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Engaging health professionals in climate change: a cross-national study of psychological distance across 12 countries

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Abstract

Background Understanding the psychological distance (PD) of health professionals toward climate change is essential to promote effective climate action and informed health policy. While climate change poses a global health threat requiring urgent collaboration, limited cross-national research exists on health professionals' perspectives, particularly on how they perceive PD in relation to climate change.

Objective This study aims to provide initial insights into how health professionals perceive climate change across different countries, focusing on key factors influencing PD, including personal experiences, uncertainty, perceptions, information environments, global interconnectedness, and climate-resilient infrastructure.

Methods This research employed an exploratory mixed-methods approach, combining descriptive surveys and in-depth semi-structured interviews with 18 early-to-mid-career health professionals from 12 countries. This design facilitated a nuanced exploration of the dimensions of PD—temporal, spatial, social, and uncertainty-related—by integrating quantitative data with qualitative insights to uncover emerging trends and hypotheses.

Results Findings reveal diverse perceptions of PD among health professionals, shaped by contextual factors such as exposure to extreme weather, information environments, and infrastructure development. These results challenge the oversimplified view that professionals in developing countries consistently perceive climate change impacts as more distant, underscoring the need for localized understandings of PD.

Conclusion Assessing PD requires consideration of its diverse dimensions to inform effective climate-related behaviors and interventions. Tailored communication strategies reflecting unique national and regional contexts are essential to engage health professionals, enabling them to drive climate discourse and policy advocacy. This study highlights the potential of the early-to-mid-career health professionals in bridging the gap between public awareness and climate action. Their unique position enables them to drive long-term climate adaptation and policy implementation, fostering both global and localized solutions to climate challenges.

Keywords Climate change, Psychological distance, Health professionals, Climate perception, Cross-national

Introduction

Climate change represents a critical and multifaceted global environmental challenge that concerns all world countries (Abbasi et al., 2022). In recent years, as extreme weather events become more frequent, climate change has increasingly become a focal point of scholarly attention [1–3].

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The role of psychological distance in climate change

Recent research has highlighted both the potential and limitations of PD in understanding climate change perceptions and responses. While PD has been widely used to explain climate inaction, recent systematic reviews suggest its relationship with climate-related behaviors may be more complex than initially theorized [4–7]. PD encompasses temporal, spatial, social, and uncertainty dimensions, explaining the perceived distance of events and objects [8]. Temporal distance refers to how imminent individuals perceive an event to be; for instance, closer temporal distance can heighten the sense of urgency regarding climate change. Spatial distance involves the geographical proximity of an event, social distance pertains to the perceived impact on others or specific groups, and uncertainty distance relates to the perceived likelihood of an event occurring [8, 9].

The concept of PD offers valuable insights for comparing how individuals and groups across different regions, cultures, and professional roles perceive and respond to climate change, though these relationships may not be straightforward [6]. For example, PD helps identify variations in perceived urgency and relevance of climate change impacts, which can inform targeted communication strategies tailored to diverse audiences [4]. While traditional assumptions suggest that closer PD leads to more concrete and urgent perceptions of climate change [8], recent evidence indicates that this relationship may be moderated by various contextual and individual factors [6, 7]. When climate change is perceived as distant in time, space, or relevance, it may seem abstract, potentially reducing concern and willingness to act [9]—though this effect is not universal or guaranteed. For instance, individuals who perceive the impacts of climate change as immediate and local are more likely to feel concerned and take action, while those who view these impacts as distant may feel detached and less motivated to respond [9].

The interaction between different dimensions of PD can produce complex behavioral response patterns that challenge simple distance-behavior relationships [5]. For instance, individuals who perceive climate change as temporally and spatially distant may still take action if they believe it poses a significant threat to their social group [5, 8]. These studies indicate that the influence of PD on climate-related behaviors may not only depend on individual-level factors commonly mentioned by researchers [4, 10], but may also be shaped by broader sociocultural factors such as cultural contexts, and social structures, all of which warrant further exploration. Understanding these complex interactions can help guide the design of more effective climate change communication and education strategies. Rather than simply attempting to reduce PD, strategies may need to consider how different dimensions of distance interact with other psychological and contextual factors to influence climate change awareness, concern, and action [5].

The role of the information environment in climate change PD research

Existing research highlights the critical role of the information environment in the study of PD related to climate change, as it directly influences public perception and understanding of climate issues [11–15].In today's networked landscape, the information environment is not merely a passive system of transmission, but a dynamic space shaped by the interactions between individuals, organizations, and digital technologies [16]. Organizations—including news outlets, public institutions, and digital platforms—play an active role in shaping the visibility, credibility, and reach of information through algorithms, content moderation, and design choices, while individuals engage not only as receivers but as participants in content circulation. These structures often prioritize emotionally engaging content, which can amplify misinformation and undermine accurate understanding of complex issues like climate change [16]. Our definition encompasses all sources of information, including mass media, communities, religious groups, and public sectors. By providing timely, accurate, and relevant information, the information environment can make people perceive climate change as more urgent and tangible, reducing the PD they feel [5, 17]. The information environment not only enhances public knowledge and awareness of climate change but also offers practical behavioral guidelines, advising the public on effective actions to mitigate climate change [5, 12]. This, in turn, increases the public's climate action literacy and promotes more environmentally responsible behaviors [5].

