A meta-analysis on the relationship between climate anxiety and wellbeing

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Abstract

Climate anxiety refers to the negative emotional reactions that a person can experience in response to climate change irrespective of prior direct experience with it. Research suggests this emotional reaction ranges from successful coping and adaptation to clinical-level psychological impairment. The Climate Change Anxiety Scale (CCAS) was designed to measure a person's level of climate anxiety impairment. However, inconsistent results when testing the relationship between CCAS scores and psychological wellbeing measures have raised questions about the scale's validity and usefulness for assessing climate change's mental health impacts. Our goal was to quantitatively summarise the direction and strength of the correlations between climate anxiety (as indexed by the CCAS) and measures of psychological wellbeing. We identified 25 studies and 60 effect sizes for inclusion, and meta-analytic results indicated a moderate negative correlation between overall CCAS scores and psychological wellbeing (r = -.296, 95% CI [-.360; -.230], p < .001). The meta-analytic estimates were consistent across CCAS subscales and diagnosis-specific measures of wellbeing. Multilevel meta-regressions used to estimate the influence of potential moderators indicated that the correlations were stronger when the sample's mean level of environmental identity was higher, and when a measure indicative of mental unwellness was used. We discuss implications for the nature of the relationship between climate anxiety and psychological wellbeing in general, and for the use of the CCAS in clinical and broader contexts.

Keywords: climate change, climate anxiety, climate change anxiety scale, CCAS, psychological wellbeing, meta-analysis

1. Background

Climate change's effects are being felt across the world (IPCC, 2021). The climate crisis impacts personal and community wellbeing through a variety of pathways, with implications for people's physical and mental health (Berry et al., 2010). One such pathway is climate anxiety, a phenomenon in which people who have not necessarily experienced climate change's impacts firsthand struggle with negative feelings about this problem (Clayton, 2021). Research has suggested that climate-related concern or anxiety has been increasing in the past 10 years (Clayton, 2021; Leiserowitz et al., 2018; Sciberras & Fernando, 2022), with rising accounts of personal experiences with climate anxiety appearing in the media (Pickering & Pickering, 2023; Pihkala, 2020a), clinical settings (Budziszewska & Jonsson, 2022; Seaman, 2016), and scientific literature (Charlson, Ali, Benmarhnia, et al., 2021).

A number of reviews have also been published addressing mental health impacts of climate change, including those focusing on mental health risks (Obradovich et al., 2018), anxiety, worry and grief responses (Ojala et al., 2021), and anxiety reactions (Soutar & Wand, 2022). Despite the growing interest in mental health impacts and climate anxiety, no previous study has attempted to summarise the consequential influence of climate anxiety on people's wellbeing. Here, we report a meta-analysis providing a quantitative summary of the association between climate anxiety and wellbeing focusing on the most widely used measure, the Climate Change Anxiety Scale (CCAS; Clayton & Karazsia, 2020). The increased interest in climate anxiety has sparked an uptick in research on the topic, but this proliferation of information can be confusing, prone to bias, and overwhelming. We therefore aimed to condense the available evidence in a way that is easy to understand for scientists, policy makers, and the general public. We hope that the results from this study help elucidate what climate

anxiety is and the impact it can have in a person's daily life. We begin with a review of the extant literature on the topic.

1.1 Climate anxiety

Climate anxiety and related concepts, such as climate-change concern and worry, have been operationalized in a variety of similar ways, usually as general emotional-cognitive phenomena (Ojala et al., 2021). In particular, climate anxiety is described as an affective response to environmental circumstances, resembling a stress or anxiety reaction, that can be felt irrespective of direct experience with climate change (Clayton & Karazsia, 2020). It is accompanied by a process of cognitive appraisal (judgments on how dangerous climate change is), repetitive thoughts, and coping/regulation efforts with the goal of reducing the unpleasantness experienced. All in all, climate anxiety can be conceptualized within a trauma, stress or grief framework (Dailianis, 2021), and its symptoms could be associated with different DSM-V diagnostic categories, such as anxiety, depression, and post-traumatic stress disorder (Clayton & Karazsia, 2020; Pihkala, 2022b). Climate anxiety can also be characterized as a crisis of hope about the future that can include existential doubts and feelings of dread, leading to a reduction in quality of life by impairing functioning in different contexts (e.g., work, education, social life) (Dailianis, 2021).

The mental health outcomes of climate change can range from normative and adaptive responses that lead to psychological flourishing (as discussed further in this section), to acute and dysregulated responses which contribute to the development of major psychopathology (Doherty & Clayton, 2011). Some individuals experience mild climate anxiety, with symptoms manifesting more occasionally, less intensely, and with limited impact on day-to-day functioning. Other individuals experience more extreme emotional consequences when symptoms reach clinical significance and linger for

longer periods (Hickman, 2020; Pihkala, 2019). In these extreme cases, personal daily functioning is heavily affected, which makes the person vulnerable to intrusive thoughts, catastrophizing, and emotional bursts of sadness and terror. Indeed, climate anxiety has been empirically linked to symptoms of depression, anxiety, and stress (Helm et al., 2018; Hogg et al., 2021; Schwartz et al., 2022; Searle & Gow, 2010; Stanley et al., 2021), as well as obsessive-compulsive disorders (Jones et al., 2012).

However, climate anxiety is not necessarily dysfunctional or pathological. Authors often caution against mixing maladaptive climate anxiety with "practical" forms of this type of anxiety, and treating climate anxiety as a psychological disorder (Ojala et al., 2021; Pihkala, 2020, 2022b; Verplanken et al., 2020; Wullenkord et al., 2021). For example, worry and anxiety can be adaptative and comprise healthy reactions to environmental threats, especially when the threat is as serious as climate change. Such emotional reactions can help a person prepare for, adapt to, and mitigate the impacts of future problems (Barlow, 2002), including in the context of climate change (Ojala, 2007). Accordingly, worry about environmental problems has been linked to positive wellbeing indicators, such as reduced frequency of risky behaviours of young people (Hokka et al., 1999), and sense of coherence regarding one's personal future (Anttila et al., 2000). While the difficult feelings climate anxiety provokes can lead to an inability to engage in meaningful pro-environmental action, a form of eco-paralysis (Pihkala, 2018), emotions underlying climate anxiety, such as habitual worrying (Verplanken et al., 2020; Verplanken & Roy, 2013), can be a source of motivation to engage in pro-environmental behaviour (Bright & Eames, 2021; Maran & Begotti, 2021; Ojala et al., 2021; Pihkala, 2022a; Reser et al., 2012; Schwartz et al., 2022). From an existential perspective, anxiety and worry are seen as rational and constructive reactions to threats to important valued objects (oneself, one's family, the

natural environment), and a mature way of facing one's responsibilities as a human (Ojala et al., 2021). Worry and anxiety can be hard to cope with, but processing them is an important aspect of psychological adaptation and growth (Ojala, 2005; Pihkala, 2022b). Despite most accounts being of a negative emotional experience, the relationship between climate anxiety and psychological wellbeing is thus not so straightforward.

Different factors may help explain why the association between climate anxiety and wellbeing varies. Personal distance to the effects of climate change and direct personal experiences with its impacts are two of the variables most frequently associated with both climate anxiety (e.g., Bratu et al., 2022; Soutar & Wand, 2022) and affect (e.g., Hackenbracht & Gasper, 2013). Experiencing direct harm from climate change is a vulnerability factor for the development of persistent mental health problems (Clayton, 2021). Worry about climate change arises from a perception that climate change can threaten one's valued objects (Boehnke et al., 1998; Wang et al., 2018). When one perceives climate change to be impacting them or those close to them (micro-worry), they can experience stronger emotional reactions and poorer mental health (Boehnke et al., 1998; Gago & Sá, 2021; Ojala et al., 2021). If, on the other hand, one worries mostly for people far away from them, society, the natural environment as a whole, and the future of the world (macro-worry), one can still experience worry but not the mental health impacts that are sometimes associated with it (Ojala, 2005).

Pro-environmental behaviour is another variable of interest for the association between climate anxiety and wellbeing. It is identified by Pihkala (2022a) as one of the core dimensions of coping and adapting to climate anxiety, and is also listed in psychoeducational resources that focus on helping people deal with feelings of climate anxiety (Australian Psychological Society, n.d.-a, n.d.-b). Individual and collective pro-

environmental behaviours have been shown to have several benefits in reducing a person's climate anxiety and improving mental health. Benefits can be mental/emotional (sense of achievement, self and collective agency and efficacy, hope, joy, praise, self-esteem), social (developing friendships, sense of belonging) as well as spiritual, and can comprise the development of new skills (knowledge, experience) and connecting with and protecting nature (Budziszewska & Głód, 2021; Gallay et al., 2022; Gunasiri et al., 2022; Patrick et al., 2022). A particularity of climate change anxiety, however, is that the threat that elicits these feelings cannot be solved by any individual person. Thus, individual's climate mitigation efforts can have the paradoxical effect of exacerbating climate anxiety. The ineffectiveness of individual climate action can lead to feelings of powerlessness, frustration, uncontrollability, burnout, being overwhelmed, and even feelings of depression (Aitken et al., 2011; Budziszewska & Głód, 2021; Heeren et al., 2023; Hoggett & Randall, 2018; Nairn, 2019; Ojala, 2012, 2013; Pihkala, 2022b).

Another factor that might influence the variability in the association between climate anxiety and wellbeing is environmental identity, which reflects a feeling of emotional as well as cognitive connection to the natural environment (Clayton & Karazsia, 2020; Clayton & Opotow, 2003). People with high levels of environmental identity demonstrate greater environmental concern and pro-environmental behaviour, and they can be more attentive to changes in the environment. They may also have stronger emotional reactions and psychopathology symptoms as a result (Dean et al., 2018). Interestingly, research has indicated that higher levels of nature relatedness–a similar trait-like appreciation and understanding of a person's interconnectedness with nature and all living things (Nisbet et al., 2008)–predicted not only increased levels of negative affect, but also increased positive affect following exposure to climate change impacts (Smith et al., 2022). Another study suggested that a pro-environmental self-

identity predicted higher levels of eco-distress, while self-related nature relatedness (an internalized identification with nature) predicted less cognitive-emotional impairment related to climate anxiety (Smith et al., 2023). Therefore, environmental identity can function as both a vulnerability and protective factor in this context.

The reviewed literature indicates the importance of climate anxiety, how it can impact people's wellbeing, and the role of personal experience, pro-environmental behaviour, and environmental identity in moderating the association between climate anxiety and wellbeing. We are aware of 6 multi-item measures that capture emotional reactions to climate change or forms of climate change distress: the Climate Change Worry Scale (Stewart, 2021), the Climate Change Anxiety Scale (Clayton & Karazsia, 2020), the Hogg Eco-anxiety Scale (Hogg et al., 2021), the Eco-anxiety Questionnaire (Ágoston, Urbán, et al., 2022), the Climate Change Distress and Impairment Scale (Hepp et al., 2023), and the Inventory of Climate Emotions (Marczak, Wierzba, et al., 2023). Although there are many measures assessing climate-related anxiety, our meta-analysis focused on the first and most widely used measure, which is described next.

