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Predicting climate change anxiety

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ABSTRACT

Anxiety about climate change is increasing. What are its predictors? In a cross-sectional survey of 323 North Americans, six possible predictors and their interrelations were investigated: climate change knowledge, prior experience with climate change impacts, generalized anxiety disorder symptoms, climate change worry, climate change risk perception, and media exposure to climate change information. A model of the connections among them was proposed. Most hypotheses about the model's structure were supported, the model had a very good fit to the data, and it accounted for 54 percent of the variance in reported climate change anxiety. The results help to explicate who experiences climate change anxiety and suggest directions toward effective means of addressing climate-related mental health concerns. Some implications for theory and practice are offered.

The IPCC's AR6 Synthesis Report (2023) concluded that climate change has, with "very high confidence," adversely affected physical and mental health in the regions that were assessed. This makes greater understanding of the causes and impacts of climate change on mental health imperative (Bourque & Cunsolo Willox, 2014; Weissbecker, 2011). Climate change anxiety (CCA), in particular, appears to be common and increasing. As long as 17 years ago, 44% of children reported experiencing worry about the future impacts of climate change (Tucci, Mitchell, & Goddard, 2007). Based on nationally representative samples in 2014 ($N = 1275$) and 2020 ($N = 1029$), Americans who believe that severe climate anxiety will become more common increased from 27% to 44% (Kotcher, Maibach, Rosenthal, Gustafson, & Leiser-owitz, 2020).

CCA has been of increasing recent research interest (Cunsolo et al., 2020). It has been described as "… forms of that anxiety which are considerably related to the climate crisis" (Pihkala, 2020, p. 2) and as negative emotional responses evoked by experiencing events associated with climate change and extreme climate events (Clayton & Karazsia, 2020). CCA is part of eco-anxiety, the broader construct that encompasses not only the climate crisis but also other environmental calamities, such as pollution and deforestation (Haaland, 2019; Helm, Pollitt, Barnett, Curran, & Craig, 2018; Hickman, 2020; Kelly, 2017).

CCA has been linked to other mental health problems, including depression, stress, anxiety, insomnia, post-traumatic stress disorder (PTSD), grief, loss of identity, survivor guilt, hopelessness, loss of place and sense of community, and suicidal ideation (Buoli et al., 2018; Cianconi, Betrò, & Janiri, 2020; Clayton, 2020; Gifford & Gifford, 2016;

Ogunbode et al., 2021; Reyes et al., 2021; Xue, Zhu, Zheng, & Zhang, 2019). Although CCA is not recognized as an official diagnostic category, survey and anecdotal evidence illustrate that distressing levels of anxiety about climate change exist in both adults (Galst, 2017) and children (Coyle & Van Susteren, 2011). However, recent authors believe that the relation between climate change and mental health has not yet received enough attention (Monsour et al., 2022; Schwartz et al., 2022; Silverman, 2019; Wight & Middleton, 2019). In particular, a relative lack of research exists about how individuals *develop* CCA. As Chen, Bagrodia, Pfeffer, Meli, and Bonanno (2020) conclude, "… research is still needed to better understand the pathways of resilience and anxiety to identify [its] robust predictors …"

The focal point of this study was to investigate factors that may influence the development of CCA, although causal studies are impossible to conduct in this area. The present study aimed to contribute to this body of research by helping to identify possible predictors of it, as well as their interrelations. Two recent studies have examined broad sets of predictors. Whitmarsh et al.'s (2022) 13 predictors accounted for 28 percent of the variance in climate anxiety; information-seeking, climate concern, flood experience, nature relatedness, and age were the strongest predictors. Wullenkord et al.'s (2021) study of over 22 predictors accounted for 40 percent of the variance in climate anxiety. Some of the strongest were pro-environmental intentions, denial of guilt, competence satisfaction, and relatedness satisfaction. However, learning more about what predicts climate anxiety should also help policy makers design more effective intervention programs to address CCA. To that end, six possible predictors of CCA were selected for study, based on the

following review of the relevant literature.[1]

1. Six possible predictors of CCA

1.1. Climate change knowledge

Information about climate change and its dire consequences might contribute to the growing incidence of anxiety about climate change. A connection between knowledge about climate change and anxiety has been demonstrated among climate scientists, who are well-informed about climate science and predictions for the future (Coyle & Van Susteren, 2011). Even for non-professionals, the internet now provides access to much distressing information about climate change and its hypothesized effects for centuries to come (Albrecht, 2011).

Evidence about the relation between knowledge about climate change and climate anxiety is mixed. Despite the low level of general knowledge about climate change among younger people, high levels of concern and anxiety among them have been found (Corner et al., 2015; Erkal, Kiliç, & Hande, 2012). Students whose courses involved information about climate change had higher climate anxiety scores (Ramírez-López, Rosetti, & Poma, 2022). More knowledge about climate change has been positively associated with CCA (Ramírez-López et al., 2022). According to others, greater climate change knowledge can lead to paralyzing anxiety (Albrecht et al., 2007; Verlie, 2021). Yet others have found that more climate-specific knowledge is negatively correlated with climate change anxiety (Zacher & Rudolph, 2023).