Moreover, proactive media coverage and information dissemination can heighten public awareness and engagement with climate change issues, encouraging greater participation in climate protection initiatives [12, 14]. However, the current online information environment often falls short in promptly providing detailed information about climate change or global warming [15]. Therefore, optimizing the information environment to better convey climate-related information is crucial for enhancing public climate awareness [12], reducing PD, and fostering proactive climate protection behaviors [9]. Improving the quality and responsiveness of the information environment can effectively elevate public understanding and behavioral responses to climate change, thereby addressing this global challenge more effectively.

Health professionals' critical role in climate change research

An increasing body of research focuses on the impact of climate change on health, highlighting the critical role of health professionals in this domain [18–21]. Positioned at the intersection of science and community, health professionals are uniquely equipped to address the health challenges posed by climate change. These challenges encompass direct impacts, such as heat stress and respiratory diseases, and indirect consequences, including the spread of infectious diseases, food and water insecurity, and mental health disorders. Depending on their roles—whether as clinical practitioners, public health officials, or policymakers—health professionals make invaluable contributions to climate change discourse by collecting empirical evidence, educating communities, and shaping health policies [22–24].

Clinical practitioners, through their frontline interactions, contribute empirical evidence by documenting the health impacts of climate change in their patients. This data is vital for policymakers in crafting effective public health strategies and climate adaptation policies [22, 23]. Public health professionals, meanwhile, play a central role in translating this evidence into actionable campaigns, using health education and awareness initiatives to enhance community understanding of climate change. In particular, early-to-mid-career health professionals play a crucial role in bridging long-term climate adaptation and immediate policy translation. While older adults may engage in certain pro-environmental behaviors, younger professionals demonstrate higher climate change awareness and adaptability to emerging climate-resilient technologies, positioning them as key drivers of climate-health interventions [25, 26]. By fostering behavioral changes, these professionals encourage individuals and families to adopt preventative measures, such as improving resilience to heatwaves and reducing exposure to vector-borne diseases [22].

Furthermore, health professionals in policymaking roles can influence systemic responses to climate change. By advocating for climate-resilient health infrastructure and integrating climate considerations into health policies, they ensure that national strategies are responsive to both immediate and long-term health risks. Recognizing their influence, some health professionals have also begun to mobilize their peers, encouraging collective advocacy for stronger climate actions and policy reforms [23, 24, 27, 28].

The contributions of health professionals are essential for understanding and addressing the health dimensions of climate change. Their unique perspectives, derived from direct clinical observations and community engagement, bridge the gap between scientific evidence and practical implementation. By leveraging their expertise and leadership, health professionals can drive impactful climate change interventions, ultimately mitigating health risks and fostering resilience at both individual and systemic levels.

Diverse impacts of climate change: from global trends to national cases

Many researchers have discussed climate change and its effects from a global perspective, often treating continental regions such as Europe, Africa and Asia as homogeneous entities [7, 29–32]. The Lancet has organized both global and European editions of the Lancet Countdown on Health and Climate Change, which emphasize the multiple crises induced by climate change worldwide and highlight issues of inequality and justice faced by vulnerable groups within Europe [17, 21, 33, 34]. This approach suggests an implicit academic tendency to view continents as monolithic units, thereby overlooking the diversity and differences within individual countries. Notably, in recent years, a growing body of research has focused on the climate change impacts at the national level. The Lancet, for example, has established special issues on health and climate change specific to countries like Australia and China [13, 20, 35, 36]. Countries such as Nepal, Afghanistan, and Pakistan are being increasingly studied as individual cases [30, 37, 38]. This shift indicates a burgeoning interest in understanding the unique impacts and responses to climate change at the national level, although comprehensive cross-national comparisons remain relatively scarce.

Existing research on climate change predominantly relies on descriptive and quantitative surveys, often treating countries as homogeneous entities. This approach highlights a potential gap in cross-national comparative studies, particularly in understanding how diverse national contexts shape perceptions of climate change. To address this gap, we conducted an exploratory mixed-methods study investigating health professionals' PD from climate change across 12 diverse countries [39].

Our research design integrates quantitative and qualitative approaches to provide a comprehensive yet preliminary understanding of PD dynamics. Exploratory mixed-method research is particularly suitable for topics with limited existing knowledge, as it allows for contextual description while uncovering deeper insights into underlying factors [40]. In this study, descriptive statistics offer contextual framing for qualitative narratives, which serve as the primary basis for analysis. Given the

small sample size, the study focuses on generating initial hypotheses and identifying trends rather than drawing generalizable conclusions.

We address the following research questions:

> Q1 To what extent do health professionals across different countries perceive psychological distance in relation to climate change?
> Q2 What factors influence the PD of health professionals regarding climate change?