1.2 The Climate Change Anxiety Scale (CCAS)

The CCAS was developed by Clayton and Karazsia (2020) to assess the extent to which a person's everyday functioning is impaired in a variety of domains as a result of climate change, and whether the impairment achieves clinical relevance–though it is not designed to be used for clinical purposes. The CCAS was developed based on existing literature on the emotional impacts of climate change and personal accounts of climate anxiety available online at the time. Its items were developed from measures of clinical symptoms consistent with descriptions of climate anxiety, mainly rumination and functional impairment. The final measure has 13 items (see Table 1) rated on a 5-point Likert-type scale response format. The first eight items correspond to the

cognitive-emotional impairment subscale, which focuses on rumination, difficulty sleeping and concentrating, nightmares, and crying (e.g., “I have nightmares about climate change”). The other five items are part of the functional impairment subscale, and focus on the respondent’s ability to work, study, and socialize (e.g., “My concerns about climate change interfere with my ability to get work or school assignments done”). A further nine items can be included in the measure, not as aspects of climate anxiety, but as potential correlates. Three items measure the person’s direct and indirect experience with climate change (e.g., “I know someone who has been directly affected by climate change”), and the last six are indicative of the person’s pro-environmental behavioural engagement (e.g., “I feel guilty if I waste energy”).

Table 1

Subscales and Items of the CCAS (Clayton & Karazsia, 2020)

CCAS item
Cognitive-emotional impairment
1. Thinking about climate change makes it difficult for me to concentrate.
2. Thinking about climate change makes it difficult for me to sleep.
3. I have nightmares about climate change
4. I find myself crying because of climate change
5. I think, “why can't I handle climate change better?”
6. I go away by myself and think about why I feel this way about climate change
7. I write down my thoughts about climate change and analyze them
8. I think, “why do I react to climate change this way?”
Functional impairment
9. My concerns about climate change make it hard for me to have fun with my family or friends.

10. I have problems balancing my concerns about sustainability with the needs of my family.
11. My concerns about climate change interfere with my ability to get work or school assignments done.
12. My concerns about climate change undermine my ability to work to my potential.
13. My friends say I think about climate change too much.

Personal experience

14. I have been directly affected by climate change
15. I know someone who has been directly affected by climate change
16. I have noticed a change in a place that is important to me due to climate change

Pro-environmental behaviour

17. I wish I behaved more sustainably
18. I recycle
19. I turn off lights
20. I try to reduce my behaviors that contribute to climate change
21. I feel guilty if I waste energy
22. I believe I can do something to help address the problem of climate change

Note. Only Items 1 to 13 are included in the CCAS scores.

The CCAS has been used in a variety of countries (e.g., Patrick et al., 2022; Simon et al., 2022), including adapted and translated versions (German, Wullenkord et al., 2021; Italian, Innocenti et al., 2021; French, Mouguiama-Daouda et al., 2022; Polish, Larionow et al., 2022; Spanish, Pérez-Loizaga, 2022; Korean, Jang et al., 2023; and Finnish, Niskanen, 2022). All versions have shown good reliability indices, but factor structures vary, with some studies suggesting a one- (e.g., Innocenti et al., 2021),

a two- (e.g., Mouguiama-Daouda et al., 2022; Wullenkord et al., 2021), or even a three-factor structure (Larionow et al., 2022).

In the authors' original scale development studies (Clayton & Karazsia, 2020), both climate anxiety subscales were significantly positively correlated (rs $\geq$ .47, ps < .001) with a general anxiety and depression measure. These results combined with non-significant correlations between the anxiety and depression measure and the pro-environmental behavioural engagement subscale, supported the scale's concurrent and discriminant validity. The correlations between climate anxiety scales and psychopathology measures were replicated, though with smaller effect sizes, in other studies using the CCAS (e.g., Feather & Williams, 2022; Wullenkord et al., 2021). Although widely used, the CCAS is not without criticism. Scholars have noted that the CCAS does not capture the entirety of the emotional experiences of climate anxiety (Wullenkord et al., 2021) and it neglects other relevant negative eco-emotions, such as guilt and anger (Ágoston, Urbán, et al., 2022).

1.3 Current Study

The conflicting results from studies examining the relationship between climate anxiety and psychological wellbeing highlight the importance of examining how these variables are associated (Paul & Barari, 2022). Exploring the nature of this relationship is important for the implementation of preventive strategies, providing resources to those who need it, planning for future impacts, and preparing adaptation efforts (Clayton, 2020; Kaplan, 2020). Climate change is worsening, so its mental health impacts are also expected to worsen (Hayes et al., 2018). There is also the question of whether climate anxiety is overly pathologized; a better understanding of how this phenomenon is connected with symptoms of psychological disorder would shed light on how clinicians should proceed when faced with patients reporting these issues.

Our goal was to quantitatively assess the direction and strength of the correlation between climate anxiety (as indexed by the CCAS) and psychological wellbeing. We did this by means of a meta-analysis, aggregating studies that have measured climate anxiety with the CCAS and at least one measure of psychological wellbeing. We used Doherty's (2018) definition of wellbeing as not only reflecting a person's mental health and absence of psychiatric conditions and behavioural disorders, but also their ability to flourish. We chose to limit our analyses to climate anxiety as measured by the CCAS because different measures have different underlying definitions of the construct they are measuring (e.g., Ágoston, Urbán, et al., 2022; Hogg et al., 2021; Stewart, 2021). By including only one measure, we hoped to maximize comparability between the included studies, and reduce sources of heterogeneity. We also opted for the CCAS because it was one of the first measures to be developed with the explicit goal of measuring climate anxiety, and therefore it has been used in more studies compared to other measures.

We expected to find non-trivial correlations between CCAS scores and wellbeing measures. We made no assumptions regarding the direction of the relationship because of the inconsistency reported by previous researchers, and the argument for climate anxiety as a form of "practical anxiety", with potential positive consequences for wellbeing (Kurth & Pihkala, 2022). We also tested how different variables may influence the relationship between CCAS scores and wellbeing by including them as moderators. Sample-level personal experience with climate change, pro-environmental behavioural engagement, and environmental identity levels were included due to their potential theoretical implications for both climate anxiety and mental health as reviewed above. These three variables were also included in the initial development study of the CCAS (Clayton & Karazsia, 2020). Additionally, we included

other relevant variables as potential moderators, namely sample characteristics (mean age and gender distribution), publication factors (year, publication status, and direction of wellbeing measure used), and some characteristics of the version of the CCAS used (scale reliability and number of factors that emerge).

2. Method

2.1 Inclusion and Exclusion Criteria

We pre-registered this study on the Open Science Framework ([osf link]). We established three eligibility criteria: (1) studies must have assessed climate anxiety with the CCAS and have included at least one measure of psychological wellbeing, understood as adverse effects on mental health (i.e., anxiety, depression, trauma symptoms, adjustment disorders) and variables indicative of one's ability to flourish (i.e., enjoy positive emotions, trust in the future) (Doherty, 2018); (2) studies had to provide correlation coefficients between the CCAS and wellbeing measure(s), or data that allow their calculation (or authors provided the study data when requested); and (3) studies had to be written in English, Portuguese, or Spanish. We were interested in how climate anxiety and domain-general psychological wellbeing were related, so we included only general measures of psychological wellbeing and excluded any climate-specific measure, such as negative climate emotions. The CCAS is itself a measure of climate-specific negative emotions and would share content overlap with other domain-specific affective measures. No other exclusion criteria were pre-specified. After consulting with a member of the University of Waikato's Ethics committee, we concluded that there was no need to seek ethical approval for the meta-analysis because the data used in this study originated from other studies which had already received ethical approvals, and therefore did not involve direct interaction with human participants (O. Medvedev, personal communication, May 5th, 2023).

2.2 Search Strategy

We collected studies through a systematic review of the literature following the guidelines set by the PRISMA 2020 report (Page et al., 2021). We broadened our search to include "grey literature" such as theses and unpublished manuscripts, to reduce the effect of publication bias. We searched the databases EBSCOHost, APA Psychnet, JSTOR, Proquest, Sage journals, SCOPUS, and SSRN in March of 2023. We searched the terms "climate change anxiety scale" or "climate anxiety scale" in the full text and expanded the search to all available databases. We limited the search to studies from 2019 onwards, to reduce the chance of identifying records that preceded the development of the CCAS. We also used a forward citation search for Clayton and Karazsia (2020) on Google Scholar to identify all studies that referenced the original paper in any capacity. We also set up a Google Scholar alert for our search terms to include newly published research. Lastly, we sent out calls for data to psychology organizations from across the world (e.g., American Psychological Association Division 34, Society of Australasian Social Psychologists, Ora Taiao), as well as to individual authors who had published work using the CCAS or who had written about climate anxiety. When we did not receive a response, we followed the original message with a reminder. A list of all sources checked, individuals and organizations contacted, and the messages sent is available in the supplemental materials.

2.3 Coding procedures

We used Mendeley desktop (version 1.19.8) to import the references of the identified studies. These were then exported to Microsoft Excel and underwent a 3-stage screening process to assess eligibility. The first author worked alone in the first two stages. The first stage involved checking titles and abstracts to remove any studies not in English, Portuguese or Spanish, studies that were not empirical (i.e., review,

commentaries), and studies that were not quantitative (e.g., interviews, focus groups). The second stage of screening required accessing the full text and excluding studies that did not use the CCAS. Finally, in the third stage of screening we excluded any studies that did not include any psychological wellbeing measure or did not provide a way to extract correlation coefficients. In the case of the latter, we requested access to the anonymized raw dataset from the original authors. The first author reviewed all the studies independently. The other authors reviewed one half of the studies (26 each) independently. All three authors then compared assessments of study eligibility and discussed any discrepancies until a consensus was reached (inter-rater reliability was 69.23% for R.J.S. and 80.77% for T.L.M.).

The final database was coded in Jamovi (version 2.2.5). We coded study characteristics, namely authors, year of the study, population, country, sampling type, and whether and where it was published. Our outcomes of interest were the Pearson correlation coefficients between the wellbeing measure and the overall CCAS score, as well as the scores for the cognitive and functional impairment subscales. To follow a more consistent and systematic approach for coding the effect sizes, we calculated the correlations directly from the raw data provided by the authors (50 effect sizes from the total of 60 included in the review, as detailed below), and when raw data were unavailable, we extracted the correlations from the articles (10 effect sizes). When the studies reported Spearman's rho correlations (7 effect sizes), we converted them into Pearson's r (Rupinski & Dunlap, 1996). We coded the name of the wellbeing measure used and whether it was positive (high scores indicate mental health and wellbeing, such as the SWLS; Diener et al., 1985) or negative (high scores indicate psychopathology, symptoms, or other forms of psychological illbeing, such as the GAD-7; Spitzer et al., 2006). The effect sizes of negative indicators were transformed to

the corresponding negative value to reflect their effect on mental health as indicators of mental illbeing, and to avoid overlap with positive indicators in the analyses and plots. Hence, a negative effect size indicates that higher CCAS scores were associated with lower wellbeing scores, and a positive effect size indicates that higher CCAS scores were associated with higher wellbeing scores. If the wellbeing measure was specific to depression/anxiety disorders or symptoms (or had a subscale that was), this correlation was also coded separately.

Correlations between the CCAS scale scores and potential moderators (i.e., personal experience with climate change, pro-environmental behaviour, environmental identity, percentage of female participants in sample, and age) were also coded, as well as each scale's mean score, transformed into comparable percent of the maximum possible (POMP) scores (Cohen et al., 1999). Lastly, we coded potential moderators related to the CCAS, namely its reliability (Cronbach's alpha) and the number of factors that emerged in the original study. Because some studies utilized modified versions of the CCAS (e.g., Cruz & High, 2022; Wullenkord et al., 2021), we included separate columns for sample-specific correlation coefficients for studies with a distinct number of CCAS items. We then compared each correlation with a z test (Lenhard & Lenhard, 2004). None of these tests was statistically significant (z values ranged from 0 to 0.946, and p values from .17 to .50), indicating that the effect sizes did not differ statistically as a function of the number of CCAS items used. Consequently, both columns were collapsed, and in the case of discrepancies, the 13-item CCAS effect sizes were used. Missing data were handled through listwise deletion.