In sum, knowledge about climate change may or may not produce CCA, and so the relation is poorly understood. Therefore, helping to clarify the role of knowledge about climate change was one of the present study's goals; the present hypothesis is that climate-change knowledge is *associated* with CCA, but a directional hypothesis was not advanced because of the mixed nature of the existing literature.

1.2. Personal experience with climate change impacts

One of the primary means by which individuals might suffer CCA is through personal experience with one or more impacts of climate change. Climate change poses an imminent mental health risk because it virtually guarantees that events such as droughts, flash floods, hurricanes, heat domes, and tsunamis will occur more frequently (Clayton, 2020; Cruz, White, Bell, & Coventry, 2020; Simpson, Weissbecker, & Sephton, 2011). Worsening climate change is associated with increases in the frequency and severity of acute weather events (Berry, Bowen, & Kjellstrom, 2010).

Thus, prior experience with climate-related impacts may be related to CCA. A medium-sized correlation was indeed found between CCA and reported experience with climate change in a US sample (Clayton & Karazsia, 2020). Similarly, reported experience with climate change was moderately associated with CCA in a survey in eight African and European countries (Heeren, Mouguiama-Daouda, & Contreras, 2022). It was significantly correlated with the functional impairment component of CCA, but not its cognitive emotional component (Simon, Pakingan, & Aruta, 2022). Extreme weather experiences predicted CCA (Bergquist, Nilsson, & Schultz, 2019; Spence, Poortinga, Butler, & Pidgeon, 2011; Zanocco et al., 2018). In sum, climate-related disaster experience has been associated with CCA in a number of studies, and so this was a hypothesis for the present study.

1.3. Generalized anxiety disorder (GAD) symptoms

Several studies (Innocenti et al., 2021; Schwartz et al., 2022; Whitmarsh et al., 2022) have found a positive correlation between reported GAD symptoms and both subscales of CCA (cognitive impairment and functional impairment). Individuals who are already dealing with GAD symptoms might be more susceptible to CCA (Sampaio & Sequeira, 2022). Therefore, reported GAD symptoms were hypothesized to predict it.

1.4. Climate change worry as a mediator

Climate change worry was hypothesized to mediate the relations between knowledge, prior experience, and general anxiety disorder symptoms with climate change anxiety. Evidence for the connections between these variables includes a positive relation between knowledge and greater environmental concern (Kelly, 2017). Knowledge about the causes and consequences of climate change significantly predicted concern about climate change in Switzerland (Tobler, Visschers, & Siegrist, 2012).

Further, apart from using different measures of knowledge and concern, several studies have reported a positive correlation between concern about global warming and self-reported knowledge (Aitken, Chapman, & McClure, 2011; Bord, O'Connor, & Fisher, 2000; Heath & Gifford, 2006; Sundblad, Biel, & Garling, 2009). Individuals with climate-related disaster experiences were more likely to report climate change concerns (Bruine de Bruin & Dugan, 2022; Demski, Capstick, Pidgeon, Sposato, & Spence, 2017). For example, flooding experience has been positively related to climate change concern (Hamilton-Webb, Manning, Naylor, & Conway, 2017; Lujala, Lein, & Rød, 2014). Some studies report a positive association between being worried about climate change and its consequences and GAD symptoms (e.g., Lenhard et al., 2023).

The present study considered the distinct roles of climate change *worry* and climate change *anxiety*. Some have recommended that affect, including worry, should be better integrated into understanding climate change outcomes (Brosch, 2021). Worry is defined as "a chain of thoughts and images, negatively affect-laden and relatively uncontrollable" surrounding "an issue whose outcome is uncertain but contains the possibility of one or more negative outcomes" (Borkovec, Robinson, Pvuzinsky, & Depree, 1983, p. 10). In sum, worry is a cognitive phenomenon (Macleod, Williams, & Bekerian, 1991) and, of course, climate change is one cause of worry for many individuals. In contrast, anxiety includes negative somatic outcomes such as muscle tensing, faster breathing, and increased heart rate (VandenBos, 2007). A period of worry may precede and cause anxiety: "... worry can play an important, perhaps essential, role in the etiology and maintenance of human anxiety" (Borkovec, 1985, p. 467).

Of course, climate change worry and CCA are related. Verplanken, Marks, and Dobromir (2020) report a correlation between them of $r = 0.39$; they thus share 15% of their variance. In a recent study (Whitmarsh et al., 2022) asked: "How worried are you personally about climate change" and this was correlated ($r = 0.26$) with CCA. The authors reported that their participants had high levels of worry about climate change but low levels of climate anxiety. Therefore, climate change worry may be correlated with, but is largely distinct from, CCA, and it likely precedes CCA (that is, individuals tend to have worried thoughts before they turn into somatic symptoms). Of course, once climate change anxiety begins, worry presumably remains part of one's overall climate change experience.

In sum, a mediating role of climate change worry was hypothesized for the relations between climate change knowledge, reported prior experience with climate change impacts, GAD symptoms, and CCA.