By focusing on these questions, we aim to provide novel insights into the psychological dimensions of climate change perception among a critical group of health professionals who play a pivotal role in public health and climate change mitigation.

Methodology

Research design

We conducted an exploratory mixed-methods research study between December 2023 and June 2024 to explore health professionals from climate change across 12 diverse countries. This study integrated quantitative and qualitative approaches, employing questionnaire surveys and in-depth interviews to analyze PD comprehensively. Given the small sample size, our focus was not on statistical inferences but rather on using descriptive statistics to contextualize the qualitative findings. This design aligns with our goal of generating initial insights and understanding emerging trends in this relatively underexplored area, particularly regarding health professionals' perceptions of climate change across different cultural contexts. The study was conducted with full ethical approval, adhering to rigorous research standards and protocols.

Recruitment

Participant selection and recruitment

Participants were selected through a combination of purposive and snowball sampling to ensure diverse representation across geographic regions, professional roles, age groups, and sex. Recruitment aimed to achieve a wide range of perspectives on PD related to climate change by considering the following criteria:

- Sex: Representation of both male and female health professionals.
- Age: Inclusion of participants aged 20–40 years to reflect early- and mid-career health professionals. This group was chosen for their pivotal role in long-term climate adaptation and policy implementation, as their careers align with projected climate-health crises.
- Professional Roles: Coverage of public health officials, clinical practitioners, academics, or officials involved in health policy.
- Geographic Diversity: Ensuring participants from diverse countries and regions.

Recruitment process

Recruitment was conducted through two main channels:

1. Poster Campaign: Posters describing the study's purpose, eligibility criteria, and participation requirements were disseminated both online and offline through Tsinghua University's networks. Posters were shared on campus noticeboards and via digital platforms frequently accessed by health professionals, such as professional forums and WeChat groups.
2. Snowball Sampling: Initial participants were encouraged to refer other eligible health professionals from their networks. This method expanded the pool of potential participants, particularly in underrepresented regions where direct recruitment was more challenging.

Initially, 22 individuals expressed interest in participating in the study. Following a structured eligibility assessment, 18 participants met the inclusion criteria and were enrolled. The selection process involved two key criteria:

1. A minimum of two years of professional experience in public health, clinical practice, academia, or health policy.
2. Foundational understanding of health-related impacts of climate change, assessed through an initial screening question about their awareness of climate-related health risks.

Research participants

The final sample consisted of 18 health professionals from four continents, representing diverse professional roles and backgrounds (see Table 1):

- Africa ($n = 9$): Ethiopia (3 participants), Ghana (2), Tanzania (2), Nigeria (1), and Zambia (1), including clinical practitioners, public health officials and health policy administrators
- Asia ($n = 7$): Afghanistan (1), Malaysia (2), Mongolia (1), Nepal (1), and Saudi Arabia (1), primarily engaged in clinical and public health practice and academia

Table 1 Health professionals' individual information

Number	Region	Country	Sex	Age	Role	Years of experience	Code
1	Africa	Ethiopia	Male	25–30	Health Policy Administrator	3–5 years	E1
2	Africa	Ethiopia	Male	30–35	Clinical Practitioner	6–8 years	E2
3	Africa	Ethiopia	Male	30–35	Health Policy Administrator	9–10 years	E3
4	Africa	Ghana	Male	25–30	Health Policy Administrator	3–5 years	G1
5	Africa	Ghana	Male	25–30	Health Policy Administrator	3–5 years	G2
6	Africa	Nigeria	Male	25–30	Public Health Official	3–5 years	N1
7	Africa	Tanzania	Male	30–35	Health Policy Administrator	6–8 years	T1
8	Africa	Tanzania	Male	25–30	Health Policy Administrator	3–5 years	T2
9	Africa	Zambia	Female	25–30	Clinical Practitioner	3–5 years	Z1
10	Asia	Afghanistan	Male	25–30	Academic Researcher	3–5 years	A1
11	Asia	Malaysia	Female	20–25	Public Health Official	1–2 years	M1
12	Asia	Malaysia	Male	20–25	Public Health Official	1–2 years	M2
13	Asia	Mongolia	Female	25–30	Clinical Practitioner	3–5 years	M3
14	Asia	Nepal	Male	25–30	Public Health Official	3–5 years	N2
15	Asia	Saudi Arabia	Male	25–30	Health Policy Administrator	3–5 years	S1
16	North America	Canada	Female	25–30	Public Health Official	3–5 years	C1
17	North America	Canada	Female	25–30	Public Health Official	3–5 years	C2
18	Europe	Russia	Female	20–25	Public Health Official	1–2 years	R1

- North America ($n=2$): Canada (2), both public health professionals working in coastal regions
- Europe ($n=1$): Russia (1), working as a public health official

Despite efforts to achieve gender balance during recruitment, male participants were overrepresented in the final sample (12 males, 6 females). These variations reflect the composition of the professional networks targeted during recruitment and the snowball sampling referrals. Nonetheless, the sample provided diverse perspectives across four continents, contributing to the richness of the data.