2.4 Statistical methods

We performed our statistical analyses in Rstudio software (version 4.2.1; R Core Team, 2022) using distinct packages, specifically the esc (0.5.1; Lüdecke, 2019), meta

(6.2-1; Balduzzi et al., 2019), metafor (4.0-0; Viechtbauer, 2010), dmetar (Harrer et al., 2019), and metapower (0.2.2; Griffin, 2020) packages. We based our analysis methodology on current best practices as outlined by Harrer et al. (2022). We performed random effects multilevel meta-analyses for each correlation pairing between CCAS scores (overall, cognitive impairment, and functional impairment) and wellbeing indicator scores (overall, depression-specific measures, and anxiety-specific measures), for a total of nine meta-analyses. The meta-analyses used Fisher's *r*-to-*Z* transformations as the outcome measure, restricted maximum likelihood (REML) model fitting, and Knapp-Hartung adjustments to account for potential low number of included studies. We used the cut-offs set by Richard et al. (2003) for interpreting correlation effect sizes, with .10 indicating a small correlation, .20 a medium, and .30 a strong correlation. Between-study heterogeneity was estimated using tau-squared (τ^2) and I^2 statistics. Publication bias was assessed using contour-enhanced funnel plots and Egger's regression tests. We conducted sensitivity analyses using the dmetar package to find outliers and repeated the meta-analyses without these studies, to test the robustness of the results. Furthermore, we performed influence analyses and used "leave-one-out" forest plots and Baujat plots to visualize each study's contribution to overall effect size and heterogeneity. We also report forest plots of the meta-analyses, which included each study's effect size and weight, as well as the pooled effect size and prediction interval, and subgroup differences (to visualize the effect of discrete moderator variables) when relevant. We report these plots only for the main CCAS-wellbeing meta-analysis, but the code to reproduce the plots across all meta-analyses, as well as to reproduce all the other analyses reported, is available in the OSF page.

We performed moderation analyses for each potential moderating variable by including them, one at a time, in the multilevel meta-analysis. Those variables that

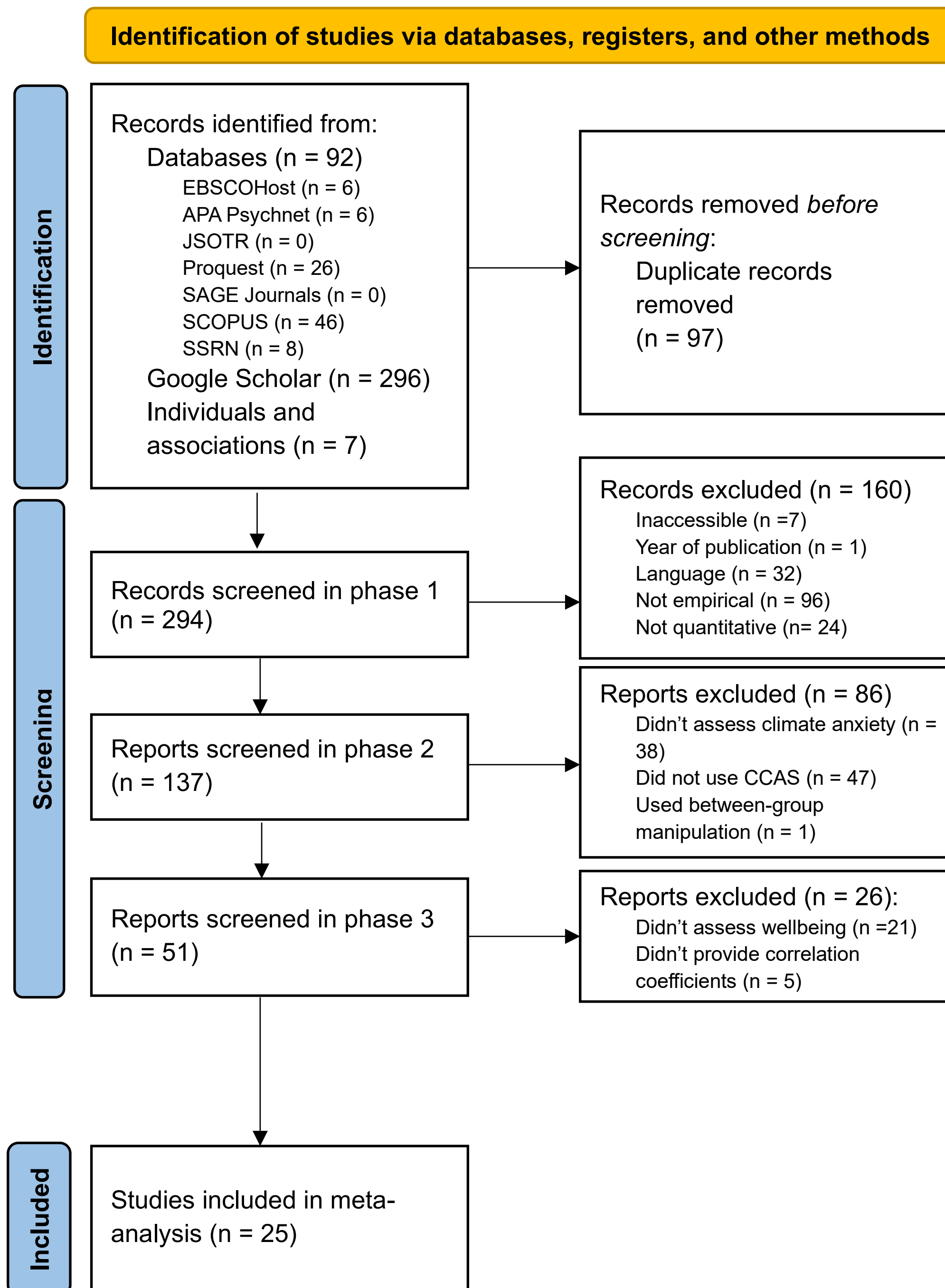
produced statistically significant interactions (*p*-values lower than .05, though we extended this criterion for marginal effects of $p < .10$) were included in a new multi-level model simultaneously, which was compared to the individual two-level meta-regression models with a likelihood ratio test. Finally, we used permutation tests to assess the robustness of the two-level regression models.

3. Results

Our search identified 395 publications. We removed 97 duplicates, followed by the removal of 160 studies during the first stage of screening, and a further 86 and 27 during the second and third stages of screening, respectively. The review of the resulting 25 studies yielded 60 effect sizes (*k*) from 24 independent samples (*s*) and contained 15,944 participants (*o*). One study (Card et al., 2022) used a subset of data from Closson et al. (in press), which explains why the number of independent samples is lower than the number of included studies. We were able to obtain the raw data for 19 of these studies. The PRISMA flowchart depicting the process of study selection is in Figure 1. One study (Thier & Lin, 2022) was eligible but later excluded because it comprised a between-participant manipulation with no pre-intervention measurement.

Figure 1

PRISMA Flowchart Describing the Systemic Literature Search



The included studies had participants from 20 countries, of which the U.S.A. was the most represented, with five of the studies (20%) being conducted there. The majority of studies (18, 72%) used a general population sample, though four (16%) used university student samples. Fourteen of the 25 studies (56%) were published in peer-

reviewed journals. Those not published in journals included five pre-prints, four theses, and one study that had completed data collection but was in the process of being written. Most studies (22, 88%) used negative measures of wellbeing, with the General Anxiety Disorder (10, 16.7%), the Depression Anxiety and Stress Scale (8, 13.3%), and the Patient Health Questionnaire (7, 11.7%) being the most frequently used. The characteristics of the included studies are given in Table 2.

Table 2

List of Included Studies and its Characteristics

Study	Population	Country	Publication status	N	Female (%)	Mean age (SD)	Wellbeing measures
Card et al. (2022)[a]	General public	Canada	Unpublished	532	50.00		Subjective social disconnectedness scale
Clayton & Karazsia (2020)	General public	U.S.A.	Published	197 199	40.61 32.16		PHQ-4
Closson et al. (in press)	General public	Canada	Unpublished	1589	48.80		K6
Coelho et al. (2023)	General public	U.S.A.	Unpublished	389	50.30	42.80 (13.60)	DASS GAD-7 CES-D PSS-4
Cruz & High (2022)	General public	U.S.A.	Published	513	61.01	52.20 (18.54)	CES-D-10 STAIS-5
Feather & Williams (2022b)	General public	Australia, New Zealand	Unpublished	401	41.90		K10 GAD-7
Feather & Williams (2022a)	General public	Australia, New Zealand	Published	760	48.00	33.40 (11.90)	MPFI PHQ-4

Study	Population	Country	Publication status	N	Female (%)	Mean age (SD)	Wellbeing measures
Hajek & König (2022)	General public	Germany	Published	3091	49.50	46.50 (15.30)	De Jong Gierveld Loneliness Scale Bude & Lantermann (2006)
Heeren et al. (2023)	General public	France, Belgium, Switzerland	Published	778			PSWQ
Hepp et al. (2023)	Adults	Australia, Canada, Ireland, Italy, Netherlands, New Zealand, South Africa, Ukraine, U.K., U.S.A.	Unpublished	379	50.30	30.72 (9.13)	BDI-II GAD-7 EUROHIS-QOL PANAS
Innocenti et al. (2021)	General public	Italy	Published	135	67.40	33.60 (12.00)	GAD-7 K10
Larionow et al. (2022)	General public	Poland	Published	106	47.20	28.90 (8.49)	PHQ-4 SEQ
Lutz et al. (2023)	University students	Canada	Published	306	78.60	20.15 (3.95)	DASS-21 SPANE SWLS MMILS AHS
Mcbride (2022)	University students High-school students	New Zealand	Unpublished	260 131	84.23 34.40		DASS ERICA

Study	Population	Country	Publication status	N	Female (%)	Mean age (SD)	Wellbeing measures
Mouguiama-Daouda et al. (2022)	General public	France, Belgium, Switzerland, Gabon, other French-speaking countries and territories	Published	305	72.13	30.80 (11.32)	BDI-II GAD-7
Niskanen, (2022)	General public	Finland	Unpublished	795	60.80		STAI-6
O'Hare & Murray (in press)	General public	Australia	Unpublished	382	70.60	46.40 (14.29)	SFPSS
Papadopoulou (2021)	General public	Greece	Unpublished	98	68.37	24.65 (6.01)	GAD-7
Pérez-Loizaga (2022)	Adolescents	Spain	Unpublished	1252	50.32	14.54 (1.78)	PHQ-4
Ramírez-López et al. (2022)	University students	Mexico	Published	468	66.38	21.60 (1.74)	GAD-7
Reyes et al. (2021)	Gen Z	Philippines	Published	433	66.51	20.40 (1.60)	MHI-38
Schwartz et al. (2022)	University students	U.S.A.	Published	308	78.80	23.30 (3.84)	GAD-7 PHQ-8
Whitmarsh et al. (2022)	General public	U.K.	Published	1338	53.00	47.10	GAD-7 FFMQ-18
Wilde (2022)	General public	U.S.A.	Unpublished	118			GAD-7
Wullenkord et al. (2021)	General public	Germany	Published	1011	51.14	43.91 (13.97)	PHQ-4 BMBPN

Note. AHS = Adult Hope Scale; BDI = Beck Depression Inventory; BMBPN = Balanced Measure of Basic Psychological Needs; CES-D = Center for Epidemiological Studies – Depression; DASS =

Depression Anxiety and Stress Scale; ERICA = Emotion Regulation Index for Children and Adolescents; FFMQ = Five-Facet Mindfulness Questionnaire; GAD = Generalized Anxiety Disorder; K = Kessler Psychological Distress Scale; MHI = Mental Health Inventory; MMILS = Multidimensional Meaning in Life Scale; MPFI = Multidimensional Psychological Flexibility Inventory; PANAS = Positive and Negative Affect Schedule; PHQ = Patient Health Questionnaire; PSS = Perceived Stress Scale; PSWQ = Penn State Worry Questionnaire; SEQ = Safety Experience Questionnaire; SFPSS = Short-Form Perceived Stress Scale; SPANE = Scale of Positive and Negative Experience; STAIS = State - Trait Anxiety Inventory Scale; SWLS = Satisfaction with Life Scale.