1.5. Media exposure as a mediator

Considerable evidence exists about how climate change knowledge, prior experience, GAD symptoms, and climate change worry are related to media exposure. Some have investigated the relation between climate

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[1] The studies by Whitmarsh et al. (2022) and Wullenkord et al. (2021) had not yet appeared when the literature search for the present study was conducted and its predictors were selected.

change information and knowledge about climate change and media exposure (Ho, Detenber, Rosenthal, & Lee, 2014; Kahlor & Rosenthal, 2009; Loy, Hamann, & Reese, 2020; Zhao, 2009). Despite an extensive review, Soutar and Wand (2022) could not find evidence that media exposure mediates the relation between knowledge of climate change and climate change anxiety, but they speculated that such a mediation exists. Having had previous encounters with flooding was linked to a preference for obtaining future hazard information (Feldman et al., 2016). A positive relation was found between natural and human-caused disasters and media exposure (Hong, Kim, & Xiong, 2019). Higher levels of general anxiety disorder symptoms were associated with greater daily exposure to social media (Hossain et al., 2020). Increased climate change concern has been linked to exposure to an Intergovernmental Panel on Climate Change special report (Ogunbode, Doran, & Böhm et al., 2020). Other evidence shows that concern about climate change is related to attending to partisan media (Carmichael, Brulle, & Huxster, 2017).

As for the relation between media exposure and CCA, many individuals receive their information about climate change through traditional and social media, which can be related to their interpretations of the threat of climate change and increase or decrease their anxiety (cf. Pihkala, 2019; Weber & Stern, 2011; Whitmarsh & Capstick, 2018). Greater exposure to climate change information in the media, especially among youth, may be associated with greater climate anxiety (Crandon, Scott, Charlson, & Thomas, 2022; Ma, Moore, & Cleary, 2022; Panu, 2020). The role of media has been explored as a potential risk factor that increases stress, particularly for those with pre-existing symptoms (Weems, Scott, Banks, & Graham, 2012), or those with PTSD from disasters, even after controlling for the effects of direct exposure (Hall et al., 2019), and with children suffering from greater levels of anxiety (Ortiz, Silverman, Jaccard, & La Greca, 2011). Doherty and Clayton (2011) considered media images and social narratives as potential mediators of climate anxiety. Attention paid to information about climate change was positively linked to more climate anxiety (Brulle, Carmichael, & Jenkins, 2012; Maran & Begotti, 2021; Marlon et al., 2019; Olausson, 2011; Risbey, 2008).

The direct relations between the four constructs (climate change knowledge, prior experience, GAD symptoms, and climate change worry) and CCA were detailed earlier. Given the evidence for connections between these four variables and media exposure to climate change information, the present study hypothesized that media exposure to climate change information mediates the relations between knowledge about climate change, prior experience, and GAD symptoms, climate change worry, and CCA.

1.6. Risk perception as a mediator

The present also study hypothesized that risk perception mediates the relation between knowledge, prior experience, GAD symptoms, climate change worry, media exposure and CCA. Considerable evidence exists for the relations between climate change knowledge, prior experience, GAD symptoms, climate change worry, media exposure and risk perception. Climate change knowledge significantly and positively predicted climate change risk perception (Hidalgo & Pisano, 2010; O'Connor, Bord, & Fisher, 1999; Reser, Bradley, Glendon, Ellul, & Callaghan, 2012; Sundblad, Biel, & Gärling, 2007; Tobler et al., 2012). Students with higher knowledge scores reported slightly higher perceptions of risk (Aksit, McNeal, Gold, Libarkin, & Harris, 2018). Personal experience with risk was a strong predictor of risk perception recurrence (Griffin, Dunwoody, & Zabala, 1998).

Personal experience with extreme weather events has predicted greater risk perception (van der Linden, 2015). Direct climate-related disaster experience was positively connected with climate change risk perception (Diakakis, Skordoulis, & Savvidou, 2021). A positive relation between prior experience with flooding and residents' flood risk perception has been reported (Botzen, Aerts, & van den Bergh, 2009;

Demski et al., 2017). Similarly, residents' prior experience was positively correlated with the perceived probability of a landslide disaster (Xu et al., 2016). Direct disaster experience was positively connected with climate change risk perception (Diakakis et al., 2021). Finally, participants' personal experience with climate change impacts and their climate risk perceptions were associated (Akerlof, Maibach, Fitzgerald, Cedeno, & Neuman, 2013).

In addition, several studies demonstrate that worry about the negative consequences of global warming is positively related to greater risk perception (Sundblad et al., 2007; Thaker, Smith, & Leiserowitz, 2020). Finally, mass media exposure is a primary source of risk perception (Han, Zhang, Chu, & Shen, 2014; Oh, Paek, & Hove, 2015; Vyncke, Perko, & Gorp, 2017). Other studies show that media exposure to information about disasters or pandemics is related to greater risk perception (Karasneh et al., 2020; Rivas, Jaldin, Canaviri, Escalante, & Ticona, 2021; Rubaltelli, Scrimin, Moscardino, Priolo, & Buodo, 2018; Sell et al., 2017). In a nationally representative sample of Norwegians, exposure to an IPCC special report was associated with greater perceived threat from climate change (Ogunbode, Doran, & Böhm, 2020).

Several studies have investigated the connection between climate change risk perception and mental health disorders such as anxiety (Farrokhi, Khankeh, Amanat, Kamali, & Fathi, 2020; Howard, Ahmed, Lachapelle, & Schure, 2020; Kubo, Tsuge, Abe, & Yamano, 2019). In one, climate-related anxiety and climate risk perception were moderately correlated (Howard et al., 2020). In another, residents of Japanese islands who perceived risks from climate change-related threats such as typhoons, floods, and drought reported anxiety from each, although the levels of anxiety varied from island to island (Kubo et al., 2019). In a third, stronger risk perceptions predicted greater climate anxiety (Reese, Rueff, & Wullenkord, 2022).

