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Modelling associations between mortality salience, environmental concerns, and climate change risk perception in the context of the pandemic

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ABSTRACT

The pandemic and climate change are mortality salience triggers. Environmental issues, attitudes, and climate change risk perceptions were hypothesised to impact how individuals perceived the threat of COVID-19 and climate change during the pandemic. The study explored: 1.) the associations between seeing a link between COVID-19 and climate change and environmental concerns; 2.) the associations between mortality salience and environmental concerns; 3.) the associations between feeling less worried during the pandemic and environmental concerns; and 4.) what these associations tell us about the relationship between mortality salience, the perceived link between COVID-19 and climate change, and feeling less worried during the pandemic. A sample of 665 respondents was achieved from an online survey in 2021. The results of the multiple regression analysis and structural equation modelling showed that environmental issues, attitudes and perceptions, time spent in nature, and climate change risk perception played a role in the extent to which individuals perceived COVID-19 as an indicator of climate change threats, whether mortality salience was made conscious, and whether there was distancing of concern about climate change and social issues during the pandemic. The study makes an important contribution to understanding psychological processes that are activated during disasters that trigger mortality salience, and how this is impacted by the human-nature nexus, and climate change risk perception.

1. Introduction

The pandemic and climate change were existential threats that humanity had to grapple with simultaneously. There exists parallels and interactions between the two threats [1]. They are both indictors of the exploitative relationship that humans have with the natural environment and an expression of the Anthropocene [2]. The likely zoonotic source of COVID-19 drew attention to the role that the destruction and exploitation of animal species and biodiversity plays in increasing human-wildlife interaction and/or conflict [3]. Climate change is likely to increase the prevalence of pandemics [4,5]. These issues are parts of a complex system that impacts the human psyche in how it processes, makes sense of, and responds to these challenges. Nevertheless, there is a lack of research that explores the psychological context of the pandemic and climate change as co-occurring mortality salience triggers with associations to the environmental attitudes and affect within a developing country where multiple other social issues also impact individuals. Given

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the psychological overlap between the pandemic and climate change [6], there was an opportunity to explore how this overlap could inform the relationship between environmental attitudes, climate change risk perception, connection with nature, and their impact on mortality salience, the perceived link between climate change and the pandemic, and negative emotional responses.

This study explored the extent to which there were associations between COVID-19 induced factors (seeing a link between climate change and COVID-19, mortality salience induction, and less worry) and environmental factors (environmental concerns, attitudes, climate change risk perception, and experience of time spent in nature). Given the lack of previous research, this study was exploratory, investigating: 1.) the link between COVID-19 and climate change and environmental concerns, attitudes, perception and experience; 2.) the associations between mortality salience and environmental concerns, attitudes, perception and experience; 3.) the associations between feeling less worried during the pandemic and environmental concerns, attitudes, perception and experience; and 4.) the relationships between mortality salience, COVID-19 and climate change, and feeling less worried during the pandemic.

We discuss the concept of mortality salience and its interconnectedness with the relationship that individuals have with nature, followed by a discussion on environmental concern and climate change during the pandemic.

1.2. Mortality salience

Pandemics are death cues that can highlight individual mortality [7]. Mortality salience provides a novel lens to explore the extent to which COVID-19 interacted with environmental attitudes. Mortality salience is a component of Terror Management Theory (TMT) that was developed in the 1980's [8]. TMT theory contends that humans have a desire for self-preservation and engage in behaviours to ease the existential terror associated with the, often repressed, awareness of death [9–11]. Repression usually allows for normal functioning in the world [12], but COVID-19 was an abrupt trigger of mortality salience potentially triggering death-anxiety. Death anxiety is the fear of one's own death [13] that is different to death uncertainty which is related to the fear of when and how death with come [14]. Individuals have varied psychological responses to disasters such as COVID-19 [15] and climate change [16]. Within a heightened mortality awareness context it is likely that the priority of concerns and associated responses are enhanced for individuals [17]. During COVID-19 it is possible that the proximal (immediate, direct, concrete) nature of the pandemic [18] shifted concerns away from concerns about climate change [19] due to its distal (remote, general, over a long period of time, abstract) nature. Given the high likelihood of future pandemics [20], there was an opportunity to explore how these factors relate to each other in order to understand what mortality salience induction events mean for the human psyche and how it relates to nature and climate change.

1.2.1. Mortality salience and the human-nature nexus

Several environmentally themed studies have shown that mortality salience has varied impacts on human-nature connections (see Ref. [21] for a review). Mortality salience has been shown to increase exploitation and consumption of natural resources [22], increase materialism [23], reduce connection to non-human animals [24], increase climate change denial [25], limit advancement of climate action [26], reduce pro-environmental behaviour [27], reduce motivation to protect the natural environment [28], and reduce environmental concern [29]. These studies add to the understanding of how death cues might impact the human-nature nexus and show a general trend that awareness of death, negatively influenced perceptions and attitudes towards the biosphere. However, these previous studies consider individual constructs in isolation rather than how multiple constructs might interact to further our understanding of mortality salience and the human-nature nexus.

1.3. The pandemic and environmental concern

Environmental research conducted during the pandemic showed no consistent trend regarding the ability of the pandemic to increase or decrease environmental concern. Some studies suggested that COVID-19 had a positive impact on environmental attitudes and perceptions where the pandemic increased nature engagement (spending time in nature) and environmental values [30], had a positive influence on intention and pro-environmental behaviour [31], increased concern and pro-environmental behaviours by those who perceived the pandemic to be result of negative impacts humans are having on nature [32], and had a positive relationship between connection to nature and pro-environmental behaviour for those that viewed the pandemic as a threat [33]. In contrast, Lucarelli et al. [34] found no shift in environmental intentions and pro-environmental behaviour before and after the pandemic, which contradicted the positive. Awuh et al. [35] also found that the pandemic did not change how people thought about the natural environment. Furthermore, a study by Stahl [36] found that increased engagement with nature did not lead to an increase in human-nature connection during the pandemic. The lack of consensus amongst these studies suggest that the impact of the pandemic on environmental attitudes and perceptions may not be universal, and therefore other factors need to be considered that might influence the human-nature nexus during the pandemic. It raises a further question around whether the pandemic increased mortality salience if the impact on environmental concern was found to be positive (or benign).