[a] Card et al. (2022) uses a sample from wave 3 of Closson et al. (in press).

3.1 Multilevel and standard meta-analysis

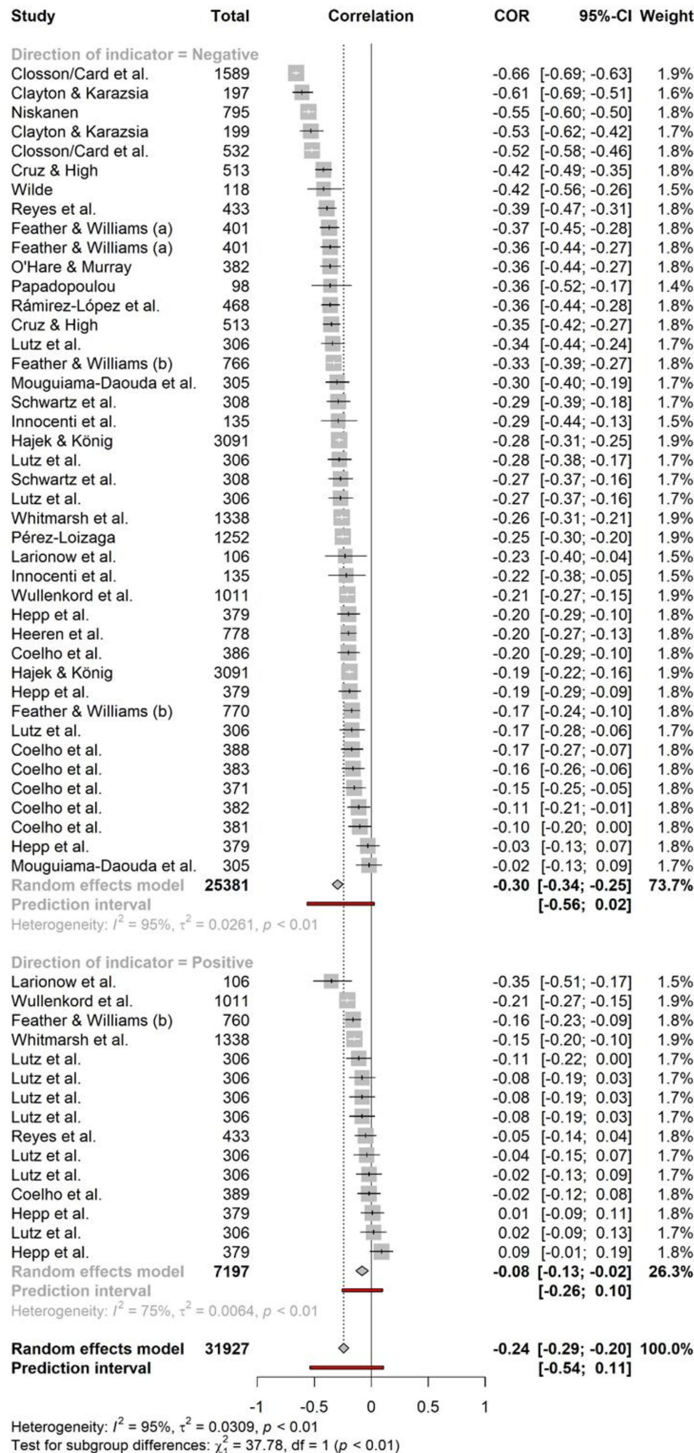
The multilevel meta-analysis of the correlation is a safer estimate of the pooled effect because it accounts for non-independence between the effect sizes (Harrer et al., 2022). On Level 1 we included all effect sizes individually, whereas in Level 2 the effect sizes were aggregated by the sample they originated from. One study did not provide a correlation between the overall CCAS score and a wellbeing indicator (only the correlations between CCAS subscales and the wellbeing indicators; McBride, 2022), resulting in a total of $k = 57$ effect sizes from $s = 23$ independent samples. The random effects multilevel meta-analysis revealed a moderate negative correlation between CCAS and overall wellbeing scores, $r = -.296$, 95% CI [-.360; -.230], $p < .001$, whereby greater levels of climate anxiety are associated with lower levels of wellbeing, and vice-versa. The same pattern of results was found using subscale scores instead of overall CCAS scores, as well as when wellbeing measures were limited to depression- or anxiety-specific measures. The pooled effect sizes ranged from $r = -.302$ (95% CI [-0.366; -0.235], $p < .001$) for the anxiety–wellbeing correlation, to -.227 (95% CI [-.295; -.156], $p < .001$) for the depression–functional impairment correlation. All the results from the multilevel meta-analyses are presented in supplemental Table S2.

A likelihood ratio test comparing the two-level model to the standard meta-analysis model (with Level 2 heterogeneity constrained to zero) supported the use of the

multilevel meta-analysis ($\chi^2_1 = 20.33$, $p < .001$), despite it being more complex. However, we also reported results for the standard meta-analysis. Each study's effect and weight, as well as the pooled effect and prediction interval of the standard meta-analysis are depicted in the forest plot in Figure 2 (the results from this analysis are in the supplemental material S3). Correlations ranged from $r = -.663$ to .088, with 95% being negative. The corresponding prediction interval for the standard meta-analysis, not multilevel, ranged from -.539 to .109, which indicates that although the expected outcome of any future individual study is a negative correlation, it is still possible for positive correlations to occur. We then examined the statistical power of the standard meta-analysis using metapower, which employs the approach proposed by Valentine et al. (2010) and considers the observed effect size, number of studies, and heterogeneity, as well as the average study size by dividing the number of observations *o* by the number of included studies *k* (for a recent application, see Griffin et al., 2021). We used this approach to calculate an *a posteriori* power analysis of this standard random-effects model. The results indicated that a minimum of five studies would be required to detect the observed effect size with 80% statistical power keeping all other parameters the same, and that our standard meta-analysis model included a sufficient number of studies to detect the existence of an effect (power = 1). Our meta-analysis was thus well-powered.

Figure 2

Forest Plot of Each Study's Effect Size and Weight, and Pooled Effect Sizes, Aggregated by Direction of Wellbeing Measure



Note. Pooled effect sizes in this figure are from standard meta-analysis, and not the multilevel meta-analysis.

3.2 Between-study heterogeneity

The extent to which the effect sizes vary from one another in a meta-analysis is called between-study heterogeneity (Harrer et al., 2022). High levels of heterogeneity can suggest the existence of effect size subgroups in the data with different true effects or the existence of moderators that significantly influence the relationship between the target variables, and hence the pooled effect size should be interpreted cautiously. The outcomes for the multilevel meta-analysis were heterogenous (Q = 1070.62, p < .001), with estimated variance of τ^2 = .010 at the effect-size level, and τ^2 = .022 at the sample level. Levels of I^2 ranged from 83.22% for anxiety-cognitive impairment correlations to 94.58% for the CCAS-wellbeing correlations. Of the total variance for the critical CCAS-wellbeing correlations, 64.87% was due to between-sample heterogeneity, 29.71% was due to within-sample heterogeneity, and 5.42% was attributed to sampling error.

High levels of heterogeneity were observed not only for the multilevel analysis but also for the standard analyses. The heterogeneity observed across our different meta-analyses indicate that the obtained pooled effect sizes may not be the most meaningful representation of how climate anxiety and wellbeing are associated, and one should examine these results together with other indicators that provide a more complete picture of the variety of results reported in and across different studies (such as the range of correlations and the prediction interval). It also highlights the need to test for potential sources of heterogeneity by examining the potential moderating effect of relevant variables, which we explore next.

3.3 Moderator analyses

We first considered each potential moderating variable one at a time. These individual moderator analyses identified the direction of the wellbeing measure (β =

.170, 95% CI [.105; .234], $p < .001$) and the mean environmental identity score for the study samples ($\beta = .011$, 95% CI [.002; .021], $p = .024$) as significant moderators of the relationship between CCAS scores and wellbeing. The use of negative wellbeing instruments and low sample mean levels of environmental identity were both associated with a stronger correlation between CCAS and outcome variables. None of the other sample characteristics (age, gender, personal experience, and pro-environmental behaviour), CCAS characteristics (reliability and number of factors), or publication factors (year and publication status) had significant moderating effects on the association between overall CCAS and wellbeing scores. However, year of publication and subscale reliability occasionally emerged as statistically significant moderators in the disorder-specific meta-analyses, with older studies and studies featuring more reliable measures displaying stronger correlations. For the CCAS – wellbeing meta-regression, we then introduced direction of wellbeing measure and mean levels of environmental identity simultaneously into the same model ($k = 21$), along with the year of publication, due to it having a marginal effect. This resulting combined model was significant, $F(3, 17) = 12.902$, $p < .001$, and a better representation of the data than any of the individual moderator models, though only the direction of the wellbeing measure retained statistical significance ($\beta = .215$, 95% CI [.116; .314], $p < .001$). Moreover, heterogeneity was still large (76.33%) after including these three moderators together in the model, with 33.07% explained at measure level and 43.26% at sample level. This means that even though the significant moderators included in the model explained a portion of the variance (especially between different samples), the obtained effect sizes were still substantially different from one another. The pooled effects for each subgroup of the wellbeing direction variable are depicted in Figure 2. Permutation testing supports the robustness of these results, $F(3, 17) = 20.574$, $p = .001$.