The relations between the five of the predictors in the model (climate change knowledge, prior experience, GAD symptoms, climate change worry, and media exposure) and climate change anxiety were detailed earlier. Therefore, risk perception was expected to mediate the relations between the five variables and CCA.

2. The present study

Overall, six potential predictors were hypothesized to form useful parts of a model capable of explaining an important portion of CCA. In terms of particular associations, nine hypotheses were advanced.

First, knowledge about climate change was expected to be related to degree of CCA. Second, experience with climate change impacts was expected to be linked to greater CCA. Third, GAD was anticipated to predict greater CCA. Fourth, climate change worry was hypothesized to mediate the relations between those three predictors and CCA. Fifth, media exposure to climate change information was expected to mediate the relation between those same predictors and CCA. Sixth, media exposure to climate change information was expected to mediate the relation between climate change worry and CCA. Seventh, the relation between the three predictors and CCA was expected to be mediated by risk perception. Eighth, the relation between climate change worry and CCA was expected to be mediated by risk perception. Ninth, risk perception was expected to mediate the relation between media exposure and CCA. The initial conceptual model is shown in Fig. 1.

3. Method

3.1. Participants

Participants over the age of 18 who resided in the US and Canada who reported experiencing at least some CCA were recruited using the CloudResearch Prime Panel. Three response-validity indicators were employed to identify and remove poor-quality data. First, potential participants were asked whether they had experienced any climate change anxiety. Those who answered "No" were excluded from the
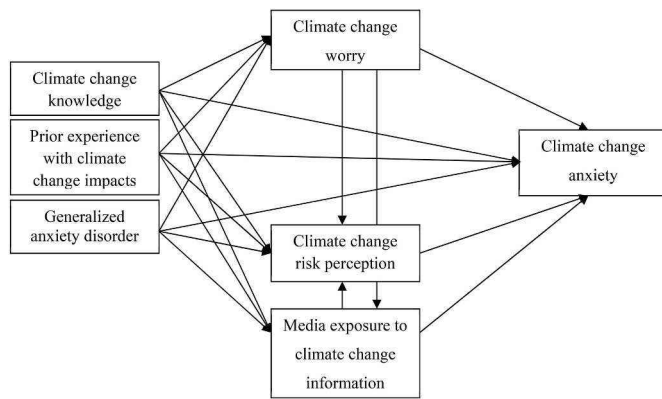
Fig. 1. The initial conceptual model.

survey. Second, the survey included three attention-checking items. For example, participants who answered "correct" to the attention-checking item "The sun is a cold planet" were excluded. Third, participants who took the survey in less than 580 s ("speeders") were excluded.

As a result, 323 participants aged 19 to 87 ($M = 54.60$; $SD = 16.7$), including 209 females, 113 males, and one person who identified as another gender were included in the sample. Educationally, 102 had a two-year college degree or technical training, 89 had a bachelor's degree, 66 had a high school diploma, 65 had a graduate or professional degree, and 11 had not completed high school. The sample's mean political ideology was between "moderate" and "somewhat left" (M = 2.68, SD = 0.97 on a 5-point scale from "strong left" to "strong right"). In terms of ethnicity, 83.3% were Caucasian, 6.2% Black, 3.7% Asian, and 6.7% reported "other" as their ethnicity.

3.2. Procedure and materials

Ethics approval was granted by University's Research Ethics Board (file 22–0500). The first page of the survey contained a letter of information for implied consent, and participants' consent was implied if they continued after reading the form. Following this, the participants were asked questions that comprised each of the main variables, as follows.

3.2.1. Climate change knowledge

Knowledge about climate change was assessed with 11 correct-incorrect questions in four subscales (adapted from Tobler et al., 2012). The questions were about the physical effects of CO_2 and greenhouse gas, the causes and consequences of climate change, and action-related knowledge. Examples include "At the same quantity, CO_2 is more harmful to the climate than methane" and "climate change is mainly caused by human activities." (See Table 1 in the supplementary materials.)

3.2.2. Personal experience with climate change impacts

The participants were asked three questions about how often they, others around them, and places to important them, had already been affected by climate change (e.g., "I have been directly affected by climate change" on a scale of 1 = "never" to 5 = "almost always," Clayton & Karazsia, 2020) (See Table 2 in the supplementary materials.).

3.2.3. Generalized anxiety disorder (GAD) symptoms

Generalized anxiety disorder was measured using the GAD-7 scale by Spitzer, Kroenke, Williams, and Löwe (2006), which the authors based on the criteria for GAD employed in the Diagnostic and Statistical Manual for Mental Disorders (DSM-IV). For example, the respondents were asked to indicate how often they had been bothered by general

Table 1
Climate change knowledge.

