mental health outcomes and psychological distress. Currently, however, there is limited ability to assess for elevated levels of climate change anxiety and to identify those who may need support. The present study, therefore, aimed to develop clinical cut-off scores on a measure of climate change anxiety.

Methods A largely representative sample of Australian young adults (aged 16–25 years) completed measures of psychological distress (Depression, Anxiety and Stress Scale-21) and the Climate Change Anxiety Scale. Markers of clinically meaningful psychological distress – elevated depression, anxiety, and stress symptoms—were used to classify cases. Receiver Operating Characteristics analyses were performed to assess the predictive ability of the indicators of psychological distress (mild, moderate, severe, and extremely severe thresholds of anxiety, depression, and stress symptoms) for detecting climate change anxiety and to ascertain optimal cut-off scores.

Results The Area Under the Curve was acceptable to moderate for detecting climate change anxiety across all analyses. Across symptom severity thresholds and markers of psychological distress, based on consideration of balancing sensitivity and specificity, results consistently suggested that a cut-score of 21 was indicative of mild-moderate climate change anxiety, with a cut-off score of 23 indicating severe-extremely severe climate change anxiety.

Conclusions The proposed cut-offs can feasibly be used to identify those with elevated climate change anxiety. Use of these cut-off scores can inform research as well as be used to guide screening, assessment, and inform clinical practice. Results also highlight a high rate of climate change anxiety in young adults.

Keywords Ecological concern, Eco-worry, Climate change worry, Psychological disorders, Wellbeing, Ecological distress

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The continued escalation of climate change and its impacts pose an increasing threat to human health, including mental health [1], yet critical gaps in responding to the health impacts of climate change remain [2], underscoring the need for continued research. While it has been widely reported that direct and indirect exposure to natural hazards is a way in which climate change can impact mental health (e.g., [3–6]), in recent years, there has been growing consideration of the impact of

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awareness of climate change on mental health, with the emergence of the concept of 'climate change anxiety'. Climate change anxiety refers to the anticipatory anxiety experienced due to awareness of the threats posed by climate change [7] and can be understood as "the chronic fear of environmental doom" ([8], p.17). While climate change anxiety and concern may be exacerbated by events such as exposure to natural hazards [9], the term climate change anxiety is most commonly used to refer to distress related to vicarious awareness of climate change and its impacts [10]. Accordingly, awareness of the impacts of climate change on wellbeing for individuals and future generations, and the existential threat posed to life and the planet itself, are understood as inducing anxiety [11, 12]. Recent research has shown that climate change anxiety is an increasingly common experience [13] that is observed around the world and across regions [14, 15].

Climate change anxiety is linked with a range of adverse mental health outcomes [16–19] globally [7]. Consistently, climate change anxiety has been shown to be associated with anxiety, stress, and depression symptoms, across youth, adult, general population, and clinical samples [20]. Evidence from clinical practice and health professionals further draws attention to impacts of climate change anxiety on wellbeing, and highlights that it is an issue requiring further consideration in healthcare service provision [21–25]. Likewise, while large multinational studies show that between 47 to 60% of respondents reported being very or extremely worried about climate change [14, 15], 45% reported that this worry then impaired their daily functioning [14]. Therefore, climate change anxiety may be experienced, by some, at levels conferring impairment in daily functioning and posing a clinical concern.

To date, however, determination and assessment of heightened climate change anxiety remains somewhat limited [26]. Whilst a range of measures for climate change anxiety have been developed over recent years, there is a lack of verified cut-off scores for identifying cases. Thus, we do not have the ability to easily assess and classify those with subclinical worry from those with elevated climate change anxiety that might be detrimental or causing functional impairment. Development of validated clinical cut-off scores is needed to guide both research and healthcare practice and, ultimately, to support responding to the gaps in mental health impacts of climate change [2].