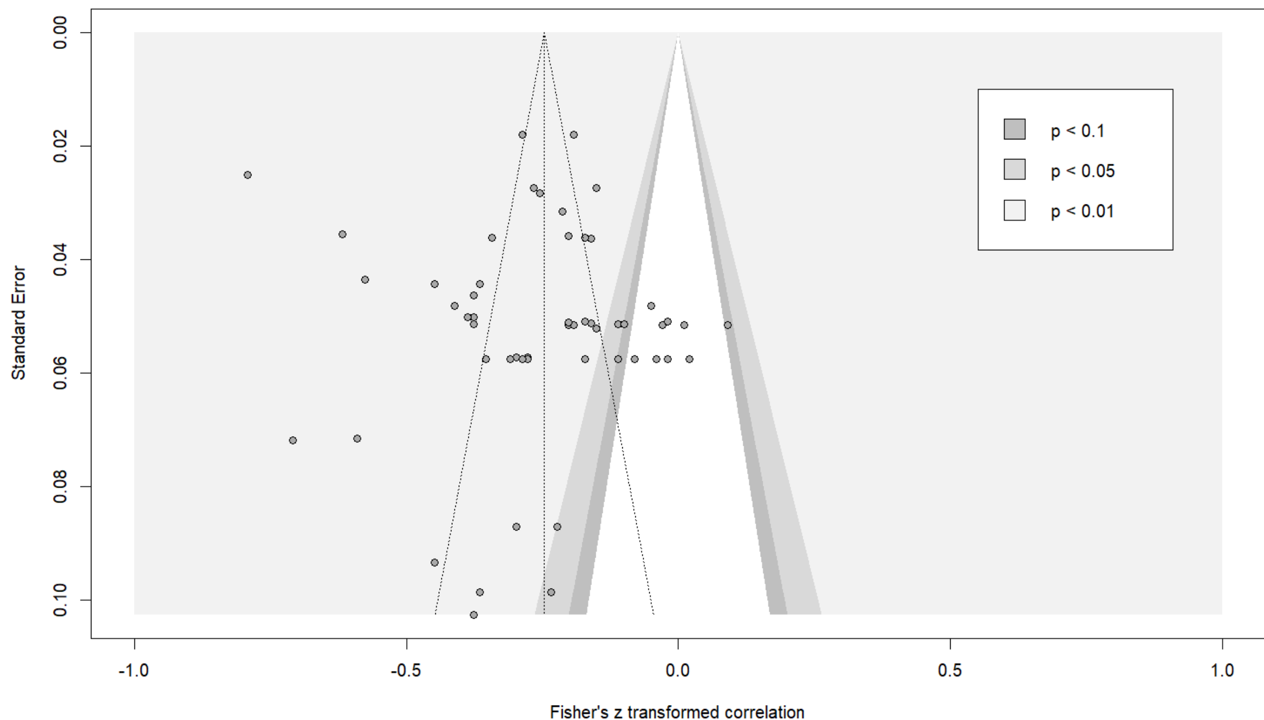
3.4 Sensitivity analyses and publication bias

Sensitivity analyses, conducted by removing 19 outlier effect sizes, returned similar results to the 57-effect meta-analysis (r = -.242, 95% CI [-.270; -.215], p < .001, I^2 = 71.7%). Only one effect size (Closson et al., in press) emerged as both an outlier and an influential case (Supplemental Figure S4). This study was retained in the analyses, despite its high relative weight, because its removal did not result in statistically significant changes to either the pooled effect size (Supplemental Figure S5) or the heterogeneity score (Supplemental Figure S6).

Figure 3 presents the funnel plot of the standard meta-analysis for the critical CCAS-wellbeing correlations. Egger's test of the intercept suggests the funnel plot is not asymmetrical, and, therefore, is not indicative of publication bias. However, there were some indicators of potential publication bias for the cognitive impairment-wellbeing, functional impairment-wellbeing, and overall CCAS-depression correlations (not shown). Due to the high level of heterogeneity of each meta-analysis, the use of publication bias tests is discouraged, as they cannot provide trustworthy results (Harrer et al., 2022). Therefore, these results are merely indicative of the potential presence of publication bias, and not necessarily confirmation of it. Regardless, publication status did not significantly moderate the relationship between overall climate anxiety levels and wellbeing scores, $F(1, 55) = 1.221$, p = .27 (with the exception of the meta-analysis between depression measures and cognitive impairment), further supporting the absence of publication bias.

Figure 3

Funnel Plot for the CCAS-Wellbeing Correlations



4. Discussion

Scholars and commentators have noted the health and psychological impacts of the climate crisis (H. L. Berry et al., 2010; Pickering & Pickering, 2023). In particular, the extant literature has examined climate-induced anxiety and how it can impact people's wellbeing (Ojala et al., 2021). Contributing to this growing literature, we report a meta-analysis to quantitatively summarise the association of climate anxiety, as assessed by the pioneering and widely used Climate Change Anxiety Scale (CCAS; Clayton & Karazsia, 2020), and psychological wellbeing. We found a moderate negative correlation between climate anxiety scores from the CCAS and psychological wellbeing measures. The direction of the meta-analytical estimate supports the idea of climate anxiety as an impairing cognitive and emotional experience associated with symptoms

of psychological disorders (such as depression and anxiety) and other indicators of mental illbeing. However, the direction of the wellbeing measure used significantly moderated the relationship between the two variables, so that correlations were stronger for negative measures compared to positive measures.

This meta-analysis follows in the footsteps of recent narrative systematic reviews of the emerging climate anxiety literature (e.g., Ojala et al., 2021; Soutar & Wand, 2022), and complements them by quantitatively summarizing results from empirical studies that met our inclusion criteria. We observed similar tendencies in the studies as previous reviews have outlined. Most of the studies we included were cross-sectional, from Western countries, and focusing on the general population. Furthermore, these reviews describe a mixed pattern of results regarding associations between climate anxiety and psychological wellbeing. Despite the wide range of correlations that were included in our study, the large majority were negative. This suggests that though some studies may report practical forms of climate anxiety, the association between climate anxiety (as indexed by the CCAS) and wellbeing, as portrayed in the literature, is predominantly negative.

4.1 Climate anxiety is negatively associated with wellbeing

Climate anxiety and related conceptualizations have long been thought of as unpleasant and impairing (Dailianis, 2021; Fritze et al., 2008). People reporting these experiences have described experiencing a variety of physical and psychological symptoms, sometimes intense enough to require psychotherapeutic help (Clayton, 2020; Hickman, 2020; Ogunbode et al., 2023; Soutar & Wand, 2022). The moderate negative correlation we found between climate anxiety and psychological wellbeing supports these earlier observations, and is in line with findings from a narrative review on climate anxiety (Ojala et al., 2021). The observed negative correlation is also consistent

with the process model of eco-anxiety and eco-grief (Pihkala, 2022b). When a person becomes aware of climate change as a threat, there is a period of awakening and a feeling of shock and potential trauma that can lead to fundamental beliefs being shattered, major life changes, and the use of maladaptive coping efforts (Doherty & Clayton, 2011). These emotions can either quickly fuel motivation for behaving more sustainably and adapting to this looming threat or trigger a cascade of increasingly more intense periods of stress, anxiety and depression. These stronger negative emotions are always a possible outcome. To avoid it, a person needs to balance acting pro-environmentally, acknowledging the feelings of loss and worry they experience, and consciously disconnecting from climate change to engage in self-care and re-energize (Pihkala, 2022b). Fluctuations between stronger negative states and successful adaptation to climate anxiety are expected and natural.

Studies using measures other than the CCAS to assess forms of climate change distress further support an association between these forms of climate-related-emotions and psychological illbeing. To illustrate, depression, anxiety and stress symptoms correlate positively with measures of eco-anxiety (Hogg et al., 2021; Stanley, Hogg, et al., 2021), climate change distress and impairment (Hepp et al., 2023; Searle & Gow, 2010), climate change worry (Gago & Sá, 2021; Stewart, 2021), and ecological stress (Lutz et al., 2023).

The development method of the CCAS may also contribute to the strength of the pooled effect size we observed. Its items originate from scales that are themselves measures of clinically relevant symptoms (e.g., rumination), and therefore inherently related to psychopathology. There is enough content overlap between the CCAS items and some of the wellbeing measures used in the included studies, namely the most frequently used one, the General Anxiety Disorder (Spitzer et al., 2006), to potentially

slant the results of correlational studies towards a stronger relationship (McBride, et al., 2021; Ojala et al., 2021). The direction of the wellbeing measure plays a significant role in supporting this idea. In the CCAS, all items have a negative orientation (see Table 1), making them more similar to items in negative wellbeing measures (e.g., “My concerns about climate change make it hard for me to have fun with my family or friends” and “I couldn't seem to get any enjoyment out of the things I did”; Lovibond & Lovibond, 1995). As a result, stronger correlations are expected in this direction. In fact, many of the included studies used negative wellbeing measures, which may have influenced the results to favour a stronger correlation between CCAS scores and wellbeing. The tendency to use negative measures when assessing wellbeing may thus contribute to an over-pathologizing of climate anxiety. Future studies should include a balanced number of positive and negative measures of wellbeing and compare results between these two types of measures to account for the potential impact of content overlap and avoid skewed results.

The moderating effect observed for the direction of the wellbeing measure could also be related to the specific aspects of wellbeing that each type of measure assesses, and how they may be differently related to climate anxiety. Whereas negative measures from the included studies focus primarily on negative affect, unpleasant thoughts, and uncontrollability (e.g., Lovibond & Lovibond, 1995; Spitzer et al., 2006), positive measures tend to focus on positive affect (e.g., Watson et al., 1988), acceptance (e.g., Medvedev et al., 2018), and satisfaction of psychological needs (e.g., Schmidt et al., 2006; Sheldon & Hilpert, 2012). It is possible that climate anxiety is less related to a lack of these pleasant aspects, as it is associated with the presence of unpleasant characteristics. A longitudinal study found climate concern was significantly associated with psychological distress after a 1-year period, but not to personal wellbeing

(McBride et al., 2021). Another study found that environmental worry was directly related to psychopathological symptoms (a negative indicator of wellbeing) but not to life satisfaction (a positive indicator of wellbeing), and that the negative association between environmental worry and life satisfaction was mediated by psychopathological symptoms (Gago & Sá, 2021). Thus, climate anxiety may be indirectly associated with difficulties in psychological flourishing. The negative feelings, thoughts, and inability to regulate them that are hallmark features of climate anxiety could be the bridges that link it to other core features characterized by the absence of positive emotions, such as hopelessness and lower quality of life.

Despite accounting for the effect of some significant moderators, namely wellbeing measure direction, there is still a large portion of heterogeneity in results that is left unexplained. This means we did not include important variables that have an effect on the association between climate anxiety and wellbeing, as they were not measured in the included studies. The process model of climate anxiety highlights three dimensions of adapting to climate anxiety (Pihkala, 2022b). We found pro-environmental behaviour did not act as a moderator of this association, but we did not account for the other two dimensions – self-care and emotional engagement. Self-care corresponds to a healthy form of distancing from engaging with climate change and the negative emotions associated with it, whereas emotional engagement refers to actively processing and working through these emotions. To successfully cope with and adapt to climate anxiety, a person needs a healthy and balanced dose of all three of these dimensions. Thus, imbalances between these facets may contribute to explaining why some studies found stronger associations between climate anxiety and wellbeing.

Another potential moderator variable of interest is pre-existing psychopathology. People with mental health and stress-related disorders can experience more intense

symptoms following traumatic events (Dodgen et al., 2016). Coming to grips with climate anxiety can involve feelings of surprise, shock, and even trauma (Kaplan, 2020; Pihkala, 2022c, 2022b). Those who are already struggling with mental health issues will have limited coping resources, and the process of gaining awareness and having to cope with distressing feelings of climate anxiety may push them over the tipping point (Clayton et al., 2021). Hence, a study whose sample included people with pre-existing psychopathology would expect to find stronger associations between climate anxiety and wellbeing variables.

Previous works have also suggested feelings of meaningfulness and positive emotions can influence how climate anxiety and wellbeing outcomes are associated. Climate anxiety can tap into existential questions such as identity, meaning, and death (Budziszewska & Jonsson, 2021; Dailianis, 2021). Existential concerns are a crucial and natural aspect of a person's life, and trying to avoid them can have negative implications for wellbeing. One study examining the link between environmental worry and subjective wellbeing in teenagers using a person-oriented approach found one subgroup of people who experienced high levels of climate anxiety and lower wellbeing, as well as another subgroup that had high levels of climate anxiety but higher wellbeing scores (Ojala, 2005). Three existential emotions – meaningfulness, hope, and anger (as well as trust in environmental organizations) –were stronger and more frequent in the high wellbeing group than on the low wellbeing group, with meaningfulness emerging as the most powerful predictor of differences between the two groups. The author suggested that these emotions could function as buffers to protect from the negative psychological consequences of environmental worry. Clayton et al. (2021) point out that finding a source of personal meaning, such as engaging in religious practices or mindfulness, can help in building personal resilience and even experiencing post-traumatic growth. These

positive emotions may thus also explain how some people are able to withstand greater levels of climate anxiety without much impact on their psychological wellbeing.