		Range
Knowledge about CO_2 and greenhouse effect	- Burning oil produces CO_2. - At the same quantity CO_2 is more harmful to the climate than methane.	Correct (1) Incorrect (0)
Causes	- The global concentration of CO_2 in the atmosphere has increased during the past 250 years. - Climate change is mainly caused by human activities. - The global increase in temperature over the last century was the largest for the past 1000 years. - The level of CO_2 concentration in the atmosphere already occurred in the past 650,000 years.	
Consequences:	… a warmer climate to increase the melting of polar ice, which will lead to an overall rise of the sea level. … the climate to change evenly all over the world. … an increase in extreme events, such as droughts, floods and storms. … a warmer climate to increase water evaporation, which will lead to an overall decrease of the sea level.	
Action-related knowledge	Nuclear power plants emit CO_2 during their operation.	

Note: Adapted from (Tobler et al., 2012).

Table 2
Personal experience of climate change.

	Range
1. I have been directly affected by climate change. 2. 2. I have known someone who has been directly affected by climate change. 3. 3. I have noticed a change in a place that is important to me due to climate change.	Never (1) to Almost always (5)

Note: Adopted from (Clayton & Karazsia, 2020).

anxiety in the last two weeks (e.g., "Not being able to stop or control worrying; " response scale: 1 = "Never," 2 = "Several days," 3 = "More than half the days," 4 = "Nearly every day").[2] (See Table 3 in the supplementary materials.)

3.2.4. Climate change risk perception

To measure climate change risk perception, eight items based on van der Linden's (2015) climate change risk perception model were used,

Table 3
Generalized anxiety disorder (GAD).

Over the last 2 weeks, how often have you been bothered by the following problems from issues other than climate change?	Range
1. Feeling nervous, anxious or on edge 2. Not being able to stop or control worrying 3. Worrying too much about different things 4. Trouble relaxing 5. Being so restless that it is hard to sit still 6. Becoming easily annoyed or irritable 7. Feeling afraid as if something awful might happen	Never (1) *Nearly every day* (4)

Note: Adopted from (Spitzer et al., 2006).

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[2] The GAD-7 items are reported symptoms of general anxiety disorder, but are not meant to diagnose GAD clinically.

which was adapted from Bord et al. (2000) and Leiserowitz (2006). For example, (e.g., "In your judgment, how serious a threat do you believe that climate change is to you personally?"). The respondents were asked to rate these items on a 7-point scale from "Not at all serious" (= 1) to "Very serious" (= 7) (See Table 4 in the supplementary materials.).

3.2.5. Climate change worry

The participants were asked to indicate the extent to which they agreed with 10 questions that concerned their worry about possible impacts of climate change, adapted from the worry themes reported by Verplanken et al. (2020). They rated the extent to which they agreed with each statement (e.g., "How often are you worried about loss of human and animal life") on a scale of 1–5 (1 = "Never" to 5 = "Almost always") (See Table 5 in the supplementary materials.).

3.2.6. Media exposure to climate change information

The items used to assess media exposure in climate change information items were adapted from Ogunbode et al. (2019). The respondents were asked how often, on a scale of 1–9 (1 = "Never" to 9 = "More than 10 times per day"), they paid attention to information about climate change and how often they followed climate change news from eight different sources (such as TV, social media, books, friends, etc.) (See Table 6 in the supplementary materials.).

3.2.7. Climate change anxiety

To measure the outcome measure in the proposed model, Clayton and Karazsia's (2020) 13-item CCA scale was used. The questions assess cognitive (e.g., "Thinking about climate change makes it difficult for me to sleep") and functional (e.g., "My concerns about climate change interfere with my ability to get work or school assignments done") impairments in response to climate change. Respondents were asked to rate these items on a 5-scale of 1–5 from "Never" (= 1) to "Almost always" (= 5) (See Table 7 in the supplementary materials.).

3.3. Demographic information

At the end of the survey, seven personal and socioeconomic questions were asked in order to understand individual differences in climate change anxiety. These were about the participants' age, gender, education status, ethnicity, marital status, political ideology, and income. See Table 8.

Table 4
Climate change risk perception.

	Range
1. How concerned are you about climate change?	Not concerned at all (1) to Very concerned (7)
2. In your judgment, how likely are you, sometime during your life, to experience serious threats to your health or overall well-being, as a result of climate change?	Extremely unlikely (1) to Extremely likely (7)
3. In your judgment, how likely do you think it is that climate change will have very harmful, long-term impacts on our society?	
4. How serious of a threat do you think that climate change is to the natural environment?	Not serious at all (1) to Very serious (7)
5. How serious would you rate the current impacts of climate change around the world?	
6. How serious of a threat do you believe that climate change is to you personally?	
7. How serious would you estimate the impacts of climate change where you live?	
8. How often do you worry about the potentially negative consequences of climate change?	Very rarely (1) to Very frequently (7)

Adopted from (van der Linden, 2015).

Table 5
Global warming worry.

How often are you worried about the following possible impacts of climate change?	Range
1. Loss of human and animal life	Never (1) to Almost always (5)
2. Destruction of natural habitats	
3. Negative societal effects and breakdown of civilization	
4. Significant changes to weather and seasons	
5. Negative impacts on myself and my significant others	
6. Changes to oceans and other bodies of water	
7. Irreversibility and uncertainty of timing	
8. Negative impacts on humanity	
9. Negative actions by other people	
10. Consumerism and associated pollution	

Adopted from (Verplanken et al., 2020).

Table 6
Media exposure about climate change information On average, how often do you read or hear about climate change from the following sources.