The Climate Change Anxiety Scale (CCAS; [27]) was one of the first measures developed to assess climate change anxiety. Since its initial validation, it has been the most widely used measure in climate change and mental health research [20]. The CCAS has been translated into multiple languages and validated in a variety of countries [28–33], as well as in youth samples [34], and has consistently shown favourable psychometric properties. To date, the CCAS has largely been used as a continuous measure indicating greater or lesser symptomatology, with validated cut-off scores lacking. In their original development of the CCAS, Clayton and Karazsia [27] proposed that a score representing "sometimes" or more on items (i.e., a mean of 3) may be indicative of climate change having significant impacts on mental health. However, this proposed threshold was based only on a review of the validation sample's means without consideration of standard deviations and population norms, and without the assessment of sensitivity and specificity needed for developing clinical cut-offs. Thus, an empirically developed cut-off score is needed. A validated cut-off score will support research, and also aid in clinical practice, including facilitating treatment access and treatment planning [26]. Therefore, the current study aimed to determine a cut-off score on the CCAS for classifying climate change anxiety.

Methods

Participants

Young people aged 16–25 years, residing in the state of New South Wales, Australia were eligible to take part. The study aimed to recruit a largely representative sample, albeit with an oversampling from rural areas. Participants were recruited by the Qualtrics online survey platform. In total, $N = 877$ completed the study measures. The mean age of participants was 21 years and the sample were predominantly female and of European descent (see Table 1).

Procedure

Participants took part in a larger study examining relationships between mental health, climate change, and coping. The study was approved by the Human Research Ethics Committee of the University of New England. Participants were directed to the survey link from advertising materials circulated by Qualtrics and partner organisations. Informed consent was obtained in Qualtrics prior to participants proceeding to the survey. Participants received a small reward for their time (e.g., gift cards, charitable donations) distributed by Qualtrics.

Measures

A range of demographic data were collected including ethnicity, area of residence (metro/rural, postcode), gender, and age.

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	M (SD)/ N(%)
Age	21.1 (2.57)
Gender	
Female	633 (72.2)
Male	240 (27.4)
Non-binary	2 (0.2)
Withheld	2 (0.2)
Location	
Metropolitan	469 (53.5%)
Rural	408 (46.5%)
Ethnicity	
European Australian or New Zealander	620 (70.7%)
Asian	106 (12.1%)
Aboriginal/Torres Strait Islander Australian	85 (9.7%)
European	14 (1.6%)
African or Middle Eastern	14 (1.6%)
South American	8 (0.9%)
Other Oceanian	8 (0.9%)
Maori New Zealander	4 (0.5%)
North American	2 (0.2%)
Prefer not to say	16 (1.8%)

Climate change anxiety

The CCAS [27] is a self-report measure that assesses psychological responses and anxiety in relation to climate change (e.g., "Thinking about climate change makes it difficult for me to concentrate"). A total of 13 items, each scored on a five-point Likert scale ranging from 1 (*never*) to 5 (*almost always*), are used to generate the total climate change anxiety scale score. Higher scores indicate greater anxiety. The CCAS developers suggested using an unweighted mean score. For the aims of the present study, we utilised a summed total score rather than mean score, as this is in line with most widely used clinical outcome measures. Aggregation can result in loss of unique information [35], whereas a summed score enables greater interpretability within practice settings. Thus, in developing clinical cut-offs that can be used in practice as well as research settings, a summed score was used. The CCAS has been widely validated, and has shown adequate reliability [27]. Reliability in the current sample was excellent; $\alpha = 0.95$.

