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INVITED ARTICLE

Climate anxiety and its association with health behaviours and generalized anxiety: An intensive longitudinal study

Marc O. Williams[1] | **Joren Buekers**[2,3,4] | **Gemma Castaño-Vinyals**[2] | **Rafael de Cid**[5] | **Laura Delgado-Ortiz**[2,3,4] | **Ana Espinosa**[2] | **Judith Garcia-Aymerich**[2,3,4] | **Sarah Koch**[2,3,4] | **Manolis Kogevinas**[2] | **Marco Viola**[2,6] | **Lorraine Whitmarsh**[7,8] | **Guillaume Chevance**[2]

[1]School of Psychology, Cardiff University, Cardiff, UK

[2]ISGlobal, Barcelona, Spain

[3]Universitat Pompeu Fabra (UPF), Barcelona, Spain

[4]CIBER Epidemiología y Salud Pública (CIBERESP), Madrid, Spain

[5]Genomes for Life-GCAT Lab, Institute for Health Science Research Germans Trias i Pujol (IGTP), Badalona, Spain

[6]Psychology Department, University of Torino (UniTO), Torino, Italy

[7]Centre for Climate Change and Social Transformations, Cardiff University, Cardiff, UK

[8]University of Bath, Bath, UK

Correspondence
Marc O. Williams, School of Psychology, Cardiff University, Cardiff CF10 3AT, UK.
Email: williamsm93@cardiff.ac.uk

Abstract

Objectives: The United Nations recognize the importance of balancing the needs of people and the planetary systems on which human health relies. This paper investigates the role that climate change has on human health via its influence on climate anxiety.

Design: We conducted an intensive longitudinal study.

Methods: Participants reported levels of climate anxiety, generalized anxiety and an array of health behaviours at 20 consecutive time points, 2 weeks apart.

Results: A network analysis shows climate anxiety and generalized anxiety not to covary, and higher levels of climate anxiety not to covary with health behaviours, except for higher levels of alcohol consumption at the within-participant level. Generalized anxiety showed completely distinct patterns of covariation with health behaviours compared with climate anxiety.

Conclusions: Our findings imply that climate anxiety, as conceptualized and measured in the current study, is not in itself functionally impairing in terms of associations with unhealthy behaviours, and is distinct from generalized anxiety. The results also imply that interventions to induce anxiety about the climate might not always have significant impacts on health and well-being.

KEYWORDS

climate anxiety, climate distress, generalized anxiety, health behaviours, intensive longitudinal study, network analysis

INTRODUCTION

The United Nations (UN) recognizes an array of social, economic and environmental threats to global peace and prosperity, and has articulated 17 goals for addressing these challenges in international partnership (United Nations Department of Economic and Social Affairs [UNDESA], 2016). All UN member states have signed up to its Sustainable Development Goals (SDGs), each of which focuses on a single aim (such as ending poverty or taking action on the climate), and all of which are integrated around the principle that development must balance the needs of people and the environment on which they rely (UN DESA, 2016).

Planetary health is a discipline that considers human health and flourishing to be dependent on keeping planetary systems, such as climate, within safe boundaries (Whitmee et al., 2015). Human activities are causing the climate to change in a way that threatens the health of the planet and, as a result, human health (Whitmee et al., 2015). The Lancet Countdown lists a number of indicators linking climate change to health: these include health hazards from high temperatures, extreme weather events, shifts in infectious disease transmission, and issues with food security and nutrition; the role of adaptation to climate impacts at both national and local levels, and recognizing the unique vulnerabilities, health risks, and the need for resilience in the face of climate change; the health co-benefits of mitigation actions across various sectors; the economic impacts of climate change and the costs of mitigating its effects; and the role of media, individual, scientific, governmental, and corporate engagement in addressing the intersection of health and climate change (Romanello et al., 2022).

Health psychology is concerned with psychological processes underpinning human health and health behaviours (Friedman & Adler, 2011). Bernard and Chevance (2023) called for the discipline's engagement with the climate crisis, and the importance of understanding individual health behaviours and their potential for enhancing both climate change mitigation and adaptation (see also, Bernard, 2019; Chevance et al., 2023; Inauen et al., 2021; Papies et al., 2024). Health behaviours, such as active travel, can provide co-benefits to health and climate change mitigation (Shaw et al., 2014). Health behaviours can also build resilience to the effects of climate change, such as the role of sleep in developing psychological resistance to rising temperatures and extreme weather events (Rifkin et al., 2018). Chevance et al. (2023) conducted a narrative review of evidence for a range of bi-directional associations between climate change and health behaviours, and proposed a model in which climate change influences health behaviours via both acute climate-related changes and longer-term trends (such as rising temperatures), through both direct and indirect pathways.