To ensure participant confidentiality while maintaining systematic data organization, we implemented an alphanumeric coding system. Each participant was assigned a code combining their country's initial letter and a sequence number (e.g., R1 for the first Russian participant). This standardized identification system facilitated clear cross-referencing throughout the analysis while protecting participant identities.

Data collection

Data were collected between December 2023 and June 2024 using a two-stage approach:

Survey Questionnaire: An online questionnaire consisting of seven questions assessed the four dimensions of PD (temporal, spatial, social, and uncertainty). Distributed electronically and building on the foundation of PD research [8]. A 5-point Likert scale (1 = strongly disagree, 5 = strongly agree) was used for all items. Example items included (see Table 2):

- Temporal Distance: Assessed with the item, "The effects of climate change will occur far in the future," gauging respondents' perceptions of the timing of climate change impacts.

Table 2 Descriptive statistics for PD survey questions

PD Dimension	Survey Question	Mean	Standard Deviation
Temporal Distance	It is uncertain what the effects of climate change will be	2.44	1.423
Uncertainty	I am uncertain that climate change is really happening	1.44	0.856
Geographical Proximity	Climate change will mostly affect areas that are far away from my country	2.39	1.195
Social Distance	My country is likely to be affected by climate change	4.44	0.662
	Climate change is likely to have a big impact on people like me		

Responses were on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). $N=18$

- Uncertainty: Measured with the item, "I am uncertain that climate change is really happening," which evaluates respondents' certainty regarding the occurrence of climate change.
- Social Distance: Measured with items such as, "My country is likely to be affected by climate change," and "Climate change is likely to have a big impact on people like me," focusing on the perceived social or personal impacts.
- Geographical Distance: Evaluated using the item, "Climate change will mostly affect areas that are far away from my country," assessing perceptions of the geographical proximity of climate change impacts.

In-Depth Interviews: Two rounds of semi-structured interviews were conducted over a six-month period (January-June 2024). This extended timeframe was necessary to accommodate participants across multiple time zones and allow for iterative analysis between rounds.

Round 1 (January 2024): Focused on exploratory themes, such as participants' interpretations of PD dimensions and their perceptions of local climate impacts.
Round 2 (June 2024): Targeted deeper insights into the factors influencing PD and behaviors related to climate change.

Each interview lasted approximately 120 min. The first round was conducted in person to build trust and ensure a comfortable interaction, while the second round employed a hybrid approach combining in-person and video conferencing to accommodate participants' schedules and geographic locations. This mixed-methods approach integrated quantitative assessments with qualitative insights, enabling comprehensive exploration of factors influencing PD (see Fig. 1).

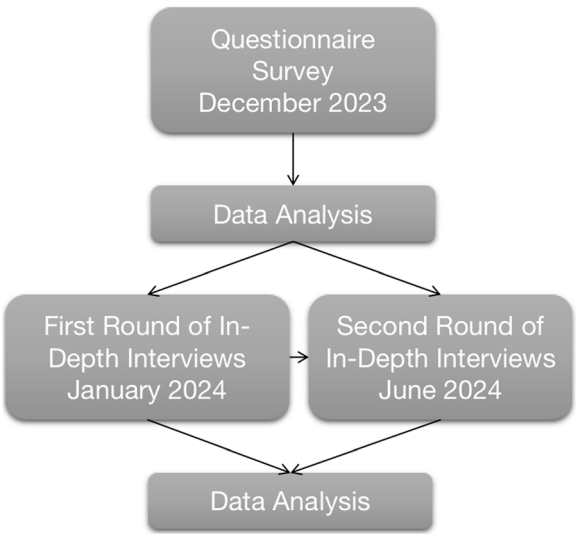

Fig. 1 The research process

Integration of questionnaire and interview data

The questionnaire data served as a foundational tool to inform the development of interview questions, ensuring that the qualitative interviews were targeted and relevant to the dimensions of PD. The integration process involved the following steps:

Identifying patterns and trends: The descriptive statistics from the questionnaire provided insights into general patterns of PD across the four dimensions: temporal, spatial, social, and uncertainty. Participants who strongly agreed or disagreed with these items were flagged for follow-up in interviews to explore the reasons behind their responses.
Highlighting outliers: Outliers in the questionnaire responses played a critical role in shaping specific interview questions. For example, a participant who expressed uncertainty about the existence of climate change ("I am uncertain that climate change is really happening") was asked during the interview to elaborate on their skepticism, exploring potential influences such as cultural, educational, or media exposure.
Rationale for follow-up questions: The quantitative data highlighted areas requiring deeper exploration. For example, if a participant rated high agreement with "Climate change is likely to have a big impact on people like me", follow-up questions such as "What specific impacts have you observed in your personal or professional life?" were included to gather qualitative insights. Conversely, for participants who rated low agreement with spatial proximity items, questions like "Why do you think climate change is perceived as distant or less relevant to your country?" were used to understand their perspectives.
Dynamic interview adaptation: The first round of interviews was designed to explore the broad themes derived from questionnaire responses, such as perceived immediacy, relevance, and uncertainty. The second round focused on refining insights based on initial interview findings, emphasizing participants' unique contexts, such as cultural or social influences.