1.4. The pandemic and climate change

Morality salience can play a role in shaping people's interpretation of climate change risk [37–39]. The pandemic impacted evaluations of risk, interpretation of the world, individual and collective priorities, and coping behaviours [40,41]. According to Evensen et al. [42], during the pandemic, climate change was less urgent for people (in the UK) compared to COVID-19, but beliefs about climate change severity did not decline. A study conducted across Spain, Netherlands, USA, UK, and Myanmar found that participants could not identify a link between climate change and infectious diseases [43] suggesting that for these participants, the

pandemic was not psychologically linked to climate change. On the other hand, a study conducted across 16 major economies found that the experience of the pandemic increased concerns about climate change [44]. Furthermore, other studies suggested a link between being impacted by the pandemic and risk perceptions of issues such as climate change [45–47]. These studies suggest a potential association between the COVID-19 pandemic and climate change risk perception, but there is a need for a deeper understanding of the dynamics of this association.

This study aimed to expand mortality salience research in the context of environmental challenges and climate change risk and to explore their interconnectedness [26]. The variables chosen for this study were based on mortality salience literature [7,10,13,48], environmental research [21,24,49,50], and climate change risk perception [51–53]. The following section describes the materials and methods used to identify and measure the dependent and independent variables.

2. Materials and methods

2.1. Participants

An overall sample of 655 was achieved. Participation was based on access and voluntariness, using convenience sampling [54]. The survey invitations were sent to a South African online panel (https://african-pulse.com/), and shared on social media. Invitations to participate ran from May 21 to June 8, 2021, during the third wave of COVID-19. During this time South Africa transitioned from adjusted level 1 to 2 on May 31, and to alert level 3 on June 15 [55]. Using a mixed recruitment strategy allowed for variability in participant participation [56]. Individuals who join online panels opt into participation, and no criteria were set for the panel, allowing for variability. Social media recruitment was done through running an online invitation where the criteria were set for South Africa, but no other determining criteria were used to allow for a broad range of participation. Participants were able to opt into participation by clicking on the invitation. Once this was done, they were taken to the participant information sheet where they needed to provide consent, before being routed to the online questionnaire if they opted to participate. Due to the data gathering method (online), the sample included mainly urban, literate individuals with Internet access, but potentially excluded those living in remote rural areas or informal urban settlements who might not have had access to the Internet.

2.2. Instruments

2.2.1. The demographic questionnaire (DQ)

In addition to the demographic information reported in Table 1, we gathered information pertaining to home language, education level, occupation status and type, and personal income (see supplementary material). We included participants that identified as South African, were above 18 years old, and felt that they were mostly competent or fluent in English as the questionnaire was in English. Table 1 reports on key demographic of the sample.

2.2.2. COVID-19 and climate change questionnaire (CCC)

The CCC was a self-developed questionnaire that explored the extent to which the pandemic impacted perceived climate change risk, degree of mortality salience, and whether the pandemic caused less worry about issues not perceived as immediately threatening.

Table 1
Sample demographics (n = 655).

Demographic variables	%
Age group	
18–25 years	28.2
26–35 years	29.7
36–45 years	19.4
46–55 years	18.9
56+ years	3.9
Gender	
Male	39.0
Female	61.0
Population group	
Black	38.7
Mixed race	10.8
Asian/Indian	5.5
White	41.0
Other/refuse	3.9
Province	
Gauteng	38.7
Western Cape	17.4
KwaZulu-Natal	10.1
Free State	3.4
Eastern Cape	2.9
Other	27.6

To our knowledge there were no existing questionnaires available that measured these constructs. Our items were identified after conducting a qualitative analysis of the literature [57] on the intersection between COVID-19 and climate change [6], mortality salience [8,11,58], and apathetic attitudes [59]. After potential variables were identified, the questionnaire was designed by selecting and adapting items that emerged from the literature [60]. We ensured the items were relevant, clear, and aligned with our research objectives and constructs being measured [61,62].

The final questionnaire consisted of 18 items on a 5-point agreement scale (1 = not at all; 4 = very much; 0 = don't know). Respondents who had identical responses across all items were excluded as they demonstrated response sets. The items were subjected to Exploratory Factor Analysis (EFA) to simplify the dependent variables and allow for a deeper more focused analysis to understand the underlying patterns within the dataset [63,64]. This analysis was done using Principal Components Analysis with varimax (orthogonal) rotation to determine independent underlying dimensions in the data (and to reduce the dimensionality of the data for further analysis). Kaiser's criterion, scree plot analysis, and the proportion of total variance explained were considered in determining the number of factors to extract. Internal consistency was assessed by Cronbach alpha.

The three emergent factors and their constituent items are shown in Table 2. The factors were 'link COVID-19 and climate change' (α = 0.860), 'mortality salience' (α = 0.770), and 'less worry' (α = 0.666). These three factors formed the dependent variables in the subsequent model testing.

2.2.3. The environmental issues and attitudes questionnaire (EIAQ)

The EIAQ measures awareness, concern, and attitudes related to general issues (e.g., social issues), South African animal and environmental issues (e.g., canned lion hunting, poaching, water scarcity), and recent challenges (e.g., HIV/AIDS) [17,59,70].

The overall concerns section consisted of 11 items rated on a 5-point degree of concern scale (1 = not at all concerned; 5 = extremely concerned; no opinion). The specific concerns section explored issues related to the environment (18 items) and animal concerns (17 items) on a 5-point concern scale (1 = not at all concerned; 5 = extremely concerned; no opinion). Attitudes (25 items) related to the environment, domestic animals, farm animals, wild animals, and general attitudes were explored on a 5-point agreement scale (1 = strongly disagree; 5 = strongly agree; don't know).