Psychological distress

The DASS-21 is a well-validated 21-item measure of psychological distress, assessing depression, anxiety, and stress symptoms [36]. Subscales for each of depression, anxiety, and stress are calculated from 7 items each, with clinical cut-offs developed for mild, moderate, severe, and extremely severe presentations of symptoms on each subscale [36]. Moderate symptoms are understood as indicative of clinically relevant symptoms, and these cut-offs have good sensitivity and specificity for predicting diagnoses obtained from structured interview (e.g., [36, 37]). The extremely severe threshold represents those with the highest population scores. The DASS-21 has a stable three-factor psychometric structure in confirmatory factor analyses, broadly representing the tripartite structure of depression, anxiety, and a relatively non-specific general distress or negative affectivity factor [38]. The measure has consistently been shown to have good psychometric properties [36]. Internal consistency in the current sample for the depression, anxiety, and stress subscales was high; $\alpha = 0.92$, $\alpha = 0.88$ and $\alpha = 0.88$, respectively.

Data analysis

To ascertain cut-off scores, Receiver Operating Characteristics (ROC) analyses were conducted using SPSS v28 (data available from the authors upon reasonable request). To date, there remains a lack of consensus as to whether climate change anxiety represents a disorder or is a normative response (e.g., [39–41]). Thus, there is not an agreed upon diagnosis of climate anxiety against which to identify cut-off scores. Therefore, in the current study, we assessed cut-off scores for the CCAS by detecting cases of those who were and were not experiencing clinically meaningful levels of psychological distress. ROC curves were used to assess the ability of the CCAS to distinguish between cases with and without clinically meaningful psychological distress. Because the mean CCAS values are linearly related to a person's total CCAS score, the ROC values will be identical regardless of whether mean or total scores are used, and we opted for total scores for ease of interpretability.

Given that there is not a validated clinical interview nor definitive existing classification for climate change anxiety, cut-offs were assessed against relevant markers of distress, as has been done previously in clinical cut-off research (e.g., [42]). In order to provide a robust determination of the most appropriate cut-off scores, the CCAS was explored against multiple markers of psychological distress (i.e. anxiety, depression, and stress) and multiple severity levels. Climate change anxiety has largely been conceptualised as representing an anxiety disorder or subtype [43] and, in the literature to date, climate change anxiety has most commonly been explored in relation to anxiety symptoms, showing consistently small to large associations [20]. Therefore, we used the presence of clinically meaningful anxiety symptoms as indicative of distress. In addition to using anxiety symptom thresholds, analyses were also performed utilising two additional markers of psychological distress: The stress scale

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of the DASS-21 has routinely been shown to be associated with climate change anxiety [20] and depression has consistently shown similar strength of association with climate change anxiety as anxiety and stress symptoms. Therefore, both stress and depression were also used as a marker of distress in further analyses. Accordingly, analyses were performed for detecting cut-offs on the CCAS against those classified as having moderate as well as extremely severe anxiety, depression, or stress. Secondary analyses were also performed for the mild and severe thresholds of each subscale.

For all analyses, the Area Under the Curve (AUC) was used to ascertain the predictive ability of the CCAS for detecting distress symptoms. An AUC of 1.0 indicates perfect diagnostic prediction, with 0.5 indicating that predication is not better than chance [44]. AUC values were characterised as AUC < 0.50—0.7 poor, 0.7—0.8 moderate, 0.8—0.9 excellent, and above 0.9 as outstanding [45]. Model fit was plotted as precision-recall curves and classification metrics included inspection of the Gini index, maximum Kolmogorov–Smirnov (K-S) metric, which is analogous to the maximum Youden Index, and the CCAS value associated with the largest K-S value. Appropriate cut-off scores were determined through examination of sensitivity and specificity. A specificity and sensitivity of > 70% is desirable for clinical and screening purposes [44]. The Youden Index (sensitivity + specificity -100) which highlights cut-off scores that maximise sensitivity and specificity [46] is reported, as are the positive predictive value (PPV) and negative predictive value (NPV). The optimal cut-off scores for the CCAS were ascertained through assessment of sensitivity and specificity as close to or above 70%, which we prioritised over the Youden Index, Gini index and maximum K-S metric. Secondary analyses were performed to then examine the predictive ability of the DASS-21 subscales for detecting presence/absence of climate change anxiety, using the newly identified cut-offs (ROC-back analysis).