One of the indirect consequences of climate change is climate anxiety (or eco-anxiety), which is anxiety associated with people's perceptions of climate change (Clayton, 2020); little research has examined how this interfaces with health behaviours. Climate anxiety can be differentiated from generalized anxiety, in which an individual worries about a range of different topics; to meet criteria for generalized anxiety disorder, worrying must feel excessive and uncontrollable to the individual according to the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; DSM-5; American Psychiatric Association, 2013). A commonly used climate anxiety questionnaire measures cognitive-emotional impairment and functional impairment (Clayton & Karazsia, 2020), whereas another distinguishes between the affective dimension of climate anxiety (i.e. the subjective experience of the emotion) and consequences to daily functioning (Hepp et al., 2022). While climate anxiety can result from a direct experience of climate events (such as post-trauma resulting from storms) (Morganstein & Ursano, 2020), it reflects a person's *perception* of climate change and can occur independently of personal experience of extreme weather events (Clayton, 2020). In the following section we summarize what is currently known about this topic, namely the interplay between climate anxiety, generalized anxiety and health behaviours, and how the current study aims to address gaps in the research.

Climate anxiety and health behaviours

Research on the associations between climate anxiety and health behaviours is in its early stages, as the literature has focused on the associations between climate anxiety and mental health. Climate anxiety has been found to be significantly and positively associated with generalized anxiety (in a UK general-population sample) (Whitmarsh et al., 2022). Heeren et al. (2023) reported a network analysis of cross-sectional data in a European sample in which a tendency to worry uncontrollably and excessively about a range of topics (a feature of generalized anxiety) was significantly associated with higher levels climate anxiety. We would expect climate anxiety to be associated with health behaviours via its association with generalized anxiety. For example, one of the features of generalized anxiety disorder is difficulty falling or staying asleep, or restless sleep, according to the DSM-5 (American Psychiatric Association, 2013). Generalized anxiety has shown associations with reduced sleep quality (Maher et al., 2022; Pillai & Drake, 2015) and reduced physical activity (Hiles et al., 2017), and stress has been found to be associated with food intake (Reichenberger et al., 2018), alcohol consumption (Keyes et al., 2012) and time spent looking at screens (henceforth: screen time) (Ge et al., 2020). The links between generalized anxiety and health behaviours are often considered bidirectional, in which, for instance, generalized anxiety impairs sleep, which in turn exacerbates anxiety (Maher et al., 2022). These behaviours, over time, have an impact on a range of diseases; for example, low physical activity is a risk factor for the development of cardiovascular disease (Piepoli et al., 2016), low sleep quality is associated with an increased risk of hypertension and Type II diabetes (Medic et al., 2017), and alcohol consumption increases the risk of a range of cancers (Bagnardi et al., 2015).

There is scant literature on the unique associations between climate anxiety and health behaviours. A cross-sectional study across 25 countries showed an association between distress about climate change and poor sleep (Ogunbode et al., 2021), although these authors did not account for the potential influence of generalized anxiety, which is known to be associated with poorer sleep quality (Maher et al., 2022; Pillai & Drake, 2015). A UK population study found no relationship between avoiding red meat consumption and climate anxiety (Whitmarsh et al., 2022). There remains to be a more comprehensive examination of climate anxiety's unique associations with a range of health behaviours. Furthermore, no study has investigated how climate anxiety varies with health behaviours longitudinally, which limits our understanding of how *changes* in climate anxiety covary with changes in health behaviours.

The current study

The present study's objective was to examine the relationship between climate anxiety, generalized anxiety, and health behaviours (sleep quality, alcohol intake, physical activity, diet quality and screen time) longitudinally. An intensive longitudinal design methodology was utilized, allowing us to capture these patterns of associations at both between- and within-person levels, given that findings might differ at these two levels (Erlebacher, 1977). Employing a network analysis methodology also allowed for the examination of multiple health behaviours in parallel, and their unique associations with climate anxiety and generalized anxiety. We would expect climate anxiety to show a positive association with generalized anxiety, and for generalized anxiety to be associated with poorer sleep quality and poorer diet, lower physical activity, higher alcohol intake and more screen time. We would not expect climate anxiety to show any unique associations with health behaviours beyond the influence of generalized anxiety.

An improved understanding of climate anxiety and its relation to health behaviours could build a mandate for combating climate change and the protection of ecosystems, meeting key aims of the UN (SDGs 13–15). This study's aims are also relevant to the UN's goal of establishing healthy lives and well-being among the population (SDG 3): by elucidating the extent of climate anxiety and its impact on health behaviours, the study will provide evidence that could guide health policies and interventions that seek to help people cope with experiences related to climate change. Furthermore, as higher levels of climate anxiety appear to be associated with higher pro-environmental behaviours (Verplanken

et al., 2020; Whitmarsh et al., 2022), our findings could be of use to behaviour change initiatives seeking to influence uptake of behaviours by inducing climate anxiety without compromising health and well-being.