Sources	Ranges
TV or radio news/programs	Never (1)
Printed and online newspapers	Less often than once a week (2)
Social media platforms	Once a week (3)
YouTube	2–3 days per week (4)
Books and magazines	4–6 days per week (5)
Scientific articles	Once a day (6)
Blogs	2 to 5 times per day (7)
Family, friends, and colleagues	6 to 10 times per day (8)
	More than 10 times per day (9)

Table 7
Climate change anxiety.

How often do the following things happen for you?	Range
1. Thinking about climate change makes it difficult for me to concentrate.	Never (1) to Almost always (7)
2. 2. Thinking about climate change makes it difficult for me to sleep.	
3. 3. I have nightmares about climate change.	
4. 4. I find myself crying because of climate change.	
5. 5. I think, "Why can't I handle climate change better?"	
6. 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. 8. I think, "Why do I react to climate change this way?"	
9. 9. My concerns about climate change make it hard for me to have fun with my family or friends.	
10. 10. I have problems balancing my concerns about sustainability with the needs of my family.	
11. 11. My concerns about climate change interfere with my ability to get work done.	
12. 12. My concerns about climate change undermine my ability to work to my potential.	
13. 13. My friends say I think about climate change too much.	

Adopted from (Clayton & Karazsia, 2020).

4. Results

4.1. Means, standard deviations, and reliabilities

The respondents perceived relatively high levels of climate change risk ($m = 5.85$, $sd = 0.89$ on the 7-point scale) and climate change knowledge ($m = 7.27$, $sd = 2.06$ out of 11 possible). The mean response to climate change experience ($m = 2.79$, $sd = 1.00$) and climate change worry ($m = 3.43$, $sd = 0.79$) were above the middle of their 5-point ranges. The mean frequency with which participants reported paying attention to climate-related media information was 3.40 ($sd = 1.26$) on a 9-point scale, which translates to between "once a week" and "two or

Table 8
Demographic variables.

	Response Range
Age	–
Gender	Male (1), Female (2), Non-binary/third gender (3), Prefer not to say (4)
Level of education	Some high school (1), High school graduate (2), Diploma/technical training(3), Bachelor's degree (4), Master's degree (5), Professional degree (6), PhD (7)
Ethnic origin	Asian (1), Black (2), Caucasian (3), Indigenous (4), Middle-eastern (5), Multiple (6), Other or prefer not to say (7)
Marital status	Single, never married (1), Married or domestic partnership (2), Separated (3), Widowed (4), Divorced (5)
Political ideology	Strongly left (1), Somewhat left (2), Moderate (3), Somewhat right (4), Strongly right (5)
Income	–

three times a week."

GAD scores were near the middle ($m = 2.14$, $sd = 0.82$) of their 4-point range. Reported CCA was relatively low ($m = 1.73$, $sd = 0.78$ on its 5-point scale). The multi-item scales had Cronbach alpha reliabilities that ranged from $\alpha = 0.85$ to 0.95. The descriptive statistics for the scales and correlations among the variables may be found in Table 9.

4.2. Modeling the possible predictors of climate change anxiety

Structural equation modeling (SEM) using AMOS 24 was employed because it allows for the simultaneous estimation of multiple and inter-related dependence relations (Cheng, 2001; Kline, 1998).To be clear, the variables in the model are *possible* predictors; survey-based studies cannot claim causality. Risk perception and the hypotheses related to it were excluded from the model because preliminary analyses revealed that risk perception conflicted with climate change worry; that is, the use of both variables resulted in opposing mediation (cf. Kenny, 2023), so that the two predictors negated each other. Of the two, risk perception made no useful contribution to the fit of the model, whereas climate change worry did. In addition, with one less element the model is more parsimonious.

The resulting model fit the data very well based on multiple SEM fit statistics and indices (see Fig. 2), and it accounted for 54 percent of the variance in CCA.
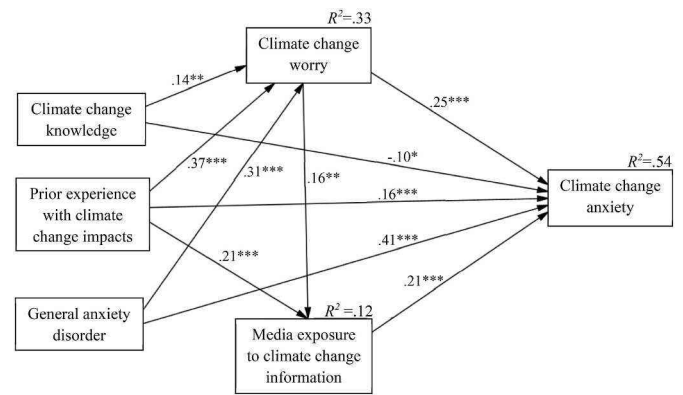
4.3. Hypotheses

The results provide support for most hypotheses. The first, that climate change knowledge would be correlated with CCA, was supported. The direction was negative: the more respondents knew about climate change crisis, the less fear they reported ($\beta = -0.10$, $p < .05$). The second, that more reported climate change experience would be significantly related to CCA was also supported ($\beta = 0.17$, $p < .001$).The third hypothesis, that general anxiety disorder would be related to CCA was strongly supported ($\beta = 0.41$, $p < .001$).