Power for conducting ROC analyses has been proposed as at least 10 participants with the diagnosis, 10 without the diagnosis, 10 false positives, and 10 false negatives [47]. Due to a lack of formal psychiatric diagnosis using a gold-standard diagnostic tool, a final determination of false positives and negatives for climate change anxiety

was not possible and thus our PPV and NPV values are indicative only. However, given that there were over 10 cases for presence and absence of each distress category (see Table 1), and the large sample, it was considered appropriate to conduct the ROC analyses.

Results

The majority of participants reported at least mild threshold symptoms of depression, stress, and anxiety (see Table 2), with anxiety symptoms the most commonly reported. Notably, 33% of the sample reported extremely severe anxiety symptoms, while 9% and 20% had extremely severe stress and depression, respectively. Scores on the CCAS ranged from 13 – 58 ($M = 23.3$, SD = 9.93).

The AUCs were highest for the CCAS to detect anxiety symptoms, therefore, anxiety results are reported in the main text. Notably, results regarding optimal cut-off scores were consistent across stress and depression symptoms and these results are reported in the supplementary material. When exploring moderate anxiety symptoms, the CCAS showed a moderate AUC of 0.703 (95% CI 0.669—0.737; Fig. 1), suggesting acceptable ability to detect the moderate anxiety threshold. A cut-off score of 23 had the highest Youden Index (Table 3) and K-S with Gini index = 0.406, albeit with poor sensitivity of 59% (precision recall curves in Fig. 2). A cut-off of 22 marginally improved sensitivity but with a lower specificity, while a score of 21 offered a balance of sensitivity and specificity with both tending toward the acceptable 70% threshold, though still suboptimal for screening purposes. Across mild anxiety, as well as mild and moderate depression and stress, a cut-off score of 21 was identified as the optimal balance of high Youden Index score and sensitivity and specificity (see supplementary materials).

When assessing extremely severe anxiety symptoms, the CCAS had an AUC of 0.729 (95% CI 0.692—0.766; Fig. 1), indicating moderate detection. While a cut-off score of 26 had a slightly higher Youden Index (Table 4) and K-S with Gini index = 0.458 (precision recall curves in Fig. 2), a cut-off score of 23 was deemed preferable, given that it maximised both sensitivity and specificity, with both nearing the 70% threshold. For detecting extremely severe anxiety symptoms, PPV was higher than

Table 2 Overview of DASS-21 categories

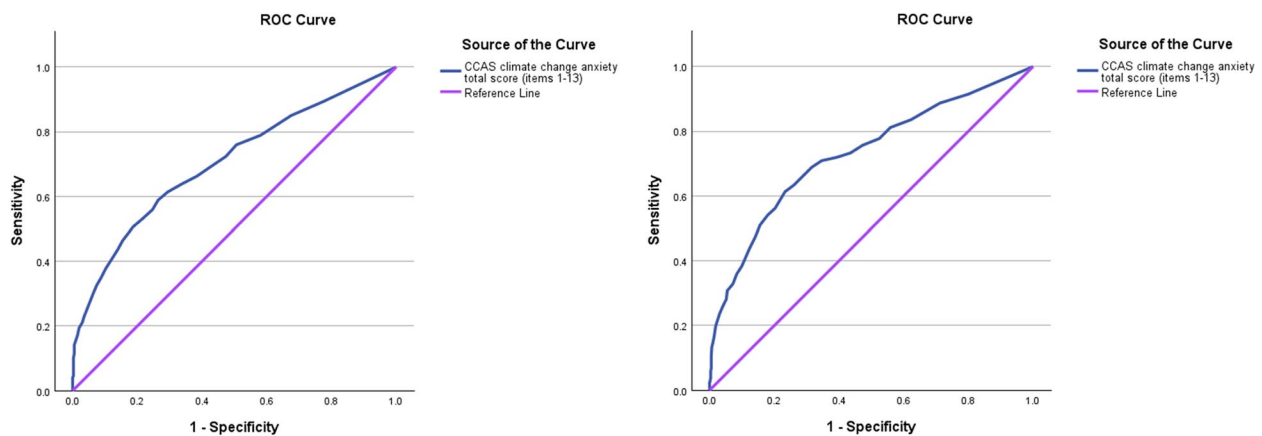|	Normal n(%)	Mild n(%)	Moderate n(%)	Severe n(%)	Extremely Severe n(%)
Depression	313 (35.7%)	87 (9.9%)	178 (20.3%)	124 (14.1%)	175 (20.0%)
Anxiety	274 (31.3%)	128 (14.6%)	90 (10.3%)	92 (10.5%)	292 (33.3%)
Stress	349 (39.8%)	108 (12.3%)	152 (17.4%)	188 (21.5%)	79 (9.0%)