EFA was conducted as described for the CCC in section 2.3.2. The emergent factors and their constituent items are shown in Tables 3–6. The factors for overall concerns were 'general concerns' (α = 0.764), 'health concerns' (α = 0.778), and 'biocentric concerns' (α = 0.537). The factors for the environmental concerns were 'human-centric' (α = 0.813), 'climate-centric' (α = 0.855), 'resource-centric' (α = 0.829), and 'science-centric' (α = 0.704). The factors for animal concerns were 'animal exploitation' (e.g.α = 0.874) and 'animal extinction' (α = 0.875). The factors for attitudes were 'shifting responsibility' (α = 0.914), 'individual contribution' (e.g. α = 0.689), 'government's responsibility' (α = 0.808), 'technological solutions' (α = 0.854), and 'apathy' (α = 0.811).

2.2.4. Climate change risk perception model (CCRPM)

The CCRPM explored psychological factors that influence public risk perceptions (see Table 7) [52]. Key factors relevant to this study included 'global', 'personal', and 'holistic risk' perception through 8 items (e.g. "How serious of a threat do you believe that climate change is to you personally?") rated on a 7-point agreement scale (1 = not concerned at all/very unlikely/not serious at

Table 2
Factor loadings for COVID and Climate Change Questionnaire (CCC).

	Factor 1 'mortality salience'	Factor 2 'link COVID-19 and climate change'	Factor 3 'less worry'
COVID-19 made me realise the fragility of my own life	**0.70**[a]		
COVID-19 made me feel pre-occupied with the possibility of my own death	**0.72**[a]		
COVID-19 made me want to distract myself from thoughts of my own possible death	**0.62**[a]		
COVID-19 made me feel that the future is too uncertain for me to make serious plans	**0.51**[a]		
COVID-19 made me feel like life is like a lottery	**0.54**[a]		
COVID-19 made me feel like I have very little control over my life	**0.73**[a]		
There is a link between climate change and COVID-19		**0.76**[a]	
COVID-19 made me more concerned about climate change		**0.75**[a]	
COVID-19 made me feel that climate change is a real personal risk in my lifetime		**0.76**[a]	
COVID-19 made me feel that the destruction of nature will impact my quality of life		**0.61**[a]	
COVID-19 made me realise that humans are having a negative impact on the natural environment		**0.57**[a]	
COVID-19 made me change my consumption behaviour (i.e. to a diet that has a lower impact on the environment; less waste; more local produce)		**0.60**[a]	
COVID-19 is a message to humans about the type of world we will live in when climate change disasters become more prevalent		**0.73**[a]	
I believe there is a relationship between the destruction of nature and COVID-19		**0.74**[a]	
COVID-19 made me feel like there is no use worrying about public issues/affairs; I can't do anything about them anyway			**0.65**[a]
COVID-19 made me feel less concerned about climate change			**0.78**[a]
Climate change is too far in the future to worry about, so I would rather focus on the current issues related to COVID-19			**0.77**[a]

[a] Only factor loadings >0.5 are shown.

Table 3
Factor loadings for The Environmental Issues and Attitudes Questionnaire (EIAQ) overall concerns.

	Factor 1	Factor 2	Factor 3
	'general concerns'	'health concerns'	'biocentric concerns'
Economic concerns (e.g. unemployment, cost of goods)	**0.70**[a]		
Personal safety (e.g. crime, theft)	**0.69**[a]		
International tensions (e.g. terrorism, war)	**0.49**[a]		
Political concerns (e.g. government inadequacy, xenophobia)	**0.73**[a]		
Social issues (e.g. poverty, education)	**0.65**[a]		
Coronavirus/COVID-19		**0.84**[a]	
Future pandemics		**0.82**[a]	
Health concerns (e.g. cancer, AIDS)		**0.66**[a]	
Environmental concerns (e.g. loss of biodiversity, global warming)			**0.69**[a]
Animal rights concerns (e.g. sentience of animals, cruelty)			**0.86**[a]

[a] Only factor loadings >0.5 are shown.

Table 4
Factor loadings for The Environmental Issues and Attitudes Questionnaire (EIAQ) environmental concerns.

	Factor 1	Factor 2	Factor 3	Factor 4
	'human-centric'	'climate-centric'	'resource-centric'	'science-centric'
Human overpopulation	**0.71**[a]			
Loss of natural area	**0.61**[a]			
Waste generation	**0.55**[a]			
Urbanisation	**0.65**[a]			
Over consumption	**0.57**[a]			
Biodiversity loss	**0.57**[a]			
Climate change		**0.62**[a]		
Rising sea level		**0.68**[a]		
Global warming		**0.60**[a]		
Natural disaster		**0.72**[a]		
Ozone depletion		**0.67**[a]		
Air pollution			**0.62**[a]	
Water scarcity			**0.70**[a]	
Natural resource depletion			**0.59**[a]	
Water pollution			**0.72**[a]	
Nuclear energy				**0.55**[a]
Pesticides				**0.59**[a]
Genetically Modified Organisms				**0.79**[a]

[a] Only factor loadings >0.5 are shown.

Table 5
Factor loadings for The Environmental Issues and Attitudes Questionnaire (EIAQ) animal concerns.

	Factor 1	Factor 2
	'animal exploitation'	'animal extinction'
Entertainment	**0.64**[a]	
Legal rights	**0.64**[a]	
Domestic breeding	**0.72**[a]	
Wild breeding	**0.58**[a]	
Factory farming	**0.64**[a]	
Domestic animal welfare	**0.63**[a]	
Farm animal welfare	**0.71**[a]	
Animals used in testing	**0.62**[a]	
Animals used in consumer products	**0.60**[a]	
Canned lion hunting		**0.73**[a]
Deforestation		**0.60**[a]
Overfishing		**0.51**[a]
Whale hunting		**0.66**[a]
Dolphin capture		**0.71**[a]
Cruelty		**0.54**[a]
Poaching		**0.70**[a]
Trophy hunting		**0.69**[a]

[a] Only factor loadings >0.5 are shown.

Table 6
Factor loadings for The Environmental Issues and Attitudes Questionnaire (EIAQ) attitudes.