Fig. 2. The structural equation model
Note: Standardized estimates, $p < .05* \; p < .01** \; p < .001***$
The model fit indices are: $\chi2$ ($df = 2$) = 0.6, $p \leq .001$; Root Mean Square Error of Approximation (RMSEA) = 0.00; Comparative fit index (CFI) = 1.00; Normed fit index (NFI) = 0.99; Goodness-of-fit index (GFI) = 0.99; Tucker-Lewis index (TLI) = 1.02. Rule of thumb guidelines are that CFI $\geq$0.95, NFI $\geq$0.95, GFI $\geq$0.95, TLI $\geq$0.95 and RMSEA $<$0.06 represent a very good model fit (Schreiber et al., 2006).

As expected, based on the fourth hypothesis, climate change worry significantly mediated the relation between knowledge, prior experience, and generalized anxiety and CCA. Fifth, media exposure to climate change information significantly mediated the relation between prior experience and CCA; however, it did not mediate the relation between climate change knowledge and CCA or between GAD symptoms and CCA. Sixth, media exposure to climate information significantly mediated the relation between climate change worries and CCA. Because risk perception was a not included in the final model, the seventh, eighth, and ninth hypotheses were not tested.

4.4. Demographics

Age and CCA were negatively correlated ($r = -0.32$, $p < .001$; younger respondents reported more CCA). However, none of the other characteristics–gender, education status, marital status, ethnicity, political ideology, and income–were significantly related to CCA (all $ps >$ .05). The participants' three main sources of information were TV/radio news/programs, social media platforms, and printed and online newspapers, respectively.

5. Discussion

The overall goal of this study was to expand understanding of climate change anxiety (CCA) by investigating the role of several possible predictors of it. General anxiety disorder symptoms, prior experience with climate-related impacts, and climate change knowledge were directly

Table 9
Descriptive statistics (N = 323).

	M	SD	α	Knowledge	Prior experience	General anxiety disorder	Risk perception	Climate change worry	Media exposure	Climate change anxiety
Knowledge	7.27	2.06	–	–						
Prior experience	2.76	1.00	.85	.18**	–					
General anxiety disorder	2.14	0.82	.93	−.13*	.28**	–				
Risk perception	5.85	.90	.89	.26**	.36**	.17**	–			
Climate change worry	3.43	.79	.93	.16**	.48**	.40**	.53**	–		
Media exposure	3.40	1.26	.86	.03	.30**	.15**	.39**	.29**	–	
Climate change anxiety	1.73	0.78	.95	−.07	.44**	.60**	.26**	.53**	.39**	–

Note.*Significant at the.05 level (2-tailed). ** Significant at the.01 level (2-tailed). Knowledge was the sum of correct answers, out of 11 possible, that is, not a scale.

related to CCA. The same three variables were also indirectly related to CCA through climate change worry. Previous experience with climate-related impacts and climate change worry were indirectly related to CCA through media exposure. This model fit the data very well and accounted for over half the variance in climate change anxiety.

Symptoms of general anxiety disorder were the most important direct predictor of CCA. This is consistent with the findings of other studies (Innocenti et al., 2021; Schwartz et al., 2022; Whitmarsh et al., 2022). This result also supports Sampaio and Sequeira's (2022) recent findings that individuals who are struggling with general anxiety are more prone to develop CCA.

The second-strongest direct predictor of CCA was prior experience with climate change impacts. This is consistent with previous studies which show that prior experience can predict it (Bergquist et al., 2019; Clayton & Karazsia, 2020; Heeren et al., 2022; Spence et al., 2011; Zanocco et al., 2018).

Climate change knowledge was a third significant direct predictor of CCA, although its effect size was small. One study has reported a positive association between knowledge and CCA (Ramírez-López et al., 2022), but the present results showed that more knowledge about climate change was (slightly) associated with less climate change anxiety, which is consistent with the findings of other studies (Lee et al., 2020; Zacher & Rudolph, 2023). Put another way, the present findings do *not* demonstrate that having more knowledge overwhelms individuals with climate anxiety, which tends to disconfirm the speculations of Albrecht et al. (2007) and Verlie (2021). *Post hoc*, one might speculate that sometimes more information about a problem eases fears, perhaps because the problem is at least clearer. More research is needed on this question.

Climate change worry was the most important mediator of the relation among the three predictors and CCA. Climate change knowledge, prior experience, and GAD symptoms were associated with CCA through climate change worry. More knowledge about climate change was associated with more climate change worry, and level of worry in turn was correlated with greater climate change anxiety. Similarly, the more climate change impacts that individuals reported, the greater level of climate change worry they reported experiencing, which was then related to greater climate change anxiety. Finally, individuals who reported more GAD symptoms were also more worried about climate change, and these individuals reported experiencing greater levels of climate anxiety. Notably, this latter connection was stronger than the direct relation between prior experience and CCA. In sum, understanding that being worried about climate change is correlated with increased CCA is important for decision and policy makers.

In the present study, media exposure mediated the relation between prior experience and CCA. Individuals who reported more climate change impacts tended to pay more attention to media-based information about climate change, and they reported greater CCA. Again, the connection between media exposure and CCA was stronger than the direct relation between prior experience and CCA. Indirect experience of climate change, through passive exposure to climate change information, seems to play an important role in predicting climate change anxiety, which is consistent with other studies (O'Neill, 2020; Whitmarsh et al., 2022).