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Fig. 1 Area under the curve for detecting moderate and extremely severe anxiety symptoms. Panel A represents the CCAS total scores predicting moderate symptoms of anxiety on the DASS-21 (AUC = .703, 95% CI .669—.737) with sensitivity plotted on the Y-axis and 1 – specificity plotted on the X-axis. ROC curve is depicted in dark blue; Reference line depicted in purple. Panel B represents the CCAS predicting extremely severe symptoms of anxiety on the DASS-21 (AUC = .729, 95% CI .692—.766) with sensitivity plotted on the Y-axis and 1 – specificity plotted on the X-axis. ROC curve is depicted in dark blue; Reference line depicted in purple. AUC, area under the curve; CCAS, Climate Change Anxiety Scale; CI, confidence interval; DASS-21, Depression Anxiety and Stress Scales-21; ROC, receiver operating characteristics

Table 3 CCAS Predicting Moderate Anxiety Symptoms (DASS-21)

Score	Sensitivity %	Specificity %	Youden Index	PPV	NPV
16	79	42	.21	63	62
17	76	49	.25	64	64
18	72	53	.25	62	64
19	69	58	.27	61	66
20	66	62	.28	61	67
21*	**64**	**66**	**.30**	**61**	**69**
22	61	71	.32	61	71
23	59	74	.33	60	73
24	56	75	.31	59	73
25	53	79	.32	59	75
26	51	81	.32	58	76

PPV Positive Predictive Value, *NPV* Negative Predictive Value

* Optimal cut-score highlighted in bold

for moderate anxiety symptoms, whereas NPV was lower. When assessing severe anxiety symptoms, as well as severe and extremely severe depression and stress symptoms, the optimal cut-off score was consistently found to be 23, maximising both sensitivity and specificity and yielding high Youden Index scores (see supplementary material).

Using the proposed cut-off scores of 21 as indicative of mild-moderate climate change anxiety symptoms, and 23 as indicating severe symptoms, 50.2% of the representative sample of young people aged 16–25 years had mild-moderate and 44.1% had extremely severe symptoms of climate change anxiety.

When assessing the predictive ability of the DASS-21 subscales for predicting cases of climate change anxiety in ROC-back analysis, the subscales also showed poor to moderate diagnostic detection (Table 5). The anxiety subscale showed marginally larger AUCs, although 95% CIs for all AUCs were overlapping, suggesting reasonably comparable diagnostic prediction across subscales.

Discussion

This study aimed to develop cut-off scores on the CCAS in order to further research into climate change anxiety and inform clinical practice. Results were consistent across assessed mental health outcomes, with the same optimal cut-off score identified for detecting mild and moderate depression, anxiety, and stress symptoms, and a consistent cut-off score also identified for detecting severe and extremely severe depression, anxiety, and stress symptoms. With consistency across all markers coalescing based on sensitivity and specificity, cut-off scores on the CCAS of 21 for mild-moderate and 23 for severe symptoms are tentatively supported as useful cut-off scores to indicate clinical severity.