Data analysis

As an exploratory study, the primary purpose of the questionnaire survey was to guide the in-depth interviews by providing preliminary insights and serving as a

pre-assessment tool for identifying key areas of inquiry. The questionnaire data were analyzed using SPSS 26.0 to evaluate the PD of health professionals regarding climate change. Descriptive statistics were utilized to ensure the consistency and validity of the survey responses. Throughout this study, we recognized that our backgrounds and experiences could shape the interpretation of data. To address this, we prioritized reflexivity by adopting participant-centered analysis and minimizing potential biases through structured and collaborative methodologies.

In parallel, the in-depth interview transcripts were transcribed verbatim and subjected to thematic analysis. This analysis aimed to identify and categorize the underlying factors influencing participants' perceptions and behaviors related to climate change. Thematic analysis was conducted manually, adhering to Braun and Clarke's six-phase framework [39]. The process included multiple readings of the transcripts for familiarization, followed by highlighting key phrases and sentences to generate initial codes. These codes were then iteratively reviewed and consolidated into broader themes, ensuring alignment with the four dimensions of PD. This systematic approach provided a comprehensive understanding of the nuanced factors shaping health professionals' perspectives on climate change.

Results and analysis

PD of climate change among health professionals

Based on the four theoretical dimensions of PD described by health professionals from 12 countries, a quadrants chart was developed to visualize the PD of climate change along four theoretical dimensions (Figs. 2 and 3). Temporal distance and uncertainty were plotted in different quadrants compared to geographical distance and social distance, highlighting their similarities in how people cognitively process these dimensions—both are about perceptions of uncertainty around climate change impacts, where higher uncertainty generally corresponds to greater temporal distance, and greater geographical distance often aligns with increased social distance in people's mental representations of climate threats.

Figure 2 depicts the relationship between uncertainty and temporal distance dimensions of psychological distance among our surveyed health professionals. The clinical practitioner from Mongolia (M3) and health

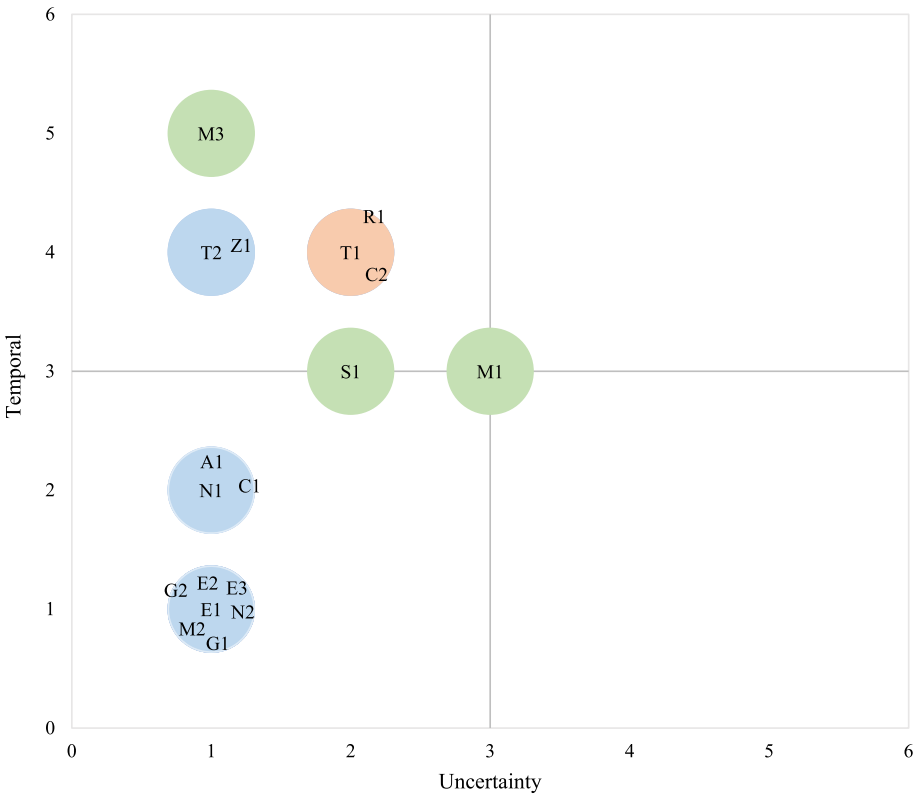

Fig. 2 PD Quadrant Map (Temporal and Uncertainty Dimensions) of health professionals. Note: Colors indicate geographical regions (blue: African countries, green: Asian countries, orange: North America). Uncertainty (x-axis) and temporal distance (y-axis) range from 0–6. Higher values indicate greater uncertainty/temporal distance regarding climate change impacts