METHODS

Study design and participants

This is an intensive longitudinal study where the participants were asked to answer questionnaires (in Spanish or Catalan) about climate anxiety, generalized anxiety and health behaviours every 2 weeks during a whole year via a smartphone app operated by Ethica Data. The Parc de Salut Mar Ethics Committee granted ethical approval for the study (CEIm-PS MAR, number 2020/9307/I). All participants provided informed consent.

Data were collected from August 2021 to December 2022. Participants from the GCAT project (Genomes for Life; Obón-Santacana et al., 2018) who had taken part in a more recent study on mental health during COVID-19 in northern Spain (the COVICAT study; Goldberg et al., 2022) were invited to take part in the present study. The GCAT project participants were mostly blood donors, who had agreed to take part in a prospective cohort study of genomic, epigenomic, and epidemiological influences of chronic diseases in Catalonia. The current study is a sub-study of the COVICAT study aiming at measuring longitudinal changes in mental health and other health indicators in a sub-sample of participants. Out of the 8497 participants from the COVICAT study, 4764 were invited to participate in the current study. A specific sampling procedure was used to specifically target the COVICAT participants presenting extreme ($N = 460$) and moderate ($N = 1243$) scores on the Hospital Anxiety and Depression Scale (HADS) subscales. The remaining part of the invited participants ($N = 3061$) were randomized control participants matched by sex, age and deprivation index. Out of the 4764 participants invited to participate, 996 download the study application and 204 participants provided data for at least 20 occasions.

Network analyses cannot be performed on datasets with missing observations, and we wished to avoid imputing data. To obtain a dataset with no missing values, a balance was struck between a dataset with a sufficient number of participants whilst also retaining a time-series of sufficient length to best characterize potential covariations between variables. Retaining participants with 20 measurement points appears to be the best compromise between a sufficiently large sample size and lengthy time series for capturing seasonal variation. For some participants, we removed additional time points (24 was the maximum number of time points) to ensure a similar number of time points per participants (a network analysis requirement). See Figure 1 for a flowchart of how participants were filtered to arrive at the final dataset. Table S1 shows that data from participants included in the final dataset were not significantly different from those who were excluded (https://tinyurl.com/bddm3ejz).

Measures and procedures

Repeated measures of the following psycho-behavioural variables were collected.

Climate anxiety

Overall climate anxiety over the last 2 weeks was measured using a single item capturing how anxious participants felt about climate change on a visual analogue scale ranging from 0 'not anxious' to 10

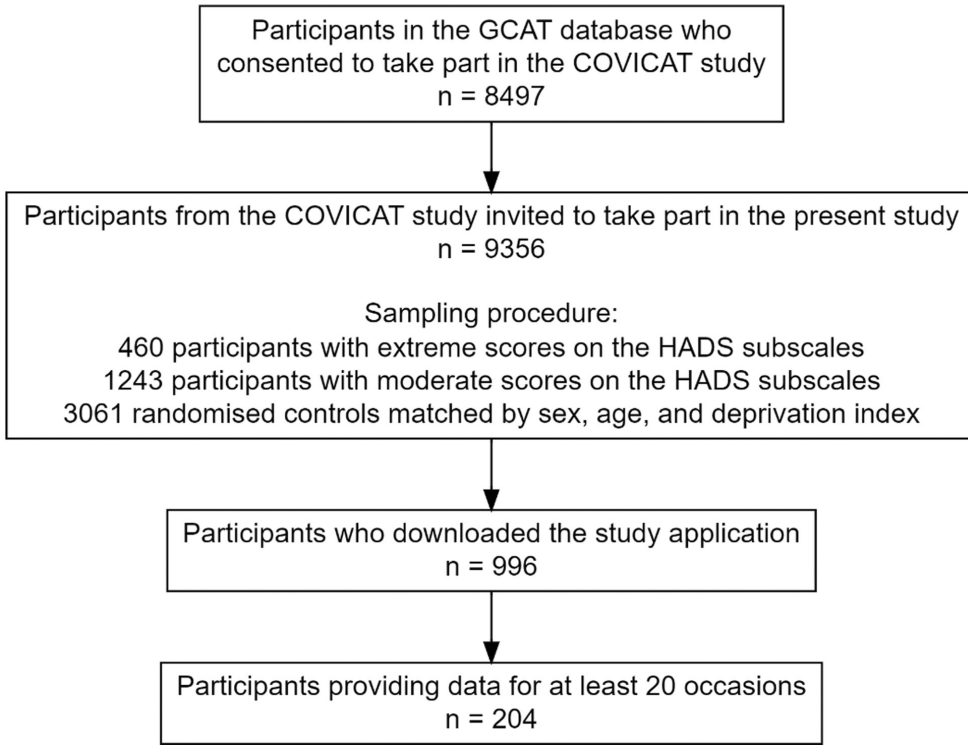

FIGURE 1 A flowchart of filters applied at each stage of participant exclusion to arrive at the final sample. HADS, Hospital Anxiety and Depression Scale.