The lower threshold cut-off score of 21 had moderate positive and negative predictive values, whereas the higher threshold cut-off score of 23 had an improved false positive rate, but a higher false negative rate. While the NPV was modest for the cut-off score of 23, given the low estimated base rate of climate change anxiety in the population [27], a cut-off that favours the positive predictive value is preferable. Similarly, no cut-off scores achieved
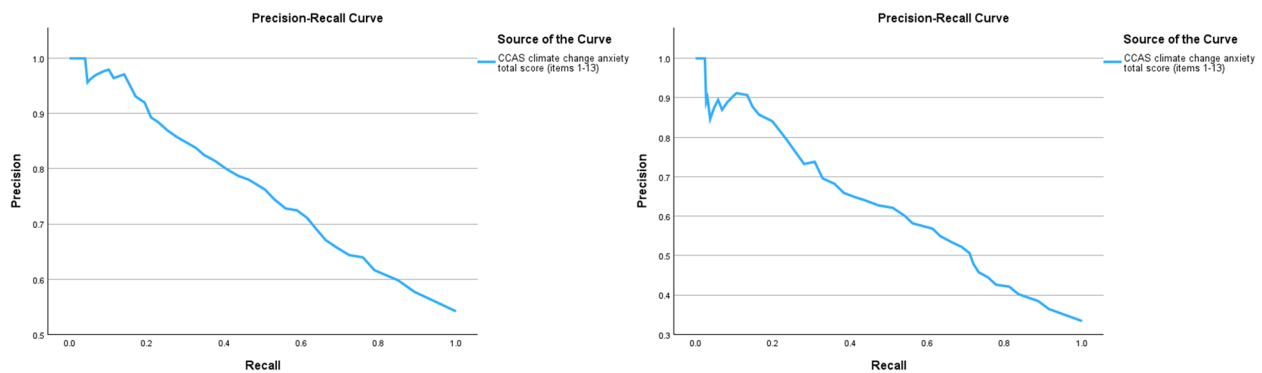
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Fig. 2 Precision-recall curve for detecting moderate and extremely severe anxiety symptoms. Panel A represents the CCAS total scores predicting moderate symptoms of anxiety on the DASS-21 with precision plotted on the Y-axis and recall plotted on the X-axis. Panel B represents the CCAS total scores predicting extremely severe symptoms of anxiety on the DASS-21 with precision plotted on the Y-axis and recall plotted on the X-axis

Table 4 CCAS predicting extremely severe anxiety symptoms (DASS-21)

Score	Sensitivity %	Specificity %	Youden Index	PPV	NPV
18	78	48	.26	81	43
19	76	53	.29	81	45
20	73	56	.30	81	46
21	72	61	.33	81	48
22	71	65	.36	82	51
23*	**69**	**68**	**.37**	**81**	**52**
24	66	71	.37	81	53
25	63	74	.37	80	55
26	61	77	.38	80	57
27	56	80	.36	78	58
28	54	82	.36	78	60

PPV Positive Predictive Value, *NPV* Negative Predictive Value

* Optimal cut-score highlighted in bold

Table 5 DASS-21 subscales predicting climate change anxiety symptoms

	AUC	95% CIs
Mild-moderate climate change anxiety		
Depression	.662	.626—.698
Anxiety	.698	.663—.733
Stress	.673	.637—.709
Severe-extremely severe climate change anxiety		
Depression	.677	.641—.712
Anxiety	.715	.681—.750
Stress	.687	.651—.722

the 70% threshold for both sensitivity and specificity, and Youden Index scores remained low, indicating suboptimal sensitivity and specificity [46]. These findings are

likely reflective of the use of related but distinct mental health outcomes against which to produce cut-off scores. Despite this, the current study provides the first exploration of cut-off scores for the CCAS and extends the original proposal of a mean cut-off score of 3, also suggesting that clinical distress is predicted at lower climate change anxiety levels than previously proposed [27]. Further, the AUCs indicated that the CCAS had moderate predictive ability for identifying anxiety symptoms, indicating that the CCAS is able to distinguish heightened levels of climate change anxiety that may confer impairment and/or high levels of distress, and might help to identify those who would benefit from additional support. Results thus support the utility of using the cut-off scores on the CCAS to classify mild-moderate and severe levels of climate change anxiety.