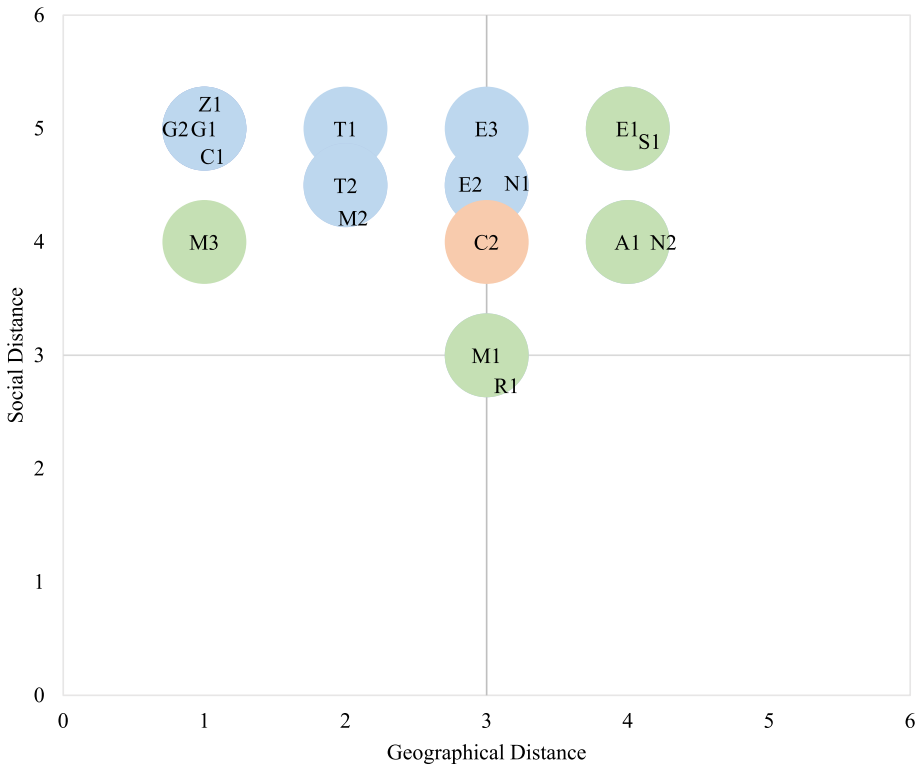

Fig. 3 PD Quadrant Map (Geographical and Social Dimensions) of health professionals. Note: Colors distinguish between geographical regions (blue for African countries, green for Asian countries, orange for North America). Geographical distance (x-axis) increases from left to right (0–6), indicating perceived distance of climate change impacts from one's country. Social distance (y-axis) increases from bottom to top (0–6), representing perceived personal/social impact of climate change

professionals from Tanzania (T1/T2), Zambia (Z1), and Russia (R1) expressed higher temporal distance (y-axis values 4–5), suggesting greater uncertainty about future climate change effects. One Canadian public health official (C2) also shared similar views about the temporal uncertainty of climate impacts. In contrast, a cluster of health professionals, including those from Ethiopia (E1, E2, E3), Ghana (G1, G2), Nepal (N2) and Malaysia (M2), reported both low temporal distance and low uncertainty (values around 1 on both axes). The academic researcher from Afghanistan (A1), public health official from Nepal (N1), and one Canadian public health official (C1) are clustered near coordinates showing low temporal distance (y-axis around 2) and low uncertainty (x-axis around 1). This positioning indicates these health professionals are both highly certain that climate change is happening and perceive its effects as temporally close rather than distant future events. Their responses suggest they view climate change as a current reality with immediate impacts, not an uncertain future possibility. Interestingly, several practitioners including the health policy administrator from Saudi Arabia (S1) and a public health official from Malaysia (M1) showed moderate levels of both temporal distance and uncertainty (values around 2–3 on both axes).

Practitioners from Mongolia, Zambia, Russia, Canada and Tanzania expressed varying degrees of uncertainty about the future impacts of climate change, which may suggest a perception of longer temporal distance in these contexts. It showed that while they recognize changes in current climate patterns, they are less certain about how these changes will evolve and affect their countries in the long term. Conversely, surveyed health professionals from Nigeria, Ethiopia, Ghana, Nepal, Afghanistan, Malaysia, and Canada are highly certain about the future impacts of climate change. This certainty implies a heightened awareness of the potential long-term risks and impacts, suggesting that they perceive the effects of climate change as imminent and pressing in the near future.

The quadrants chart (see Fig. 3) reveals the social and geographical dimensions of PD regarding climate change among surveyed health professionals. Those working in African regions (coded as G1/G2, T1/T2, Z1,N1, E2/E3) reported low geographical distance (x-axis values around 1–3) and high social distance scores (y-axis values above

4), indicating they personally view climate change as a proximate issue with significant impact on their communities. The interviewed public health officials from Canada (C1/C2) expressed views similar to their African counterparts.

Among the surveyed Asian health professionals, perspectives were more diverse. The clinical practitioner from Mongolia (M3) and a public health official from Malaysia (M2) shared perspectives aligned with viewing climate change as a locally relevant issue. In contrast, the health policy administrator from Saudi Arabia (S1), public health official from Nepal (N2), and academic researcher from Afghanistan (A1) reported higher geographical distance scores (x-axis values around 4–5), indicating they perceive climate change impacts as more distant from their immediate environment. The interviewed public health official from Russia (R1) and another from Malaysia (M1) displayed moderate geographical distance but lower social distance scores (around 3 on both axes), suggesting they view climate change impacts as having moderate implications for their immediate social context.