'extremely anxious', based on an item used in previous studies (i.e. 'how anxious are you about climate change?') (Bouman et al., 2020).

Physical activity

Participants indicated, over the past 2 weeks, how many days, on average, they had engaged in at least 30 min of physical activity sufficient to slightly increase their breathing rate (1: none, 2: 1 day/week, 3: 2 days/week, 4: 3 days/week, 5: 4 days/week, 6: 5 days/week, 7: 6 days/week and 8: every day). This single item assessment method has been validated for monitoring changes in physical activity against accelerometer-derived measures (O'Halloran et al., 2020).

Perceived sleep quality

Participants rated the overall quality of their sleep, on average, on a visual analogue scale ranging from 0 'terrible' to 10 'excellent'. This single item measure has been validated against longer, validated, sleep questionnaires (Snyder et al., 2018).

Alcohol intake

Participants indicated how many days, on average, they had drunk alcohol over the past 2 weeks (1: none, 2: 1 day/week, 3: 2 days/week, 4: 3 days/week, 5: 4 days/week, 6: 5 days/week, 7: 6 days/week and

8: every day). This question was developed in accordance with guidelines for developing population surveys about alcohol consumption (Nugawela et al., 2016).

Screen time

Screen time was calculated by summing scores from two items asking about how many hours during the day, on average, they had spent using screen devices as their primary activity (television, smartphone, laptop or tablet) on (a) weekdays and (b) weekends (1: none, 2: 1 h or less per day, 3: 2–3 h/day, 4: 3–4 h/day and 5: more than 4 h/day). This item was selected from a longer questionnaire measuring screen time in adults (Vizcaino et al., 2019).

Diet quality

Participants rated how healthy their diet was (i.e. including lots of fruits and vegetables and few fatty foods, sweets, and processed foods) on a visual analogue scale ranging from 0 'bad' to 10 'excellent'. This single, self-rated item, has received validation against subjective and objective measures of dietary intake (Loftfield et al., 2015).

Generalized anxiety

The Generalized Anxiety Disorder 2-Item (GAD-2) scale measures core symptoms of generalized anxiety disorder using two items, asking participants how often they (i) felt anxious, and (ii) experienced uncontrollable worry, over the previous 2 weeks (1: never, 2: less than half the days, 3: more than half the days and 4: almost every day) (Kroenke et al., 2007). In Spanish samples, the GAD-2 has high internal consistency and good sensitivity and specificity, and concurrent validity with other validated measures of anxiety (García-Campayo et al., 2012).

Measures used for ancillary analyses

Ancillary analyses were conducted to examine different patterns between variables according to group, based on demographic and psychological data provided by participants as part of the COVICAT study. Participants completed the HADS (Zigmond & Snaith, 1983) adapted for Spanish samples (Herrero et al., 2003). The HADS was only collected at baseline. The HADS is a measure of anxiety and depression symptoms, and provides separate scores for each kind of presentation. An accepted cut-off for the presence of clinically significant anxiety is 8 (Herrero et al., 2003), which was the cut-off used in this study to form low-and high-anxiety groups (i.e. separate network analyses were then performed for these two groups). The HADS adapted for Spanish samples shows good internal consistency and external validity (Herrero et al., 2003). Participants also provided their age and gender at baseline.

Statistical analyses

Prior to conducting network analyses, distributions of all variables were inspected for normality and skewness. Bivariate associations for all included variables were calculated and, for the purpose of determining the within- versus between-person variability of climate anxiety, intra-class correlations (ICC) were also calculated for this variable.

Network analyses were performed including the following variables: climate anxiety, generalized anxiety, perceived sleep quality, physical activity, alcohol intake, diet quality and screen time. We calculated the networks using partial correlations methods as described by Costantini et al. (2019). Variables (or 'nodes') included in a network analysis are connected by an 'edge' if they correlate after controlling for all other correlations between variables in the network. Edges have two important features. First, their weight is graphically represented by the thickness of the lines connecting two variables, where thick lines indicate strong associations and thin lines indicate weak associations. Second, their sign is represented by colour, with blue and red lines representing positive and negative associations respectively (see Epskamp et al., 2018).

Ancillary analyses were performed to produce separate networks by group. One of the group analyses compared participants above and below the cut-off of clinically-significant anxiety by reference to their score on the HADS (Zigmond & Snaith, 1983) adapted for Spanish samples (Herrero et al., 2003). Ancillary analyses also calculated separate networks for men/women and lower-age/higher-age individuals.