Our results highlight that the CCAS was able to detect clinical levels of symptomatology and distinguish between those with and without distress, demonstrating that above threshold scores on the CCAS are indicative of having clinically relevant symptoms of psychological distress. Thus, while climate change anxiety is a rational response, results align with past findings that highlight impaired functioning from climate change anxiety (e.g., [14]), suggesting that some individuals may require or benefit from support in relation to their climate change anxiety.

In order to best support those experiencing climate change anxiety such that functioning is impaired, gaining insight into nosology is of value. Information around nosology can help to guide and inform intervention or modes of support offered, where needed. The present findings also contribute to understanding possible classification of climate change anxiety. With anticipatory worry representing a core feature of climate change anxiety, conceptual overlap with generalised anxiety disorder (GAD) has been suggested

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[7, 43], which would indicate treatments in line with those for GAD might prove fruitful. Yet other studies suggest that climate change anxiety pertains to perceptions of dread or threat, rather than a general tendency to worry [26]. It has also been argued that climate change anxiety might be understood in line with post-traumatic stress disorder or specific phobias, or represent something distinct [43]. Results here indicate that, while climate change anxiety has overlap with depression, anxiety, and stress symptoms, prediction remained poor to moderate, indicating that climate change anxiety, at least as measured by the CCAS, is a distinct albeit related construct. AUCs were fairly comparable across outcomes, but were highest for detecting symptoms of anxiety and lowest for the stress subscale. Concomitantly, secondary analyses also highlighted that the anxiety subscale of the DASS-21 had better predictive ability for detecting climate change anxiety than depression or stress; however, again each subscale performed similarly with poor to moderate detection. Accordingly, results provide some support for understanding climate change anxiety within the context of anxiety disorders classification; however, the results also indicate that climate change anxiety may be distinct from panic-related symptoms and the negative affect symptoms of anxiety, as are most closely assessed by the DASS-21 items. Whether climate change anxiety may better align within the stress and trauma diagnostic category also remains to be explored in more depth. Further clarification is needed in order to best guide clinicians providing intervention or support for climate change anxiety.

While measures such as the CCAS are increasingly being used, to date, these have been used as continuous variables. The lack of previously validated cut-off scores has reduced the ability to engage in prevalence research. Despite a suggestion that climate change anxiety base rates may be low [27], several studies have indicated high rates of climate change worry (e.g., [14, 15]). Notably, our study highlighted high rates of climate change anxiety in a representative sample of young people, underscoring the critical need to better understand and support those with climate change anxiety. The finding of a high rate of climate change anxiety in the sample of young people is also consistent with suggestions that young people may be a vulnerable group and are most affected by climate change anxiety [14, 22, 23, 48]. The high rate further underscores the critical need for climate action at policy level. Further prevalence studies in diverse samples and older age groups are also needed.

The development of cut-off scores to enable classification of cases of climate change anxiety will further support climate change anxiety research around nosology and treatment. For example, there is currently minimal evaluation of psychosocial interventions delivered in the context of climate change [49], and even less evidence for interventions treating climate change anxiety [40, 50]. The ability to classify those needing climate change anxiety interventions will support future intervention research. Likewise, being able to assess the effectiveness of any treatments through reduction of symptoms to subthreshold levels will aid in evaluation of interventions.