Factors contributing to PD of climate change

Extreme weather experiences

The study reveals that the temporal distance and uncertainty dimensions of PD regarding climate change among health professionals are significantly influenced by their direct encounters with extreme weather events. Health professionals in countries like Zambia, Tanzania, Nepal, Canada, and Afghanistan, which frequently experience severe weather conditions, demonstrated heightened awareness of climate change impacts. For instance, in Zambia, seasonal changes and their impact on health were highlighted:

> *"The seasonal changes in Zambia have become more extreme, with significant variations in rainfall during the rainy and dry seasons." (Z1)*

Afghanistan, Russia, Saudi Arabia, and Mongolia experience extreme high or low temperatures, as described by participants:

> *"Afghanistan experiences extreme high and low temperatures, with summer temperatures reaching above 50 °C and very low winter temperatures." (A1)*
> *"Mongolia experiences extreme high temperatures and extreme low temperatures, which are related to climate change."(M3)*
> *"It is getting warmer and warmer every year. I remember when I was a child, it was about − 30 degrees, but now it's just about − 25 degrees maximum. The change in temperature is quite noticeable." (R1)*

In Saudi Arabia, adaptation to extreme heat is notable:

> *"Saudi Arabia often faces extreme high temperatures, sometimes reaching up to 52 degrees Celsius, but people have adapted to these conditions." (S1)*

The experiences described above reflect the critical role of direct encounters with extreme weather in reducing the temporal and spatial dimensions of PD. Health professionals who experience climate-induced health challenges firsthand, such as heat-related illnesses or coastal erosion, are more likely to perceive climate change as an immediate and tangible threat. For instance:

In Malaysia, the impact of sea-level rise was linked to coastal erosion affecting small islands:

> *"Sea level rise may lead to coastal erosion, and Malaysia has small islands affected." (M2)*

In Nepal, frequent floods, landslides, and heatwaves highlighted the vulnerabilities of local communities:

> *"Nepal experiences floods, landslides, and heat waves, which are connected to climate change." (N1)*

In Tanzania, extreme heat and associated health effects were noted:

> *"In Tanzania, we experience extremely high temperatures and skin diseases, particularly for children, as well as sea level rise." (T2)*

These direct experiences appear to reduce the PD to climate change and may shape health professionals' perspectives on advocacy and response. For some, heightened awareness of climate-induced health challenges could potentially drive a greater interest in climate-resilient policies and interventions [41].

Blurred comprehension

The uncertainty surrounding the impacts of climate change contributes to varying dimensions of PD, particularly among health professionals. Despite widespread acknowledgment of climate change, ambiguity about its causes and future effects persists in many regions, complicating perceptions and responses.

Countries like Nigeria, Ethiopia, Ghana, and Afghanistan, which frequently experience extreme high temperatures, exhibit greater certainty about the tangible impacts of climate change. This certainty stems from firsthand exposure to severe weather events, which make climate change consequences more immediate. In contrast, participants from Mongolia and Russia often expressed lower urgency due to environmental stability and their

governments' capacity to manage climate-related issues. This relative stability diminishes the perceived immediacy of climate change impacts.

In some regions, comprehension is further blurred by challenges in distinguishing between natural disasters and climate-induced phenomena. For instance, health professionals in Zambia and Tanzania highlighted difficulties in attributing events like heavy rainfall or sea-level rise directly to climate change:

> *"Natural disasters are not necessarily the result of climate change; they might be natural occurrences. For example, volcanic eruptions and floods may just be natural events and not caused by climate change." (Z1)*

Similarly, a participant from Mongolia conveyed uncertainty about the causes of climate change:

> *"I believe climate change is happening, but I don't think it's only human forces that facilitate it. I'm not sure it's just human influence and impact on climate change. Maybe it's kind of a natural process as well." (M1)*

Blurred comprehension of climate change reflects a critical dimension of PD: uncertainty. This uncertainty varies based on contextual factors, including exposure to extreme weather, governmental response capacity, and access to information. Participants from regions with robust infrastructure or stable environments often perceived climate change impacts as distant or less pressing. Conversely, direct exposure to severe weather clarified the immediacy and severity of climate risks, reducing uncertainty and fostering greater concern.

Information environment

The information environment plays a crucial role in shaping the PD of climate change among health professionals. Media platforms, such as social media (e.g., Facebook in Malaysia, Zambia, Saudi Arabia, Mongolia, Afghanistan, and Nigeria), print media (e.g., newspapers in Malaysia and Nepal), and broadcast media (e.g. television and radio in Canada and Afghanistan), were frequently cited as key sources of climate information (see Table 3). These platforms help to bridge the gap by providing immediate and tangible accounts of climate change impacts.