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
	'shifting responsibility'	'individual contribution'	'government's responsibility'	'technological solutions'	'apathy'
Environmental impacts are often overstated	**0.63**[a]				
Environmental issues should be dealt with primarily by future generations	**0.76**[a]				
Issues around the welfare of domestic animals are often overstated	**0.63**[a]				
Issues around domestic animals should be dealt with primarily by future generations	**0.80**[a]				
Issues around the welfare of farm animals are often overstated	**0.70**[a]				
Issues around farm animals should be dealt with primarily by future generations	**0.75**[a]				
Issues around the welfare of wild animals are often overstated	**0.70**[a]				
Issues around wild animals should be dealt with primarily by future generations	**0.79**[a]				
Wild animals need to contribute economically to deserve protection	**0.62**[a]				
Each individual/household can contribute to a better environment		**0.67**[a]			
Each individual/household can contribute to domestic animal welfare and protection		**0.74**[a]			
Each individual/household can contribute to farm animal welfare and protection		**0.70**[a]			
Each individual/household can contribute to wild animal welfare and protection		**0.77**[a]			
The government is responsible for the welfare of the environment			**0.78**[a]		
The government is responsible for the welfare of domestic animals			**0.79**[a]		
The government is responsible for the welfare of farm animals			**0.80**[a]		
The government is responsible for the welfare of animals in the wild			**0.76**[a]		
Environmental issues will be resolved primarily through technological progress				**0.78**[a]	
Domestic animal issues will be resolved primarily through technological progress				**0.64**[a]	
Farm animal issues will be resolved primarily through technological progress				**0.80**[a]	
Wild animal issues will be resolved primarily through technological progress				**0.73**[a]	
I find it hard to change my habits to be more environmentally-friendly					**0.81**[a]
Environmental problems is not a priority for me					**0.66**[a]
The effects of environmental destruction, such as climate change, is too far in the future to concern me					**0.54**[a]
It takes too much effort to adapt an environmentally friendly lifestyle					**0.74**[a]

[a] Only factor loadings >0.5 are shown.

all/very rarely; 7 = very concerned/very likely/very serious/very frequently). Knowledge about climate change was determined through the understanding of 'cause', 'impact', and 'response' (e.g. conserving energy, eating less meat) was rated on a 4-point change scale (1 = reduce climate change a lot to 3 = not going to reduce climate change at all, 4 = don't know) (α not relevant for these scales as they test knowledge).

Generalised/holistic affect [52] was determined by three items (e.g., "I feel that climate change is …"; α = 0.882) rated on a 7-point affective scale (1 = very pleasant/favourable/positive to 7 = very unpleasant/unfavourable/negative). 'Personal experience' of extreme weather was determined by two items (recall experienced extreme weather events) on a 4-point frequency scale (1 = never, 2 = once, 3 = twice, 4 = more than three, 4 = can't remember) [52]. 'Descriptive social norms' (e.g., "Most people I care about are doing their bit to help slow climate change"; α = 0.861) and 'prescriptive social norms' (e.g., "It is generally expected of me that I do my bit to help reduce the risk of climate change"; α = 0.676) were explored with seven items on a 7-point agreement scale (1 = strongly disagree/very unlikely to 7 = strongly agree/very likely) [52].

Table 7
Summary of study variables and conceptual differences.

Analytical instruments	Conceptual description	Conceptual nuance	Factors and Variables	Description of factors and variables
Dependent variables				
COVID-19 and Climate Change Questionnaire (CCC)	Explored the extent to which the pandemic impacted the perceived link between COVID-19 and climate change, how COVID-19 impacted mortality salience, and how COVID-19 impacted feeling less worried	Impact of COVID-19	Link COVID-19 and climate change; mortality salience; less worry	All factors related to the immediate experience of COVID-19 and how that impacted personal, social, and environmental concern
Independent variables				
Environmental Issues and Attitudes Questionnaire (EIAQ)	The EIAQ explored concerns and attitudes related to global issues (e.g., climate change), South African issues (e.g., canned lion hunting, poaching), and proximal challenges (e.g., COVID-19).	General concerns	General societal; health; and biocentric concerns	General societal concerns included economic, personal safety, international tensions, political and social issues. General health concerns included cancer, TB, Aids, etc. General biocentric concerns included the loss of biodiversity, global warming, animal cruelty, animal sentience, and laws to protect animals
		Specific concerns	Human-centric; climate-centric; resource-centric; science-centric; animal exploitation; animal extinction	Human-centric concerns included the impact of humans on the biosphere related to issues such as overpopulation and waste. Climate-centric concerns included climate change, and natural disasters. Resource-centric concerns included water scarcity and natural resource depletion. Science-centric concerns included the impact of scientific advancements on the biosphere such as pesticides and nuclear energy. Animal exploitation included concerns such as factory farming and vivisection. Animal extinction included concerns such as deforestation and poaching.
		Attitudes	Shifting responsibility; individual contribution; government's responsibility; technological solutions; apathy	Shifting responsibility was passing on environmental issues to future generations. Individual contribution was the attitude that it is the responsibility of individuals to make a positive contribution to environmental and animal issues. Government's responsibility was an attitude that governments need to take sole responsibility for environmental and animal issues. Technological solutions were the attitude that technological progress will solve issues. The attitude of apathy was that environmental and animal issues are not a priority or too much effort to deal with.
Climate Change Risk Perception Model (CCRPM)	The instrument developed by Van der Linden (2015) explored psychological factors that influenced public risk perceptions of climate change and included cognitive, experiential, and socio-cultural factors.	Risk Perception Index	Global; personal; and holistic risk	Determined the degree to which the participant perceived climate change as a risk to the natural environmental, personal, or as a societal risk.
		Knowledge about climate change	Cause; impact; response	Determined the degree of knowledge regarding the extent to which certain anthropogenic activities impact climate change.
		Generalised/ holistic affect Personal experience of extreme weather	Personal experience	Determined how climate change is seen, felt, or personally experienced. Determined how often, in the last five years, there was an experience of flooding and other extreme weather events.
		Social norms	Descriptive; prescriptive social norms	Explored the importance of important referent others taking personal action

(*continued on next page*)

Table 7 (*continued*)

Analytical instruments	Conceptual description	Conceptual nuance	Factors and Variables	Description of factors and variables
				against climate change, and the extent to which they felt socially pressured to personally help reduce the risk of climate change.
		Broad value orientations	Biospheric; socio-altruistic values; egoistic values	Determined the importance of 12 values as guiding principles in their lives.
Time spent in nature	Determine whether individuals spent less, same, or more time in nature than before COVID-19.	Physical connection with nature		

DV: The dependent variable is the effect. Its value depends on changes in the independent variable.
IV: The independent variable is the cause. Its value is independent of other variables the study.