Increased detection of climate change anxiety may also be beneficial in routine healthcare practice, especially amongst populations most vulnerable [26]. Further, evidence from clinical practice and mental health professionals underscores the relevance of considering symptoms of climate change anxiety in clinical care (e.g., [21–24]). However, currently, healthcare professionals have limited guidance on how to assess or manage climate change anxiety [40, 51, 52], with the ability to screen for climate change anxiety limited due to lack of validated cut-offs. Having validated cut-off scores on a measure of climate change anxiety will enable screening and assessment in clinical and healthcare practice, and consequently facilitate early intervention. Given that the mental healthcare system lacks the resourcing to cope with the impacts of climate change [23, 53], fostering early intervention may be crucial. Such assessment can also guide mental health service provision, such as where treatment planning and case formulation need to consider climate change anxiety symptoms.

Limitations

The study is presented with several limitations. Developing cut-off scores against a gold-standard diagnosis, such as from a structured diagnostic interview, is considered preferable. Given that there is no formal diagnosis of climate change anxiety upon which to establish optimal cut-off scores, related mental health outcomes reflecting psychological distress were used. The lack of diagnosis limited the ability to assess power and limits conclusions that can be drawn around the predictive ability of the CCAS and optimal cut-off scores. Nonetheless, the assessment of cut-off scores against multiple mental health outcomes, all of which provided the same optimal cut-off scores enhances confidence in the results. Additionally, the use of self-reported measures for classifying disorders in order to ascertain cut-off scores has been commonplace throughout the literature, even where diagnostic interviews are validated and available (e.g., [54–59]). While the literature cautions against considering climate change anxiety as pathological, should climate change anxiety be classified as its own disorder in the future, further validation of the cut-off scores with a standardised clinical interview would be valuable.

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In this study, cut-off scores were assessed based on the English version of the CCAS in a sample residing in Australia, albeit with a range of cultural backgrounds. The CCAS has been widely translated, and verification of cut-off scores in additional languages or versions would also be warranted. Additionally, multiple subscales of the CCAS are proposed [27], and additional exploration of the predictive ability of each of these and associated cut-off scores may be considered in the future. The sample recruited for this study was a non-clinical young adult sample and further verification of cut-off scores with a clinical sample or diverse ages may be beneficial. However, these cut-offs were developed in a largely representative sample and distress levels were generally high, suggesting that results could generalise.

Conclusion

Based on analysis of the CCAS for predicting a range of indicators of clinically relevant psychological distress, we propose a cut-off of 21 for detecting mild to moderate symptoms of climate change anxiety. Such a cut-off score may be especially useful in research to better understand climate change anxiety. A cut-off score of 23 is proposed to detect severe cases of climate change anxiety, and the more conservative cut-off may be especially useful in clinical practice where detection may facilitate treatment [60]. The development of cut-off scores for climate change anxiety allows for the assessment of climate change anxiety in healthcare settings, and can support treatment planning and early intervention for individuals experiencing climate change anxiety. Results also underscore the high levels of distress and functional impairment experienced by those with climate change anxiety, and high rates of climate change anxiety in young people.

Abbreviations

AUC	Area Under the Curve
CI	Confidence Interval
CCAS	Climate Change Anxiety Scale
DASS-21	Depression, Anxiety, and Stress Scale
PPV	Positive Predictive Value
NPV	Negative Predictive Value
ROC	Receiver Operating Characteristic

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s40359-024-02240-4.

Supplementary Material 1.

Authors' contributions
SC was responsible for conceptualisation, overseeing data analysis and interpretation, and drafting the manuscript, SW conducted data analysis and contributed to drafting the manuscript, AL conceptualised the larger study and was responsible for study design, oversaw data collection and data management, and contributed to drafting the manuscript, WB contributed to study design and drafting the manuscript, PT reviewed and undertook data analysis and guided interpretation, and contributed to drafting the manuscript.

Data availability
The datasets analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Ethics approval was provided by the University of New England Human Research Ethics Committee. Informed consent was obtained from participants prior to proceeding to the study survey.

Consent for publication
Not Applicable.

Competing interests
The authors declare no competing interests.

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