We computed both between-person and within-person networks. The purpose of a between-person network was to understand the average associations between climate anxiety, generalized anxiety, and health behaviours across all participants and the whole study duration. By doing this, we could capture the general patterns of relationships among variables during the study intervention. The between-person network represents average behavioural relationships across all 20 time points for each individual, offering insight into the global patterns of association between outcomes.

The within-person network analysis focuses on individual variances from their own average levels of climate anxiety, generalized anxiety and health behaviours. We computed this network by subtracting each participant's overall average behaviour from their scores at each time point. The objective here was to examine whether changes from the average level of one variable over time were associated with changes from the average level for other variables. This within-person approach allows us to capture unique patterns occurring within individuals that might not be reflected in the broader, between-person analysis. By calculating both types of networks, we aimed to build a more holistic understanding of psycho-behavioural inter-relationships, capturing both stable and time-varying patterns of association.

All analyses were performed using RStudio (Version 2023.06.0+421; R Core Team, 2022). The 'least absolute shrinkage and selection operator' (LASSO) estimation and the Extended Bayesian information Criterion (EBIC) were used to estimate the covariance structures in both between- and within-person networks. The network analyses were performed with high specificity and low sensitivity, limiting false-positive findings. The data and code used in the present study can be found in the Supporting Information (https://tinyurl.com/bddm3ejz).

RESULTS

Participant characteristics

Data was provided by 204 participants; there were 125 women, 71 men and eight people did not provide their gender, as they had registered to the app study with an unknown email address and we were therefore unable to re-identify them in the descriptive dataset. The sample had a mean age of 55 (SD = 8; range: 44–70) (see Table 1 for descriptive statistics for the remaining variables included in analyses).

Tables 2 and 3 show bivariate correlations between all the variables included in network analyses (at between- and within-person levels respectively).

TABLE 1 Descriptive analyses for all psycho-behavioural variables, and minimum/maximum scores for each of their scales.

Variable	Mean (SD)	Min–Max score for each scale
1. Anxiety symptoms	7.15 (3.11)	0–21
2. Generalized anxiety	2.20 (.52)	1–4
3. Climate anxiety	4.98 (2.21)	0–10
4. Sleep quality	6.04 (1.97)	0–10
5. Diet quality	6.70 (1.56)	0–10
6. Physical activity	4.19 (1.90)	1–8
7. Alcohol consumption	3.35 (2.30)	1–8
8. Screen time	3.49 (.71)	1–8

Note: Variable 1 represents the mean/SD of participants' HADS-anxiety score taken at baseline. Variables 2–8 represent the mean/SD scores of participants' mean scores across all 20 observations.

Abbreviation: HADS, Hospital Anxiety and Depression Scale.

TABLE 2 Bivariate correlations between psycho-behavioural variables (between-person).

	PA.b	Drinks.b	SleepQ.b	Diet.b	Screen.b	Climate.b
PA.b						
Drinks.b	.04					
SleepQ.b	.16*	−.03				
Diet.b	.22**	.00	.48***			
Screen.b	−.02	.14*	−.18*	−.21**		
Climate.b	.10	−.05	−.08	−.02	−.04	
GAD.b	−.12	.02	−.18*	−.17*	.06	.04

Note: Climate = climate anxiety; Diet = healthy diet; Drinks = alcohol intake; GAD = generalized anxiety; PA = physical activity; Screen = screen time; SleepQ = sleep quality.

*$p < .05$. **$p < .01$. ***$p < .001$.

Within-person variability in psycho-behavioural variables

Participants' scores on the climate anxiety question were found to have an ICC of .74, indicating that 74% of the variability in scores was due to stable differences between individuals on the measure, whereas the remainder (1−ICC) was due to within-person variability in the experience of climate change, as well as measurement error (26%). As such, individuals' levels of climate anxiety was deemed to vary both within- and between-individuals, justifying network analyses that analysed the interplay of climate anxiety at both levels of analysis. The ICC of the GAD-2 scale (averaged across both items) was found to be .81 (.78 and .68 for feelings of anxiety and experiences of uncontrollable worry respectively). These ICC scores are comparable to what has been found for measures of generalized anxiety. For example, Vîslă et al. (2021) reported ICC scores of .69 and .66 for measures of anxiety and worry controllability respectively.

Measures of health behaviours were found to have the following ICCs: physical activity (.69), alcohol (.86), sleep quality (.67), healthy diet (.66) and screen time (.67).

Network analyses

Figure 2 (left diagram) shows between-participant associations between all variables (for exact values of network edges, see Tables S2 and S3; https://tinyurl.com/bddm3ejz). Climate anxiety was not associated

TABLE 3 Bivariate correlations between psycho-behavioural variables (within-person).