4.2 Implications

Our results have important implications for the study of climate anxiety. First, they reassert the need to include assessments of indirect, vicarious impacts of climate change on psychological wellbeing. Mental health is already overlooked in comparison to the direct impacts, particularly on physical health, in the context of climate change (Charlson et al., 2022). The World Health Organization (2022) describes mental health as a basic human right, and mental health problems as a major cause of death and disability around the world, which lead to major economic losses for nations. Including measures of climate anxiety in holistic assessments of individual and community-level impacts of climate change, provides knowledge of where resources must be allocated to prevent the exacerbation of symptoms (cf. Hayes & Poland, 2018).

Related to that, the method of assessing climate anxiety needs to be carefully considered due to the implications it may have for results. Self-report questionnaires are often used in these types of studies (Hayes & Poland, 2018) as they are economic and easy to compare, making them ideal for continued monitoring. As our study shows, the specific measures used to assess wellbeing can have important implications for the results and the inferences that can be made from them. To avoid biased interpretations of associations between variables, studies should not rely solely on negative measures of wellbeing and should include a positive (or at least mixed) measure. Some level of content overlap is inevitable, given climate anxiety's similarities to mental health disorders like anxiety and depression (another eco-anxiety measure, the Hogg eco-anxiety scale, was also modelled on a measure of psychopathology, the GAD-7; Hogg et al., 2021). However, an increasing understanding of the specific construct of climate

anxiety as something similar but fundamentally unique from other forms of psychological distress, could lead to the development of measures that are better able to differentiate these experiences and provide a clearer picture of how they are associated.

4.3 Limitations

Despite its strengths, our meta-analysis has some limitations that warrant discussion. First, we did not perform any formal quality assessment of the included studies (e.g., including only pre-registered studies, with a-priori power analysis). A recent set of meta-analyses on the effects of growth mindset on student's academic achievement revealed that the quality of the studies included can significantly impact the results of the meta-analysis (Macnamara & Burgoyne, 2023). Nineteen of our included studies (76%) were not pre-registered. By not employing these restrictions, we were able to include a larger number of studies and increase the robustness of our results, at the expense of risking the capturing of methodological flaws and biases in the original studies.

Second, because researchers can differ in the methods they used to calculate correlations and in how to report them, we made an effort to collect the raw data from the studies' authors so we could more systematically calculate the effect sizes and minimize this source of error. Nevertheless, we were unable to obtain the raw data for all studies and relied on the original reported values for some. Likewise, many studies did not measure our moderator variables, and very few measured all of them, resulting in smaller sample sizes for our moderator analyses and lower statistical power. This was especially problematic the more specific the meta-analysis was, and when modelling all moderators simultaneously. Third, the high heterogeneity scores precluded any meaningful assessment of publication bias. We thus relied on more informal methods like visually inspecting the funnel plot and moderation analyses.

Fourth, and importantly, despite the well-documented negative association that we also found in our meta-analysis, the correlational nature of current climate anxiety studies does not allow for causal inferences to be made (Ojala et al., 2021). It is as possible for climate anxiety to lead to the development of negative emotions and psychopathological symptoms, as it is for people with psychopathological symptoms to pay more attention to threatening climate information or view it from a more negative perspective (Beevers et al., 2015; MacLeod et al., 1986), or for a third underlying variable to influence both climate anxiety and psychological wellbeing (Ojala et al., 2021). To our knowledge, only one study has so far employed a longitudinal design to investigate the temporal relationship between climate change concern and psychological wellbeing, suggesting that climate concern may cause psychological distress (though it was not related to life satisfaction; McBride et al., 2021). More longitudinal and experimental research on this topic is needed.

While our meta-analyses are unable to provide any new insight about the flow of causation between climate anxiety and psychological wellbeing, it raises questions about whether these variables should be considered separately given their conceptual overlaps. Our results suggest that content overlap may explain why CCAS scores are more strongly associated with measures of psychological illbeing. However, climate anxiety and illbeing should not be seen as the same thing, given the variety of possible outcomes a person experiencing climate anxiety and other climate-change emotions may follow (Doherty & Clayton, 2011). There is thus a discrepancy between how researchers conceptualize climate anxiety theoretically and how they measure it empirically. Disentangling climate anxiety from general psychological wellbeing is important for future research aimed at examining more closely the nature and direction of the relationship between these two constructs (c.f. Hodson, 2021).

4.4 Future studies

Future studies could build on our findings by conducting meta-analyses with emerging measures of climate anxiety. The Hogg eco-anxiety scale (Hogg et al., 2021), for example, has seen increased use in this context (Hogg, Stanley, & O'Brien, 2023) and will soon have been used in enough empirical studies to warrant a meta-analysis of its own, as will other emergent measures. This will allow researchers to establish whether the pattern of results we found extends to other measures of climate change anxiety, or if they are specific to the CCAS. Similarly, climate change evokes other emotions alongside anxiety, such as anger, guilt and hope (Ágoston, Csaba, et al., 2022; Pihkala, 2022c). These emotions could be the target of similar meta-analyses as different emotions could have different patterns of association with psychological wellbeing. Lastly, work is needed on identifying which variables can account for the heterogeneity in the association between climate anxiety and psychological wellbeing. We explored some of these variables and proposed potential initial avenues of research (emotional engagement and self-care, pre-existing psychopathology, as well as meaningfulness and positive emotions). The variety of correlational studies that have focused on associations between climate anxiety and numerous other variables is a good indicator of how many possibilities there are in this area of research. It is a matter of systematically testing which of these have a significant moderating effect. Moderating variables may help explain why some people are more vulnerable than others when it comes to the psychopathological outcomes of climate anxiety and may suggest new targets for interventions aimed at limiting the debilitating impacts of climate anxiety. Our study provides an additional contribution to the growing literature investigating the mental health impacts of climate change.

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Wullenkord, M. C., Tröger, J., Hamann, K. R. S., Loy, L. S., & Reese, G. (2021). Anxiety and climate change: a validation of the Climate Anxiety Scale in a German-speaking quota sample and an investigation of psychological correlates. *Climatic Change*, *168*(3–4). https://doi.org/10.1007/s10584-021-03234-6

Supplemental materials

Supplemental Material S1

Search Strategy

(Values in parentheses correspond to the number of results yielded by each search)

- Databases searched (92) – search conducted on March 29th, 2023
  - Search strings:
    - “Climate anxiety scale” OR “Climate change anxiety scale”
    - Search starting from 2019
- EBSCOHost (6)
  - All databases, full text
- APA Psychnet (6)
  - All databases, full text
- JSOTR (0)
  - All databases, full text
- Proquest (26)
  - All databases, full text
- Sage journals (0)
  - Full text
- SCOPUS (46)
  - Full text
- SSRN (8)
  - Full text
- Web of Knowledge
  - Couldn’t access

- Reference lists examined
  - Clayton and Karazsia (2020), using Google Scholar (292) – March 30th, 2023

- Contacted authors who have published articles using the CCAS and authors who wrote seminal works on climate/eco-anxiety in the past (0) – March 27th, 2023
  - Message:

Hello Dr. ____,
Firstly, I wanted to thank you again for helping us in the early stages of our project. We have since put up a pre-registration for our meta-analysis on OSF, which you can access via this link (https://doi.org/10.17605/OSF.IO/GKXM6), if you are interested in following our progress.
We are continuing our efforts in collecting all the data we can gather on the relationship between climate anxiety and wellbeing. We are now extending our reach even further, by getting in contact with various associations and networks that would be interested in the outcomes of our research. To that end, if you belong to or know of any such collective that aligns with our objectives, we would once again be very grateful if you could share with them the request below.
Thank you for your time and consideration.
Best regards,
Tomás Gago

Dear colleagues,

We are in the process of conducting a meta-analysis of studies that used Clayton and Karazsia's 2020 instrument, the CCAS (the Climate Change Anxiety Scale) to assess climate anxiety and how this variable is related to different measures of psychological wellbeing, both in the form of negative (such as psychopathology symptoms) and positive indicators (i.e. life satisfaction, positive emotions, ...).
We are looking not only for published studies, but also unpublished manuscripts, preprints, dissertations, conference presentations, raw data, and works in progress that match the following criteria:
- Studies must assess climate anxiety as indexed by the CCAS and at least one measure of psychological wellbeing, defined as adverse effects on mental health and variables indicative of one's ability to flourish
- Studies must provide correlation coefficients, or other data that allows for its calculation (or authors provide usable data upon request)
- Studies must be written in English, Portuguese, or Spanish
If you have any studies or data that may match these criteria (regardless of the study's results) and you would like it to be included in our meta-analysis, we would be very grateful if you would share them with us to the following email address: tomasoomgago@gmail.com
Let us know how you would like your work to be cited. We would also appreciate it if you could forward this message to any colleagues that are working on relevant research to our project. The pre-registration for this study is available on OSF (https://doi.org/10.17605/OSF.IO/GKXM6).
We will be more than happy to clarify any questions you may have. You can reach us at the email above. Thank you very much for your time and consideration.
Best regards,
Tomás Gago
Dr. Rebecca Sargisson
Dr. Taciano Milfont
University of Waikato, Tauranga, New Zealand

  - A reminder email was sent during data collection requesting access to raw data if no response was received

- Contacted psychological associations across the world – March 28th, 2023 (7)
  - Message:

Dear ____,
My name is Tomás Gago. I am a psychology student from Portugal just starting my PhD at Waikato University in New Zealand, under the supervision of Dr. Rebeca Sargisson and Dr. Taciano Milfont. The topic of my research is climate anxiety, and I am particularly interested in the Climate Change Anxiety Scale as a means of quantifying and examining this phenomenon.
The first stage of my PhD is conducting a meta-analysis of the studies that have used this questionnaire. To that end, we were hoping you could help us circulate the message attached below through your network's mailing list, if you believe it aligns with your goals as well, so we could reach as far of an audience as we can.
Thank you for your time and consideration of our request.
Best regards,
Tomás Gago

Dear colleagues,
We are in the process of conducting a meta-analysis of studies that used Clayton and Karazsia's 2020 instrument, the CCAS (the Climate Change Anxiety Scale) to assess climate anxiety and how this variable is related to different measures of psychological wellbeing, both in the form of negative (such as psychopathology symptoms) and positive indicators (i.e. life satisfaction, positive emotions, ...).
We are looking not only for published studies, but also unpublished manuscripts, preprints, dissertations, conference presentations, raw data, and works in progress that match the following criteria:
- Studies must assess climate anxiety as indexed by the CCAS and at least one measure of psychological wellbeing, defined as adverse effects on mental health and variables indicative of one's ability to flourish
- Studies must provide correlation coefficients, or other data that allows for its calculation (or authors provide usable data upon request)
- Studies must be written in English, Portuguese, or Spanish
If you have any studies or data that may match these criteria (regardless of the study's results) and you would like it to be included in our meta-analysis, we

would be very grateful if you would share them with us to the following email address:
tomasoomgago@gmail.com
Let us know how you would like your work to be cited. We would also appreciate it if you could forward this message to any colleagues that are working on relevant research to our project. The pre-registration for this study is available on OSF (https://doi.org/10.17605/OSF.IO/GKXM6).
We will be more than happy to clarify any questions you may have. You can reach us at the email above. Thank you very much for your time and consideration.
Best regards,
Tomás Gago
Dr. Rebecca Sargisson
Dr. Taciano Milfont
University of Waikato, Tauranga, New Zealand