2.2.5. Time spent in nature

Participants were asked to indicate on a scale from 1 (less time than before), 2 (same amount of time as before), 3 (more time than before), or 0 (unsure) whether they spent more or less time in nature than before COVID-19.

2.3. Conceptual determinants and nuances of the analytical instruments

The research aimed to explore which independent variables were significantly associated with the link between COVID-19 and climate change, the impact of COVID-19 on mortality salience, and whether COVID-19 made people worry less about broader less immediate issues. Conceptual overlap amongst the dependent variables was minimised by conducting orthogonal factor analysis to group similar items together. The study included a range of independent variables to identify significant associations between the dependent variables and independent variables. Conceptually, the independent variables dealt with issues of concern, attitudes, risk perception, knowledge about climate change, affective experience of climate change, personal experience of extreme weather, social norms, broad value orientations, and physical contact with nature. Table 7 shows conceptual differences and nuances of the study factors and variables. The questionnaire is provided as supplementary material.

Ethics approval

Ethical clearance (number H21/03/14) was granted unconditionally by the university's Human Research Ethics Committee (non-medical). Electronically captured consent was received.

3. Analysis

The final subscales were formed by averaging the scores of the items making up the subscale. The CCRPM scales' data were cleaned and then scored according to the authors' [52] instructions.

Given the exploratory nature of the study, for each CCC factor, the association between the factor and the remaining study variables was assessed by simple and multiple regression. Categorical variables were dummy-coded with respect to a meaningful reference category (coded as 1 = the category; 0 = the rest). Study variables with significance $p < 0.05$ in univariate regression analyses were included in the multiple regression model. Multicollinearity was assessed by VIF >10. Non-significant variables were successively removed until only significant variables remained. Highly correlated independent variables were avoided (rho >0.75). The RPI Personal and Global scales were highly correlated with the Holistic scale (due to the manner in which this scale was calculated), therefore only the Holistic scale was used.

Thereafter, structural equation modelling in AMOS was utilised to confirm the relationships between the manifest (indicator) variables and their latent variables, and secondly, to evaluate the associations between the latent variables in the model. The associations between latent variables and other "self-standing manifest variables" [65], [p.392], for example single item indicator

Table 8
Fit statistics for the final measurement model.

p-value for model	Chi-square = 2287.087	Degrees of freedom = 958	Probability level <.001	Lack of Fit
cmin/df	2,387			Good
CFI	0,911			Acceptable
GFI	0,861			Lack of Fit
AGFI	0,843			Good
SRMR	0,0559			Acceptable
RMSEA	0,046			Good
PCLOSE	0,998			Good
TLI	0,904			Acceptable

variables, were also modelled. Sample size estimation was based on an anticipated structural equation model, with the detection of a medium effect size (0.3) with 5 latent and 15 observed variables with 80 % power at the 5 % significance level. A minimum sample size of 200 was required [66,67]. The actual sample size of 655 thus meets the sample size requirements.

4. Results

As an initial step, the measurement model was tested to identify whether the indicator variables effectively measured their respective latent constructs (see Table 8). The initial measurement model had fit indices of: Chi-square(958) = 2513.24 $p < 0.001$, SRMR = .0556, RMSEA = .049 (90 % CI = .047 - .052), CFI = .896, TLI = .888. Given these questionable fit results, modification indices were considered.

The modification indices suggested that the error terms of two pairs of 'shifting responsibility' items, and one pair of 'link COVID-19 and climate change' items be covaried. As these items shared similarity in their wording, suggesting the possibility of common method bias, the inclusion of the recommended variances was sensible. The final measurement model, post modification, displayed acceptable to good fit, including the following indices: Chi-square(958) = 2287.09 $p < 0.001$, SRMR = .0559, RMSEA = .046 (90 % CI = .043 - .048), CFI = .911, TLI = .904. The cut-offs for drawing fit conclusions were based on [64] recommendations and although the Chi-square was significant (suggesting a lack of fit), this statistic is often influenced by sample size and should be considered in the context of the other fit indices. Once the measurement model was fitted, the structural equation model was plotted.

The results first show the multiple regression models for the three dependent variables: 'mortality salience', 'link COVID-19 and climate change', and 'less worry'. The results then show the structural equation modelling that was utilised to evaluate the associations between the variables.

4.1. 'Mortality salience'

The 'mortality salience' subscale determined the degree to which the pandemic increased mortality salience and feelings of lack of control over one's life. The results of the multiple regression analysis that determined significant associations between this subscale and the remaining variables is shown in Table 9.

The biggest contributors to 'mortality salience' were 'link COVID-19 and climate change' (CCC), 'less worry' (CCC), 'health' issues and attitudes (EIAQ: Environmental issues and attitudes overall), and 'less time in nature than before' (Time spent in nature).

The perceived 'link COVID-19 and climate change' was associated with a significant increase in 'mortality salience. 'Less worry' from climate change, the future, and public issues due to COVID-19 was associated with a significant increase in 'mortality salience'. 'Less time spent in nature' than before COVID-19 started (vs. the same) was associated with a significantly higher score on 'mortality salience'.

4.2. 'Link COVID-19 and climate change'

The 'link COVID-19 and climate change' subscale determined the degree to which the pandemic increased concern about climate change, that there was a link between the destruction of nature and the cause of the pandemic, and the need for a change in consumption behaviour. The results of the multiple regression that determined significant associations between this subscale and the remaining variables is shown in Table 10.