	PA.w	Drinks.w	SleepQ.w	Diet.w	Screen.w	Climate.w
PA.w						
Drinks.w	.08***					
SleepQ.w	.06***	.02				
Diet.w	.11***	−.10***	.14***			
Screen.w	0	−.01	−.02	.01		
Climate.w	.01	.03*	.01	.01	.02	
GAD.w	−.02	.02	−.07***	−.03*	−.02	.02

Note: Climate = climate anxiety; Diet = healthy diet; Drinks = alcohol intake; GAD = generalized anxiety; PA = physical activity; Screen = screen time; SleepQ = sleep quality.

* $p < .05$. *** $p < .001$.

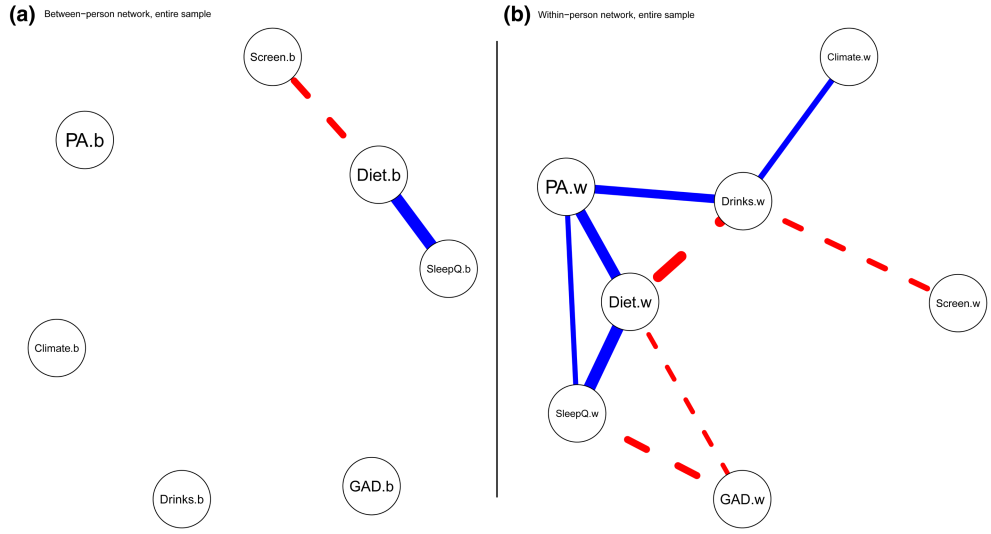

FIGURE 2 Between-person (left) and within-person (right) associations between climate anxiety, generalized anxiety and health behaviours. Climate = climate anxiety; Diet = healthy diet; Drinks = alcohol intake; GAD = generalized anxiety; PA = physical activity; Screen = screen time; SleepQ = sleep quality. Blue (full) lines are positive associations and red (dashed) lines are negative associations.

with health behaviours and generalized anxiety at the between-participant level. Physical activity and alcohol consumption were not associated with other health behaviours or generalized anxiety at the between-participant level, whereas, on average, across all time points, healther diet was associated with less screen time and better sleep quality.

As seen in Figure 2 (right diagram), the within-person network analysis found a significant positive covariation between climate anxiety and alcohol intake. In other words, when people reported higher climate anxiety at any given time point than their average level of climate anxiety across all time points, they also tended to report a higher level of alcohol consumption than their average level of alcohol consumption across all time points.

A significant positive covariation was found between alcohol intake and physical activity, and significant negative covariations were found between alcohol intake, screen time and diet. A significant positive covariation was found between healthy diet, physical activity and sleep quality, and a significant negative covariation was found between healthy diet and generalized anxiety. A significant positive

covariation was found between sleep quality and physical activity, and a significant negative covariation was found between sleep quality and generalized anxiety.

Ancillary analyses

As we might expect those with clinically significant levels of anxiety to differ in how they cope with climate anxiety, separate network analyses were conducted to compare participants below the cut-off for clinically significant levels of anxiety on the HADS-anxiety measure (total score <8; $n = 122$), and those at or above the cut-off ($n = 74$). Separate analyses were also conducted by gender (men [$n = 71$]/women [$n = 125$]) and age (below the mean age of 55 [$n = 97$]/55 and above [$n = 71$]), as some previous work has found women and younger people to have higher levels of distress relating to climate change (Reser et al., 2012).

There were no significant associations between climate anxiety or generalized anxiety and any health behaviours for all between-person analyses. For within-person analyses, climate anxiety showed positive covariation with alcohol consumption for people with clinically significant levels of anxiety and for younger participants, and generalized anxiety showed negative covariation with sleep for all analyses except for men. Generalized anxiety also showed negative covariation with diet quality and alcohol consumption for younger participants, negative covariation with physical activity for older participants, and negative covariation with diet quality for women.

The network outputs by group can be found in the Supporting Information (Figures S1–S3), and the values of each edge within the networks are to be found in Tables S4–S15 (https://tinyurl.com/bddm3ejz).