- APA Div 34
- SASP (responded March 27th; 5)
- EASP (responded April 4th; 1)
- NZPS (responded March 29th; couldn't send out call for data)
- Ora Taiao (responded March 28th)
- CPA
- EPG Groningen
- Ecopsi Portugal
- AASP (responded April 6th, couldn't send out call for data)
- PAPU
- NLPA
- IIAP Div 4
- DGPs (responded March 31st; 1)
- SIP
- Psicamb (responded March 31st)
- SBP (responded April 12th)
- IACCP

- Google scholar alarm for "Climate anxiety"/ "Eco-anxiety" (4)

Supplemental Table S2

Pooled Effect Sizes, Heterogeneity and Moderators of all Meta-Analyses Performed

Meta-analysis	*k*	*s*	*r*	95% CI	Effect-size level τ^2	Sample level τ^2	I^2	Moderators	*β* [95% CI]	*F*(df1, df2)	I^2
Wellbeing											
CCAS	57	23	-.296***	[-.360; -.230]	.010	.022	94.58%	Gender (f)	.004 [-.002; .010]	*F*(1, 53)=1.682	
								Age	-.001 [-.006; .005]	*F*(1, 47)=.094	
								Personal experience	-.007 [-.018; .005]	*F*(1, 12)=1.528	
								PEB	.000 [-.001; .001]	*F*(1, 36)=.000	
								Environmental identity	.011 [.002; .021]	*F*(1, 19)=5.988*	
								Year	.095 [-.002; .192]	*F*(1, 55)=3.819	
								Publication status (pub)	.082 [-.067; .231]	*F*(1, 55)=1.221	
								Wellbeing direction (pos)	.170 [.105; .234]	*F*(1, 55)=27.924***	
								Scale reliability	-1.459 [-3.844; .926]	*F*(1, 48)=1.512	
								Number of factors	-.049 [-.143; .046]	*F*(1, 54)=1.058	
								Environmental identity	.009 [-.000; .018]	*F*(3, 17)=12.902***	76.33%
								Year	.060 [-.066; .186]		
								Wellbeing direction	.215 [.116; .314]		
CCAS [a]	38		-.242***	[-.270; -.215]	.005		71.70%				

Meta-analysis	*k*	*s*	*r*	95% CI	Effect-size level τ^2	Sample level τ^2	I^2	Moderators	*β* [95% CI]	*F*(df1, df2)	I^2
Cognitive Impairment	50	18	-.273***	[-.346; -.197]	.010	.022	92.70%	Gender (f)	.001 [-.002; .005]	*F*(1, 46)=.765	
								Age	-.001 [-.007; .005]	*F*(1, 37)=.144	
								Personal experience	-.007 [-.017; .004]	*F*(1, 14)=1.920	
								PEB	-.000 [-.009; .008]	*F*(1, 37)=.004	
								Environmental identity	.011[.000; .021]	*F*(1, 19)=4.674*	
								Year	.093 [-.007; .193]	*F*(1, 48)=3.479	
								Publication status (pub)	-.007 [-.177; .164]	*F*(1, 48)=.006	
								Wellbeing direction (pos)	.189 [.127; .251]	*F*(1, 48)=37.221***	
								Scale reliability	-.660 [-1.690; .369]	*F*(1, 42)=1.675	
								Number of factors	-.089 [-.202; .024]	*F*(1, 47)=2.523	
								Environmental identity	.007 [-.002; .017]	*F*(3, 17)=15.844***	77.02%
								Year	.068 [-.070; .206]		
								Wellbeing direction	.230 [.146; .315]		
Cognitive Impairment [b]	32		-.211***	[-.242; -.179]	.005		61.30%				
Functional Impairment	50	19	-.252***	[-.319; -.182]	.007	.020	91.93%	Gender (f)	.001 [-.002; .004]	*F*(1, 49)=.538	
								Age	-.002 [-.007; .003]	*F*(1, 40)=.669	
								Personal experience	-.005 [-.015; .005]	*F*(1, 14)=1.218	
								PEB	.002 [-.007; .010]	*F*(1, 37)=.152	
								Environmental identity	.011 [.003; .019]	*F*(1, 19)=9.034**	
								Year	.091 [-.003; .185]	*F*(1, 51)=3.760	
								Publication status (pub)	.022 [-.136; .180]	*F*(1, 51)=.078	
								Wellbeing direction (pos)	.145 [.085; .205]	*F*(1, 51)=23.639***	
								Scale reliability	-.703 [-1.791; .385]	*F*(1, 45)=1.696	

Meta-analysis	*k*	*s*	*r*	95% CI	Effect-size level τ^2	Sample level τ^2	I^2	Moderators	*β* [95% CI]	*F*(df1, df2)	I^2
								Number of factors	-.060 [-.163; .043]	$F(1, 50)=1.384$	
								Environmental identity	.010 [.003; .016]	$F(3, 17)=13.119^{***}$	65.09%
								Year	.041 [-.045; .126]		
								Wellbeing direction	.166 [.068; .265]		
Functional Impairment [c]	36		$-.190^{***}$	[-.216; -.164]	.003		54.00%				
Depression											
CCAS	15	13	$-.262^{***}$	[-.346; -.174]	.000	.021	90.08%	Gender (f)	-.000 [-.007; .007]	$F(1, 13)=.000$	
								Age	-.000 [-.006; .006]	$F(1, 11)=.002$	
								Personal experience	-.004 [-.024; .017]	$F(1, 4)=.235$	
								PEB	-.002 [-.011; .007]	$F(1, 9)=.289$	
								Environmental identity	.009 [-.006; .023]	$F(1, 4)=2.780$	
								Year	.105 [.005; .204]	$F(1, 13)=5.150^{*}$	
								Publication status (pub)	-.180 [-.373; .014]	$F(1, 13)=4.024$	
								Scale reliability	-2.072 [-4.348; .205]	$F(1, 11)=4.013$	
								Number of factors	-.081 [-.188; .026]	$F(1, 12)=2.697$	
								Year	.090 [.020; .160]	$F(3, 9)=10.383^{**}$	54.02%
								Publication status	-.105 [-.303; .093]		
								Scale reliability	-2.778 [-4.269; -1.286]		
CCAS [d]	12		$-.236^{***}$	[-.283; -.189]	.004		64.4%				
Cognitive Impairment	15	13	$-.263^{***}$	[-.342; -.180]	.000	.019	87.53%	Gender (f)	-.001 [-.005; .003]	$F(1, 14)=.303$	
								Age	-.000 [-.006; .005]	$F(1, 10)=.030$	
								Personal experience	-.004 [-.019; .011]	$F(1, 5)=.481$	

Meta-analysis	*k*	*s*	*r*	95% CI	Effect-size level τ^2	Sample level τ^2	I^2	Moderators	*β* [95% CI]	*F*(df1, df2)	I^2
								PEB	-.003 [-.010; .005]	$F(1, 10)=.579$	
								Environmental identity	.007 [-.007; .021]	$F(1, 4)=2.155$	
								Year	.092 [-.005; .188]	$F(1, 14)=4.132$	
								Publication status (pub)	-.169 [-.331; -.006]	$F(1, 14)=4.970^{*}$	
								Scale reliability	-1.167 [-2.105; -.230]	$F(1, 13)=7.233^{*}$	
								Number of factors	-.079 [-.185; .027]	$F(1, 13)=2.621$	
								Year	.082 [.010; .155]	$F(3, 11)=7.579^{**}$	62.42%
								Publication status	-.034 [-.170; .102]		
								Scale reliability	-1.239 [-2.030; -.447]		
Cognitive Impairment [d]	13		$-.234^{***}$	[-.277; -.190]	.003		58.4%				
Functional Impairment	17	14	$-.227^{***}$	[-0.295; -0.156]	.000	.014	84.89%	Gender (f)	-.002 [-.005; .002]	$F(1, 15)=.893$	
								Age	-.001 [-.006; .004]	$F(1, 11)=.146$	
								Personal experience	-.003 [-.018; .013]	$F(1, 5)=.176$	
								PEB	-.001 [-.008; .006]	$F(1, 10)=.129$	
								Environmental identity	.009 [-.003: .021]	$F(1, 4)=4.759$	
								Year	.099 [.020; .177]	$F(1, 15)=7.208^{*}$	
								Publication status (pub)	-.139 [-.283; .005]	$F(1, 15)=4.239$	
								Scale reliability	-.964 [-1.783; -.144]	$F(1, 14)=6.362^{*}$	
								Number of factors	-.056 [-.147; .036]	$F(1, 14)=1.706$	
								Year	.092 [.039; .146]	$F(3, 12)=11.733^{***}$	38.8%
								Publication status	.007 [-.091; .105]		
								Scale reliability	-1.012 [-1.582; -.442]		

Meta-analysis	*k*	*s*	*r*	95% CI	Effect-size level τ^2	Sample level τ^2	I^2	Moderators	*β* [95% CI]	*F*(df1, df2)	I^2
Functional Impairment [d]	14		-.207***	[-.246; -.167]	.003		54.20%				
Anxiety											
CCAS	22	19	-.300***	[-.368; -.230]	.002	.020	90.29%	Gender (f)	.002 [-.005; .008]	*F*(1, 18)=.280	
								Age	.002 [-.007; .010]	*F*(1, 15)=.163	
								Personal experience	-.005 [-.018; .008]	*F*(1, 6)=1.052	
								PEB	-.000 [-.008; .007]	*F*(1, 12)=.005	
								Environmental identity	.012 [.005; .020]	*F*(1, 4)=21.443**	60.92%
								Year	.075 [-.022; .171]	*F*(1, 20)=2.602	
								Publication status (pub)	.064 [-.098; .225]	*F*(1, 20)=.680	
								Scale reliability	-2.081 [-4.613; .452]	*F*(1, 17)=3.005	
								Number of factors	-.022 [-.124; .081]	*F*(1, 19)=.197	
CCAS [e]	17		-.304***	[-.352; -.253]	.007		73.00%				
Cognitive Impairment	21	17	-.281***	[-.339; -.222]	.001	.012	83.22%	Gender (f)	-.001 [-.005; .002]	*F*(1, 17)=..546	
								Age	.001 [-.005; .008]	*F*(1, 12)=.161	
								Personal experience	-.005 [-.015; .005]	*F*(1, 7)=1.546	
								PEB	-.001 [-.008; .006]	*F*(1, 12)=.103	
								Environmental identity	.011 [.004; .018]	*F*(1, 4)=20.169*	
								Year	.069 [-.007; .145]	*F*(1, 19)=3.640	
								Publication status (pub)	-.034 [-.172; .103]	*F*(1, 19)=.275	
								Scale reliability	-1.144 [-2.073; -.216]	*F*(1, 17)=6.764*	
								Number of factors	-.049 [-139; .041]	*F*(1, 18)=1.318	
								Environmental identity	-.001 [-.162; .160]	*F*(3, 1)=4.282	70.09%
								Year	-.032 [-.990; .926]		

Meta-analysis	*k*	*s*	*r*	95% CI	Effect-size level τ^2	Sample level τ^2	I^2	Moderators	*β* [95% CI]	*F*(df1, df2)	I^2
								Scale reliability	-5.036 [-60.405; 50.333]		
Cognitive Impairment [f]	17		-.278***	[-.320; -.236]	.005		66.00%				
Functional Impairment	22	18	-.237***	[-.298; -.174]	.001	.014	82.90%	Gender (f)	-.001 [-.004; .003]	*F*(1, 18)=.074	
								Age	-.000 [-.007; .007]	*F*(1, 13)=.003	
								Personal experience	-.004 [-.016; .008]	*F*(1, 7)=.738	
								PEB	.001 [-.006; .008]	*F*(1, 12)=.038	
								Environmental identity	.012 [.005; .018]	*F*(1, 4)=25.622**	
								Year	.075 [-.006; .156]	*F*(1, 20)=3.775	
								Publication status (pub)	-.002 [-.148; .145]	*F*(1, 20)=.001	
								Scale reliability	-.576 [-1.598; .445]	*F*(1, 18)=1.405	
								Number of factors	-042 [-.133; .048]	*F*(1, 19)=.960	
								Environmental identity	.013 [-.001; .026]	*F*(2, 3)=10.294*	59.8%
								Year	-.020 [-.217; .176]		
Functional Impairment [g]	18		-.216***	[-.261; -.170]	.006		67.00%				

Note. [a] Effect sizes dropped: “Clayton & Karazsia”, "Clayton & Karazsia", "Cruz & High", "Closson/Card et al.", "Closson/Card et al.", "Hepp et al.", "Hepp et al.", "Hepp et al.", "Niskanen", "Reyes et al.", "Reyes et al.", "Lutz et al.", "Lutz et al.", "Lutz et al.", "Lutz et al.", "Lutz et al.", "Lutz et al.", "Mouguiama-Daouda et al.", "Coelho et al.".