The biggest contributors to 'link COVID-19 and climate change' were 'mortality salience' (CCC), increased 'environmental awareness' (EIAQ: Environmental awareness), 'holistic' (CCRPM: Risk Perception Index), 'climate-centric' concerns (EIAQ: Environmental concerns), and 'shifting responsibility' attitudes (EIAQ: Shifting responsibility).

The factor 'mortality salience' related to the conscious or subconscious recognition of one's own mortality and the resulting impact on thoughts, emotions, and behaviours and perceived lack of control over one's life was associated with a significant increase in the 'link COVID-19 and climate change' scale. Being more aware of environmental issues (vs. same as before) was associated with a significant increase in the 'link COVID-19 and climate change' scale. Risk Perception Index 'holistic' included seeing climate change as

Table 9
Multiple regression results for 'mortality salience' as the dependent variable.

Variable	standardised coefficient	SE	coefficient	SE	t	p-value
EIAQ: Environmental issues and attitudes overall						
Health	.281	.034	.227	.028	8.155	<.000[a]
CCC: Covid and Climate Change						
Link COVID-19 and climate change	.354	.034	.357	.035	10.277	<.000[a]
Less worry	.354	.032	.328	.029	11.193	<.000[a]
Time spent in nature						
Less time than before	.094	.036	.159	.061	2.619	.009[a]
Same amount of time than before/Unsure	0					
More time than before	.060	.036	.125	.074	1.687	.092

Note. N = 631, Adj $R^2 = 0.39$, $F(5, 625) = 80.4$, $p < 0.0001$.
[a] = $p < 0.05$.

Table 10
Multiple regression results for 'link COVID-19 and climate change' as the dependent variable.

Variable	standardised coefficient	SE	coefficient	SE	t	p-value
EIAQ: Environmental awareness						
I am more aware than before	.178	.038	.276	.059	4.678	<.000[a]
My awareness is the same as before	0					
I am now less aware than before	.059	.037	.193	.119	1.618	.106
EIAQ: Environmental concerns						
Climate-centric	.140	.042	.115	.034	3.335	<.001[a]
EIAQ: Attitudes						
Shifting responsibility	.124	.036	.099	.029	3.418	<.001[a]
CCRPM: Risk Perception Index						
Holistic	.201	.045	.140	.031	4.455	<.000[a]
CCRPM: Response knowledge						
Response knowledge	.096	.036	.045	.017	2.651	.008[a]
CCRPM: Social norms						
Prescriptive norm	.116	.040	.075	.026	2.905	<.004[a]
CCC: Covid and Climate change						
Mortality salience	.290	.036	.286	.036	8.022	<.000[a]

Note. N = 544, Adj $R^2 = 0.34$, $F(8,535) = 35.8$, $p < 0.0001$.
[a] = $p < 0.05$.

a concern and risk for self and society, and was associated with a significant increase in the 'link COVID-19 and climate change' scale. 'Climate-centric' environmental concerns related to worry about climate change, rising sea levels, natural disasters, and ozone depletion was associated with a significant increase in the 'link COVID-19 and climate change' scale. 'Shifting responsibility' related to attitudes that environmental/domestic animal/farm animal/wild animal issues were overstated and for future generations to deal with, and was associated with a significant increase in the 'link COVID-19 and climate change' scale.

4.3. 'Less worry'

The 'less worry' subscale determined the degree to which the pandemic decreased concern about climate change and public issues/affairs. The results of the multiple regression analysis that determined significant associations between this subscale and the other variables is shown in Table 11.

The biggest contributors to 'less worry' were 'mortality salience' (CCC), 'experience with extreme weather' (CCRPM: Extreme weather personal experience), 'apathetic' attitudes (EIAQ: Attitudes), 'more time in nature than before' (Time spent in nature), 'less time in nature than before' (Time spent in nature).

'Mortality salience' that determined mortality salience and lack of perceived control was associated with a significant increase in feeling less worried about climate change because it was too far into the future and a feeling of lack of control over public issues. Personal 'experience' of extreme weather (vs none) such as flooding, severe heat waves, droughts, storms in the last five years was

Table 11
Multiple regression results for 'less worry'.

Variable	standardised coefficient	SE	coefficient	SE	t	p-value
EIAQ: Environmental issues and attitudes overall						
Biocentric concerns	−.076	.039	−.074	.037	−1.976	.049[a]
EIAQ: Environmental concerns						
Climate-centric	−.150	.039	−.138	.036	−3.840	<.000[a]
EIAQ: Attitudes						
Shifting responsibility	.097	.044	.088	.040	2.209	.028[a]
Individual contribution	−.095	.033	−.132	.046	−2.833	<.005[a]
Technological solutions	.081	.040	.080	.040	2.004	.045[a]
Apathetic	.231	.039	.226	.039	5.863	<.000[a]
CCRPM: General Holistic Affect						
General holistic affect	−.115	.035	−.061	.018	−3.322	<.001[a]
CCRPM: Extreme weather personal experience						
Experience	−.103	.032	−.284	.088	−3.208	<.001[a]
No Experience	0					
CCC: Covid and Climate Change						
Mortality salience	.294	.033	.316	.035	8.937	<.000[a]
Time spent in nature						
Less time than before	−.082	.035	−.149	.064	−2.336	.020[a]
Same amount of time than before/Unsure	0					
More time than before	−.087	.035	−.194	.080	−2.443	.015[a]

Note. N = 631, Adj $R^2 = 0.40$, $F(11,619) = 39.4$, $p < 0.0001$.
[a] = $p < 0.05$.

associated with a significant decrease in the score for 'less worry'. Apathetic attitudes was associated with a significance increase in feeling less worried about environmental and public issues during COVID-19. More time or less time spent in nature during COVID-19 (vs same time) was associated with a decrease in the 'less worry' score.