Sensitivity and specificity analyses

We followed the tutorial provided by Epskamp (2019) to determine the sensitivity and specificity of our network analyses for a sample size of 204 and the number of nodes included in our network, which indicated high specificity (.86) and moderate sensitivity (.57).

While the purpose of including participants who had provided data for at least 20 time points was to capture potential seasonal variation in questionnaire responses, we tested whether increasing network sensitivity by reducing this requirement to 10 time points ($n = 375$) would reveal additional relationships for the variable of central interest (climate anxiety). The network analysis revealed no difference in the associations between climate anxiety and other variables, with the exception that there was no longer an association between climate anxiety and higher alcohol consumption (see Figure S4; https://tinyurl.com/bddm3ejz). We consider the implications of this in the "Discussion" section.

DISCUSSION

This study aimed to understand the interplay between climate anxiety, generalized anxiety, and a range of health behaviours. There are two notable findings: the lack of association between climate anxiety and generalized anxiety, and the lack of association between climate anxiety and any health behaviours, except for higher alcohol intake at the within-participant level.

The lack of association between climate anxiety and generalized anxiety at the between- and within-person levels (and their non-significant bivariate association at both levels; see Tables 2 and 3) is of note. Gago et al. (2024) found that the majority of studies have found an association between generalized anxiety and climate anxiety when using the climate change anxiety scale (CCAS; Clayton & Karazsia, 2020). Nonetheless, the effect size of this association can be small (e.g. Hepp et al., 2022), and at least one study has found no correlation between the CCAS and generalized anxiety (Mouguiama-Daouda et al., 2022).

The CCAS was based on measures of psychopathology (in particular, repetitive negative thinking and impairment) (Clayton & Karazsia, 2020), and it has been argued that it appears only to measure emotional/functional *impairment* as opposed to climate anxiety per se (Wullenkord et al., 2021). On the other hand, our study asked participants to note how anxious they felt about climate change, with no indication of impairment or cognitive rumination. As such, it is perhaps unsurprising that we did not find an association between climate anxiety with generalized anxiety, as worry (repetitive thinking) that feels uncontrollable (impairing) is a key feature of generalized anxiety as measured by the GAD-2 (Kroenke et al., 2007). Future meta-analyses are required to further understand under which conditions different measures of climate anxiety and generalized anxiety are associated.

There is no firm evidence from our results that climate anxiety, as conceptualized and measured in the present study, is associated with poor functioning with regard to most common health behaviours. On the other hand, generalized anxiety was associated with a less healthy diet and lower sleep quality at the within-person level, consistent with previous findings (Pillai & Drake, 2015; Reichenberger et al., 2021). We believe that this could also reflect the conceptual difference between our measures of climate anxiety and generalized anxiety, in which only the latter captured functional impairment. Ancillary analyses indicated that alcohol use only covaried with climate anxiety for those with clinically significant levels of anxiety symptoms and among the younger adults in the sample. Studies have shown that more anxious individuals find it harder to cognitively disengage from threat (for a review see Cisler & Koster, 2010), and it is possible that some individuals consume alcohol in order to cope with the reality of climate change. A systematic review of adults' anxiety responses to climate change highlighted emotional distancing from the issue as a major coping strategy (Soutar & Wand, 2022). Ojala (2012) reported similar findings in a young sample, in which cognitive and behavioural distraction were methods employed to divert attention away from climate change (emotion-focused coping; Frydenberg, 2008). This association would need to be replicated, but we can surmise that some individuals cope with the threat of climate change through alcohol intake, which might numb the emotional experience. An additional explanation might also be that climate anxiety has seasonal variation, with potentially higher climate anxiety in summer when temperatures are higher, which is also a time of year when alcohol intake is likely to be higher (Uitenbroek, 1996). The association between climate anxiety and higher alcohol consumption was no longer evident in network analyses conducted on a narrower range of time points (10), which lends support to this possibility.

Other findings in the network analysis cohere with previous findings on the links between different health behaviours, which increases our confidence in the validity of our results. For example, our finding that better sleep quality is associated with lower generalized anxiety is consistent with research that has found associations between better sleep quality and lower stress (Maher et al., 2022). The finding that higher generalized anxiety is associated with a less healthy diet echoes previous findings that higher stress levels are associated with increased eating (Reichenberger et al., 2021). The finding that screen time is associated with a less healthy diet is consistent with the findings from a meta-analysis, which found that increases in screen time during COVID-19 were associated with less healthy eating (Trott et al., 2022).

While the association between more physical activity and higher alcohol consumption might seem counter-intuitive at first, when viewed from a multiple health behaviours perspective it is consistent with the idea of behavioural coupling, in which drinking alcohol tends to occur in situations involving higher physical activity (e.g. as socializing involves travelling to meet friends as well as alcohol consumption). Conroy et al. (2015) reported a daily diary study, in which there was a within-person association between higher alcohol intake and more physical activity. Socializing could also explain the association between higher alcohol intake and less screen time, as engaging with others would presumably entail less absorption in TV, mobile devices, etc. As social behaviour was not included in the study, the network analysis was unable to determine whether these associations still exist when controlling for frequency of socializing.