[b] Effect sizes dropped: "Clayton & Karazsia", "Clayton & Karazsia", "Cruz & High", "Cruz & High", "Closson/Card et al.", "Closson/Card et al.", "Feather & Williams (a)", "Hepp et al.", "Hepp et al.", "Hepp et al.", "Reyes et al.", "Reyes et al.", "Lutz et al.", "Lutz et al.", "Lutz et al.", "Lutz et al.", "Mouguiama-Daouda et al.", "Coelho et al.".

[c] Effect sizes dropped: "Clayton & Karazsia", "Clayton & Karazsia", "Cruz & High", "Feather & Williams (b)", "Closson/Card et al.", "Closson/Card et al.", "McBride", "Hepp et al.", "Hepp et al.", "Hepp et al.", "Rámirez-López et al.", "Reyes et al.", "Lutz et al.", "Lutz et al.", "Lutz et al.", "Mouguiama-Daouda et al.", "Coelho et al.".

[d] Effect sizes dropped: "Clayton & Karazsia", "Clayton & Karazsia", "Hepp et al.". [e] "Clayton & Karazsia", "Feather & Williams (b)", "Niskanen", "Mouguiama-Daouda et al.", "Coelho et al.".

[f] Effect sizes dropped: "Clayton & Karazsia", "Clayton & Karazsia", "Mouguiama-Daouda et al.", "Coelho et al.".

[g] Effect sizes dropped: "Clayton & Karazsia", "Clayton & Karazsia", "Cruz & High", "Mouguiama-Daouda et al.".

$^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$

Supplemental Table S3

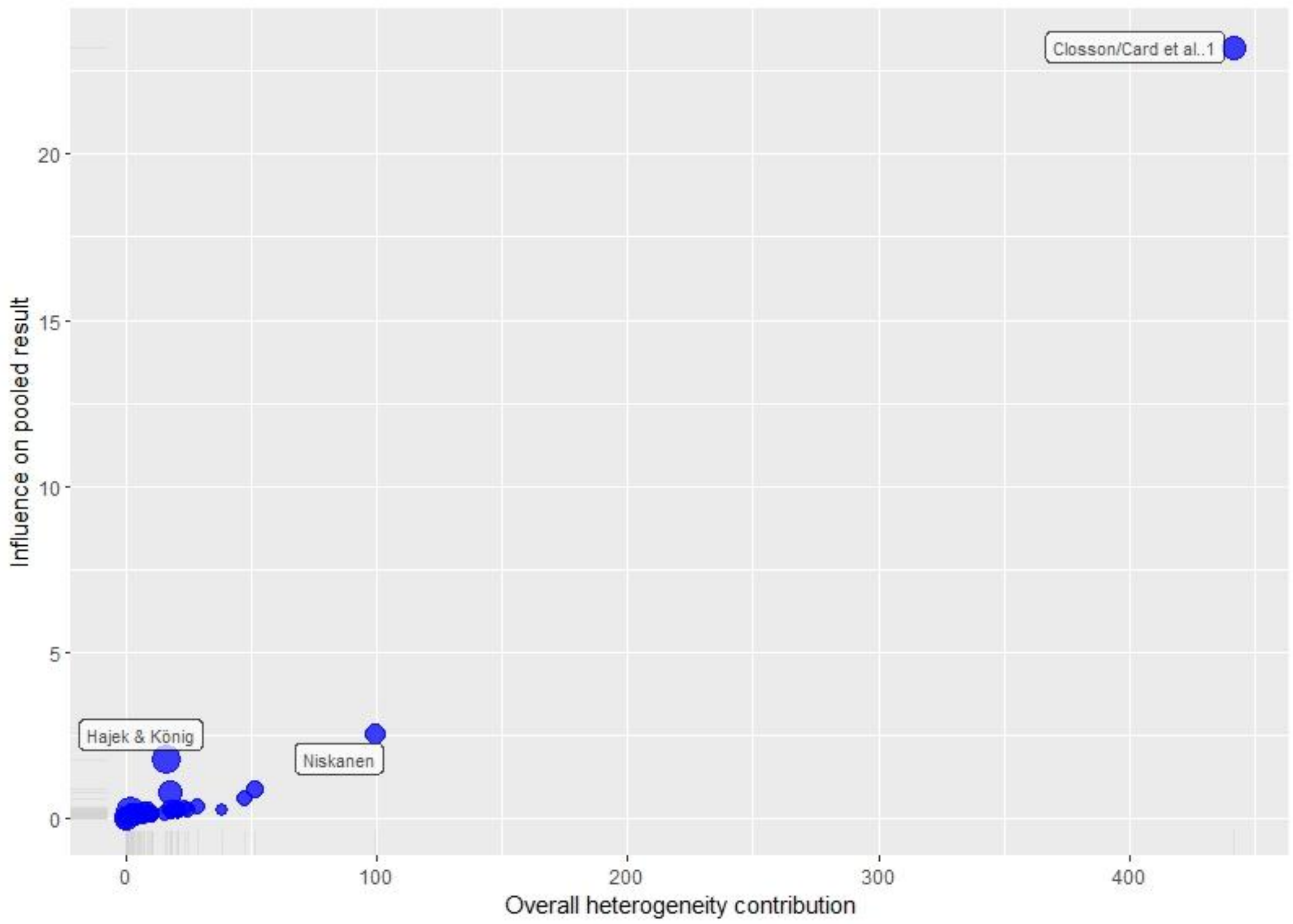
Standard Meta-Analyses Results

Meta-analysis	*k*	*r*	95% CI	τ^2	I^2
Wellbeing					
CCAS	57	$-.242^{***}$	[-.287; -.196]	.031	94.8%
Cognitive Impairment	50	$-.222^{***}$	[-.270; -.172]	.030	94.2%
Functional Impairment	50	$-.204^{***}$	[-.248; -.160]	.025	93.5%
Depression					
CCAS	15	$-.278^{***}$	[-.366; -.185]	.027	88.6%
Cognitive Impairment	16	$-.272^{***}$	[-.352; -.189]	.023	86.4%
Functional Impairment	17	$-.236^{***}$	[-0.305; -0.163]	.017	83.3%
Anxiety					
CCAS	22	$-.302^{***}$	[-.366; -.235]	.023	90.5%
Cognitive Impairment	21	$-.282^{***}$	[-.338; -.223]	.015	81.5%
Functional Impairment	22	$-.237^{***}$	[-.296; -.176]	.016	82.9%

$^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$

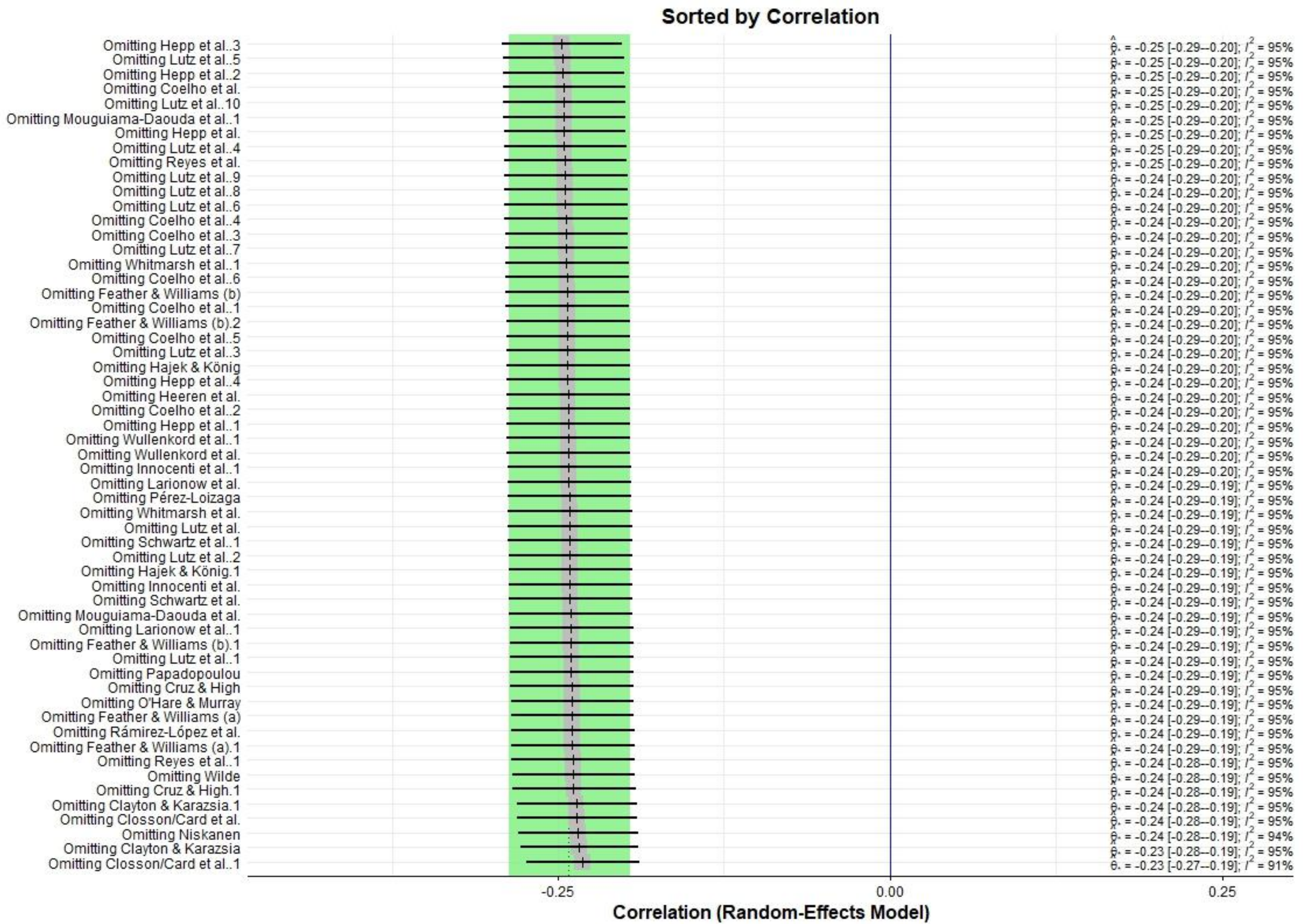
Supplemental Figure S4

Baujat Plot for CCAS-Wellbeing Meta-Analysis



Supplemental Figure S5

"Leave-one-out" Effect Size Plot for CCAS – Wellbeing Meta-Analysis



Supplemental Figure S6

“Leave-one-out” Heterogen