4.4. Structural equation model

The final structural equation model displayed acceptable fit, including the following fit indices: Chi-square(1104) = 2591.05 $p < 0.001$, SRMR = .0611, RMSEA = .044 (90 % CI = .043 - .047), CFI = .902, TLI = .9. The final structural equation model differed from the initially specified model in that a path from 'mortality salience' to 'less worry' was removed due to a lack of significance ($p = 0.311$), and a path between 'climate centric' and increased 'environmental awareness' was added due to a substantially large modification index (56.434). As the proposed path was theoretically justifiable and resulted in an improvement to the fit indices, the decision was taken to include the estimation of this path. See Tables 12–13 for detail.

The structural equation model in Fig. 1 shows various direct and indirect associations on the dependent variables. The methodology is described in the methods section above.

Fig. 1 shows that increased environmental awareness was associated with a significant increase in 'link COVID-19 and climate change'. Holistic risk perception was associated with a significant increase in 'link COVID-19 and climate change'. Climate-centric environmental concern was associated with a significant increase in 'link COVID-19 and climate change' and increased environmental awareness. Shifting responsibility was associated with a significant increase in 'link COVID-19 and climate change'. Health concerns were associated with a significant increase in 'mortality salience'. Apathetic attitudes and the belief that technology will solve environmental issues was associated with a significant increase in 'less worry'. Spending more time (than before) in nature during COVID-19 was associated with a significant decrease in 'less worry'. Experience of extreme weather events was associated with a significant decrease in 'less worry'.

5. Discussion

The latest IPCC report [68] indicated a future for humans where climate change disasters and zoonotic diseases are likely to be more frequent and intense due to the destructive impact humans are having on the natural environment. The COVID-19 pandemic, as a mortality salience induction event [69], provided an opportunity to understand psychological responses with regard to environmental issues, attitudes, and climate change risk perceptions in the context of these cumulative threats. Using multiple regression analysis and structural equation modelling, the study aimed to explore the associations between COVID-19 induced factors (seeing a link between climate change and COVID-19, mortality salience induction, and less worry) and environmental factors (environmental concerns, attitudes, climate change risk perception, and experience of time spent in nature). The discussion is oriented around the results of the structural equation model.

5.1. Associations between the dependent variables

The results showed that 'mortality salience' was associated with an increase in 'link COVID-19 and climate change'. 'Link COVID-19 and climate change' and 'less worry' were associated with an increase in 'mortality salience'. This finding substantiated the fundamental principle of mortality salience[7,8], demonstrating that individuals experiencing mortality salience, characterized by a sense of vulnerability and lack of control, tend to exhibit either an external focus (expressing concern about the connection between nature destruction and COVID-19, labelled as 'link COVID-19 and climate change') or an internal focus (resulting in reduced concern about climate change and other issues, termed as 'less worry'). Additionally, the results add to our understanding of mortality salience in the context of environmental concerns during a pandemic where multiple factors can impact the triggering of mortality salience. This has implications for how mental health is approached during a pandemic and also how the environmental movement communicates climate change messages during a pandemic (or other mortality salience events like wars and civil unrest). When people become more aware of their own mortality they are likely to go through an enhancing process where their existing worldviews and values are relied upon to cope with the threatening situation. This 'doubling down' as a psychologically protective feature could hinder action that is required to deal with climate change in the long term or a pandemic in the short term [70].

There existed a reinforcing mechanism where COVID-19 increased concern about environmental issues such as climate change

Table 12
Structural equation model fit statistics.

p-value for model	Chi-square = 2591.048	Degrees of freedom = 1104	Probability level <.001	Lack of Fit
cmin/df	2,347			Good
CFI	0,902			Acceptable
GFI	0,853			Lack of Fit
AGFI	0,837			Good
SRMR	0,0611			Acceptable
RMSEA	0,045			Good
PCLOSE	1			Good
TLI	0,9			Acceptable

Table 13
Structural equation model.

Predictor Variable	Outcome (criterion) variable	standardised estimate[a]	estimate	SE	CR	p-value
More time than before	Less worry	−0.091	−0.175	0.074	−2.372	0.018
Apathy	Less worry	0.688	0.738	0.07	10.482	[b]
Extreme weather personal experience	Less worry	−0.082	−0.234	0.109	−2.145	0.032
Climate-centric	Increased environmental awareness	0.311	0.17	0.022	7.635	[b]
Holistic	Link COVID-19 and climate change	0.346	0.2	0.031	6.466	[b]
Health	Mortality salience	0.434	0.278	0.039	7.067	[b]
Increased environmental awareness	Link COVID-19 and climate change	0.17	0.259	0.053	4.902	[b]
Less worry	Mortality salience	0.382	0.318	0.041	7.659	[b]
Climate-centric	Link COVID-19 and climate change	0.176	0.147	0.046	3.177	0.001
Shifting responsibility	Link COVID-19 and climate change	0.127	0.126	0.04	3.147	0.002
Mortality salience	Link COVID-19 and climate change	0.22	0.26	0.088	2.952	0.003
Link COVID-19 and climate change	Mortality salience	0.262	0.222	0.067	3.335	[b]

[a] Can be interpreted like standardised beta coefficients in a regression. E.g. When Health increases by one standard deviation, Mortality Salience increases by 0.434 standard deviations. The strength of relationship (weak, moderate, strong) can be read like correlations (below .4 weak, .4 - .7 moderate, .7+ strong). These are rough guidelines and even weak to moderate relationships can be theoretically and practically meaningful.
[b] $= p < 0.001$.

('link COVID-19 and climate change') that in turn enhanced mortality salience. This suggested that being concerned about environmental issues during COVID-19 increased the awareness of one's mortality. Contrarily, not worrying about climate change and social issues ('less worry') during COVID-19 provided a feedback mechanism that enhanced the awareness of one's own mortality ('mortality salience'). This finding corresponds to research that showed mortality salience reduced biocentric motivations [28], lowered pro-environmental behaviour intentions [71], and lowered environmental concern [29].

5.2. Link COVID-19 and climate change

Increased environmental awareness was associated with a significant increase in 'link COVID-19 and climate change' and suggested that for individuals with more awareness of environmental issues, it was easier to make links between the destruction of nature, pandemics, and climate change threats. This was aligned with Breves and Schramm [72] who argued that environmental immersiveness was able to reduce psychological distance and increased pro-environmental behavioural intentions.