Our study also has implications for behaviour change interventions to increase pro-environmental behaviour. As our study did not find within-person changes in climate anxiety in our sample as a whole

to covary with changes in mental health (generalized anxiety) and most of the health behaviours that were measured, our findings suggest that interventions to induce climate anxiety in order to encourage pro-environmental behaviour may not have significantly negative health implications. This hypothesis deserves to be tested in future trials inducing climate anxiety.

Strengths and limitations

The main strength of this study is its intensive longitudinal nature, and the conclusions that can be reached about within- and between-person variation on an array of psycho-behavioural variables. The use of network analysis allowed for examining unique associations between variables when controlling for multiple other variables; this, in combination with the use of high specificity in analyses, limits the chance of spurious findings.

The use of brief and single-item questionnaires was unavoidable given the intensive nature of the study and the need to minimize participant burden and attrition; however, this does raise issues of conceptual coverage, and therefore limits the generalizability of our findings to different facets of climate anxiety. Further work could extend this research to examine impairment from climate anxiety, as well as exploring how health behaviours related to other emotional responses to climate change (such as anger, depression, grief and guilt; Ágoston et al., 2022; Stanley et al., 2021). Further, the reliability and validity of the single-item measure of climate anxiety used in the present study has not yet been established, which limits the strength of conclusions that can be drawn from our findings. Another limit to generalizability is the age of the sample (mean = 55). Whether the findings apply to younger samples remains to be seen. A large proportion of the sample was also drawn from a cohort of blood donors, and these might be particularly conscientious individuals with respect to health behaviours.

We selected commonly-studied health behaviours for this study, but did not include health behaviours that have significant pro-environmental benefits, such as active travel or avoiding red meat and dairy consumption; for these behaviours, we may be more likely to expect a relationship with climate anxiety if they are undertaken to mitigate climate change (cf. Verplanken et al., 2020). Such considerations open up the possibility to study different causal pathways between climate anxiety and health behaviours, including those mediated by generalized anxiety and those mediated by other factors.

It would be illuminating for future research to include additional health behaviours, such as social engagement, which form the basis of collective climate action. Research is beginning to delineate the co-benefits of pro-environmental behaviour for mitigating climate change as well as enhancing well-being, and socially orientated pro-environmental behaviours appear to be particularly strongly associated with well-being (Capstick et al., 2022).

Climate anxiety might fluctuate with weather patterns that bring climate change to the forefront of people's minds. A fine-tuned analysis of weather patterns for different geographical regions was beyond the scope of this study, but it would illuminating explore this in future.

Conclusions

This paper has offered insight into the associations between climate anxiety and health behaviours, and its distinctiveness from generalized anxiety. Our intensive longitudinal study has shown that within-person variance in climate anxiety does not covary with within-person variance in generalized anxiety or health behaviours, with the exception of alcohol consumption. Specifically, those with higher levels of clinically significant anxiety, as well as younger individuals, show an association between climate anxiety and higher alcohol intake. Climate anxiety did not covary with any variable at the between-person level. These findings imply that climate anxiety, as conceptualized and measured in the current study, is not in itself functionally impairing for a range of behaviours. Our findings suggest that interventions to induce climate anxiety in order to increase uptake of pro-environmental behaviours may not

always cause adverse impacts on health or mental well-being. However, as our study measured only one facet of climate anxiety, further work is needed to validate these findings and to compare them with other ways of measuring this construct.

AUTHOR CONTRIBUTIONS

Marc O. Williams: Conceptualization (equal); Formal analysis; Writing – original draft; Writing – review and editing (equal). Guillaume Chevance: Conceptualization (equal); Supervision; Project Administration; Methodology (equal); Writing – review and editing (equal). Judith Garcia-Aymerich: Methodology (equal); Writing – review and editing (supporting). Joren Buekers: Writing – review and editing (supporting). Gemma Castaño-Vinyals: Writing – review and editing (supporting). Rafael de Cid: Writing – review and editing (supporting). Laura Delgado-Ortiz: Writing – review and editing (supporting). Ana Espinosa: Writing – review and editing (supporting). Sarah Koch: Writing – review and editing (supporting). Manolis Kogevinas: Writing – review and editing (supporting). Marco Viola: Writing – review and editing (supporting). Lorraine Whitmarsh: Writing – review and editing (supporting).

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available at https://tinyurl.com/bddm3ejz.

ORCID

Marc O. Williams https://orcid.org/0000-0001-7623-6085
Joren Buekers https://orcid.org/0000-0003-4866-5741
Marco Viola https://orcid.org/0000-0003-2470-4283

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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