The present results also confirm that greater exposure to media information among individuals who have already experienced more climate change impacts is associated with greater CCA. In this study, media exposure did not mediate the relation between climate change knowledge and climate change anxiety. A review by Soutar and Wand (2022) had suggested that this mediation might exist; however, their extensive review did not find any support for that hypothesis, and the present results are consistent with this conclusion.

The relation between climate change worry and CCA was mediated by exposure to media information about climate change. Individuals who were more worried about climate change and its consequences tended to pay more attention to media information about climate change, and this was associated with increased climate anxiety.

Finally, younger individuals expressed more CCA than older people, which is in line with other findings (Baker, Clayton, & Bragg, 2021; Burke, Sanson, & Van Hoorn, 2018; Clayton & Karazsia, 2020; Hickman et al., 2021; Nairn, 2019; Whitmarsh et al., 2022; Wu, Snell, & Samji, 2020). According to one observer (Gunasiri, 2022), younger individuals will be more exposed to the consequences of climate impacts, and their anxiety will become a more general characteristic of society as they become the main portion of it. This speculation will be confirmed or not when longitudinal studies are done.

5.1. Implications

Knowing what predicts the development of CCA is vital for mental health professionals and policy-makers as they try to effectively help their clients and constituents cope with it. First, the most important predictor of climate change anxiety was reporting GAD symptoms. This should assist mental health professionals who offer ecopsychology or eco-therapy treatment to develop techniques for reducing climate change anxiety. Second, mental health professionals and policy makers should be aware that having prior climate-related experience may trigger climate change anxiety. Third, health-related policy makers should strive to increase their clients' and constituents' knowledge about climate change because knowledge decrease is related to decrease CCA.

In addition, mental health professionals should differentiate climate change worry from CCA and be aware that climate change worry could worsen with time and lead to CCA. Because worry and anxiety are different, they need different treatment. Some (e.g., Albrecht, 2011) have suggested that climate change anxiety might lead to a form of paralysis and thus lead to less mitigation action. However, we note that very recent studies have reported *positive* relations between CCA and pro-environmental behavior (Verplanken et al., 2020; Whitmarsh et al., 2022; Wullenkord, Tröger, Hamann, Loy, & Reese, 2021).

The present results suggest that CCA experienced by individuals with prior experience and those who are worried about climate change and its consequences may be exacerbated when they pay more attention to climate change information in the media. As a result, media stories about climate change perhaps should include warnings for individuals who have already experienced climate impacts, and perhaps should offer constructive advice about how to tackle climate change's negative consequences.

Finally, the results showed that younger people are more likely to experience climate anxiety. More research is needed to investigate the effects of climate anxiety on the mental health of young people.

5.2. Limitations and future directions

This study, like all, had some limitations that future research may wish to overcome. First, influences other than those included here may also help to predict CCA because the 54 percent achieved by this model. Second, as always, the model is limited in terms of causality by the cross-sectional survey nature of the study and by its sample, which was from wealthy Western countries. The study needs replication with a wider range of cultures.

Third, the present study focused on how often and which sources the participants watched or listened to, but not to the content of the messaging. The *kind* of information presented by different media outlets probably is important for producing or reducing climate change anxiety. Individuals who "doomscroll" presumably develop greater climate change anxiety than those who attend to positive and hopeful media messages. Future studies could also take the emotional tone of information (e.g., negative vs. positive affect) into account, as well as each media's general stance on climate change (e.g., acceptance versus denial).

Further, knowing which media outlets are attended to by which demographic groups as an individual's main source of information

about climate change should help concerned organizations and governments to know where to spend resources on messaging to tackle climate change anxiety, assuming that the messages conveyed by the media are based on research that promotes healing. Perhaps a secondary analysis of these data might yield important directions for future research and implications for practice.

5.3. Conclusions

In a survey of adult North American community members, the present study investigated how six variables (climate change knowledge, prior experience with climate change impacts, GAD symptoms, climate change worry, climate change risk perception, and media exposure to climate change) predict the growing phenomenon of climate change anxiety and relate to each other. The study also helped to clarify the role of climate change knowledge, about which earlier results were mixed: more climate knowledge was modestly associated with less climate change anxiety.

The study also enhances knowledge by advancing beyond the reporting of a series of correlations between predictors and CCA; it posited and confirmed an integrated model to help explain it. One advantage of the new model is that it reveals how the predictors are related to each other, as well as how they are related to climate change anxiety. Among these relations, the study shows that media exposure and climate change worry–which is distinct from climate change anxiety–are important mediators of the relations between climate change knowledge, past experience with climate change impacts, and reported symptoms of general anxiety disorder, and CCA. Overall, this relatively parsimonious model (just five predictors) has a very good fit to the data and accounts for 54 percent of the variance in climate change anxiety.

Author contributions

Zahra Asgarizadeh: Investigation, Methodology, Formal analysis, Writing- Original draft preparation, Visualization, Data Curation.

Robert Gifford: Conceptualization, Supervision, Funding acquisition, Project administration, Validation, Writing - review & editing.

Lauren Colborne: Investigation, Writing- Original draft preparation.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvp.2023.102087.

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