Holistic risk perception was associated with a significant increase in 'link COVID-19 and climate change'. This result suggested that climate change risk awareness increased the understanding of the relationship between environmental issues, such as climate change, and the pandemic. While these factors may impact an individuals' ability to perceive connections between global issues (pandemic and climate change), van Valkengoed et al. [73] argued against the idea that perceiving climate change as distal leads to reduced climate change action, and that reducing the perceived distance alone does not consistently result in an increase in climate action. These contrasting findings are important to navigate as urbanisation is rising fastest in the Global South where people are also at increased risk for climate change threats and future pandemics [see Refs]. [74,75]. However, understanding climate change risk perceptions is more complex with the potential for mediating variables impacting the perceived link between climate change and the pandemic.

Climate-centric environmental concern was associated with a significant increase in 'link COVID-19 and climate change' and increased environmental awareness. Therefore, concerns related to climate change, rising sea levels, natural disasters, and ozone depletion had a positive influence on seeing a link between climate change, environmental issues, and COVID-19. This suggested that pre-COVID environmental concerns influenced individuals to acknowledge the link between the pandemic and climate change. This relates to research showing that mortality-loaded climate messaging increased pro-environmental behaviour for those with an environmental worldview [76], mortality salience increased eco-guilt within pro-environmental individuals where environmental values were made salient [77], and mortality salience increased environmental concern for individuals who gained self-esteem from environmental behaviour [29].

Shifting responsibility was associated with a significant increase in 'link COVID-19 and climate change'. Shifting responsibility to future generations and the belief that some issues were overstated, was a perception that was able to increase the perceived link between the destruction of nature and the pandemic. Shifting responsibility could be interpreted as a coping mechanism during the pandemic. This result added to the understanding of how certain psychological barriers such as worldviews, norms, and perceived risks limit climate change engagement [78]. It also suggested that during the pandemic attention to climate change might have been reduced, but for some their concern was not reduced [79]. Overall, the results suggest that shifting responsibility was a coping mechanism during COVID-19 to reduce mortality salience.

5.3. Mortality salience

Health concerns were associated with a significant increase in 'mortality salience' which confirmed the impact of health threats on mortality salience and death-anxiety [see Ref]. [80].



Fig. 1. Structural equation model.

5.4. Less worry

Apathetic attitudes and the belief that technology will solve environmental issues was associated with a significant increase in 'less worry'. Apathy about environmental issues, and denial that individuals could make a difference to these issues or that the problems would be solved through technology, was associated with being less worried about climate change and social issues during the pandemic. This result could be partially explained by a 'finite pool of worry' [79] or that these concerns fell outside existing worldviews and therefore individuals defended their existing individualistic worldviews during the pandemic [see Refs]. [8,76].

Spending more time (than before) in nature during COVID-19 was associated with a significant decrease in 'less worry' supporting the ability of nature to increase feelings of connectedness [81–83] and reduced feelings of loneliness [30]. Experience of extreme weather events was associated with a significant decrease in 'less worry' (i.e., increased worry). This result confirmed the impact that past experience of natural disasters had on mortality salience [see Ref]. [39] and increased concern about climate change [see Refs]. [84,85].

Overall the results show the complex interplay between (a) how people reacted to the pandemic (it was evident that not everyone saw the pandemic as a mortality salience event); (b) even if it was a mortality salient event the way in which people made a connection

with the environment was varied (for some people the perceived threat of COVID-19 outweighed their concern for anything else, whereas for others it heightened their concern for other mortality salience events); and (c) there were multiple other influencing factors, including feedback mechanisms. The study contributes practically by providing further insight into how mortality salience induction events could impact climate change risk perceptions and environmental concern. This is important because governments and practitioners need to re-evaluate messaging and strategies during these events to mitigate potential impacts on the psyche from mortality salience events and how these impacts might affect the human-nature nexus. The results also suggest that messaging from environmental groups needs to be more nuanced to target different groups.

6. Limitations and future research

Fieldwork was conducted one and a half years after the initial outbreak of the pandemic that might have impacted the types of people that were able or willing to respond to the survey as people might have recovered from the initial flood of information and the high degree of uncertainty in health outcomes that occurred at the start of the pandemic. The study under-reported those living in rural areas or without internet access which means that the results are only reflective of an urban area where individuals might have had more access to information and perhaps had more media exposure which could have influenced their perceptions and mortality concerns. Due to the urban reach of the study the results are not generalisable to the broader South African population. The multiple regression analyses and structural equation modelling identified potential associations, but a significant association does not automatically imply causality. The study was not a purely TMT study where mortality salience was introduced in a controlled environment with a delay. Future research could explore additional psychological mechanisms, such as personality, and how interactions of these constructs might then impact the behaviour of individuals. Another opportunity to further work in this field would be to understand the role that depression and anxiety might play during mortality salience induction events and how that impacts human-nature nexus pathways.

7. Conclusion

With the increasingly destructive impact of humans on natural spaces, densification of natural areas, and human-wildlife conflict, pandemics are likely to increase in frequency in parallel to climate change impacts [2]. The study provided insight into the underlying mechanisms that impact whether people become more concerned about the natural environmental versus distancing themselves during a mortality salience induction event. Furthermore, the study highlighted the nuances that impact 'link COVID-19 and climate change' and 'less worry' providing depth to the understanding of the mechanisms behind mortality salience in the context of environmental issues such as climate change. Research of this nature is important for addressing gaps in sustainability work if we are to effectively understand the human-nature nexus in the context of climate change objectives and pandemics [see Ref]. [86].

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Data availability statement

Data will be made available on request.

CRediT authorship contribution statement

Andrea Marais-Potgieter: Writing – original draft, Visualization, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Andrew Thatcher:** Writing – review & editing, Supervision, Resources, Methodology, Data curation, Conceptualization. **Ian Siemers:** Validation, Software, Formal analysis, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e36722.

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