Table 3 Information environment for climate change

Category	Content	Countries
Public Sector		
Environment	Environmental Protection Agency (Ethiopia) Ministry of Environment, Water, and Agriculture (Saudi Arabia) Ministry of environment forest (Nepal, Nigeria) Ministry of Environment and Tourism (Mongolia)	Ethiopia, Mongolia, Nepal, Nigeria, Saudi Arabia
Agriculture	Ministry of Agriculture (Ethiopia)	Ethiopia
Health	Ministry of Health (Ethiopia) Disaster Management Department (Tanzania)	Ethiopia, Tanzania
Meteorological	Tanzania Meteorological Agency (Tanzania) Environment and Climate Change (Canada) Afghanistan Meteorological Department (Afghanistan)	Afghanistan, Canada, Tanzania
Media		
Social Media	Facebook (Malaysia, Zambia, Saudi Arabia, Mongolia, Afghanistan, Nigeria, Canada)	Afghanistan, Canada, Malaysia, Mongolia, Nigeria, Saudi Arabia, Zambia
Print Media	Newspaper (Malaysia, Nepal, Canada)	Canada, Malaysia, Nepal
Broadcast or TV	News station (Malaysia, Zambia, Saudi Arabia, Nigeria) Broadcast Cooperation (Ethiopian, Zambia) Radio (Canada, Afghanistan)	Malaysia, Nigeria, Saudi Arabia, Zambia
Religion	Christian, Islam religious leaders	Zambia, Afghanistan, Nigeria, Ethiopia
Community Activities		
Education	Educational courses by Addis Ababa University and Gandhi Medical College (Ethiopia) Climate change school clubs (Canada)	Canada, Ethiopia
Activity	Climate change protest (Canada)	Canada
NGO	UNICEF projects and conferences (Mongolia) WWF the worldwide fund for nature (Nepal) NCCSP: Nepal climate change support program (Nepal)	Mongolia, Nepal
Institute	Micrology, Hydrology and Environment (Mongolia)	Mongolia

In developed countries, although people might not experience the physical effects of climate change directly, they are significantly influenced by constant news coverage and visual representations of its global impact. A participant from Canada highlighted this psychological dimension:

> *"In developed countries, the impact of climate change is more psychological, leading to anxiety and negative health outcomes." (C2)*

However, challenges such as limited media accessibility in remote areas and government control over information often hinder effective communication. For instance, a participant from Afghanistan highlighted:

> *"In Afghanistan, we have very limited resources. Most of the cities are far from the center of Afghanistan, they don't watch television, they don't read newspapers. Now the government has changed, most of them don't watch television. There is limited awareness and understanding of climate change among the general population in Afghanistan. Most of the people, especially farmers, don't have any idea about climate change. I think we didn't hear anything from the news or from the radio or from the television about how Afghanistan faces these challenges for climate change." (A1)*

Similar challenges were noted in Zambia and Nigeria, where poverty and infrastructural barriers further restricted access to reliable climate information:

> *"Especially rural people have limited access to media due to poverty." (N1, Z1, E3)*

Participants from Russia highlighted another dimension—governmental control over media—which limits the dissemination of unbiased information:

> *"Government control over media content restricts the public's ability to receive unbiased information about climate change." (R1)*

- Public sectors in climate education

In some countries, public sector initiatives and educational institutions play an essential role in raising awareness of climate change. Ministries and agencies, such as the Environmental Protection Agency in Ethiopia, the Ministry of Environment, Water, and Agriculture in Saudi Arabia, and the Ministry of Environment and Tourism in Mongolia, actively promote climate-related information. Educational institutions, including Addis Ababa University in Ethiopia and climate change school clubs in Canada, also contribute by integrating climate change topics into their curricula, fostering long-term awareness.

Despite these efforts, participants from several countries identified systemic gaps in collaboration between governments and scholars, which hinder effective climate action. For example, an Ethiopian participant noted:

> *"There is a gap between the government, scholars studying climate change, and those directly contributing to it." (E1)*

This highlights how even resource-rich nations can face challenges when government priorities and focus are misaligned.

In Afghanistan, governance failures exacerbate climate challenges. A participant noted,

> *"The climate change problems become more serious due to poor management and lack of effective policies." (A1)*

This underscores the critical need for stronger integration of academic research into governmental initiatives and the inclusion of individuals or groups directly impacting climate change.

Similarly, in Canada, a participant pointed to complacency among the public and some government departments:

> *"The public and some government departments do not feel the direct threat of climate change, so the measures are not serious enough." (C2)*

This reflects a broader issue in regions where climate impacts are not yet acutely felt, resulting in inadequate responses.

International organizations also play a role in addressing climate challenges, yet their impact can be limited, as one Afghan participant noted: *"Although some international organizations are working on it, these efforts are not always effective." (A1).* This highlights the need for more context-specific and actionable strategies tailored to local realities.

In Zambia, resource constraints and competing priorities further exacerbate these challenges, as noted by one participant:

> *"They develop main sectors because they do not have enough resources... I feel climate change might not be a priority for them, so they will let people do what they have to do." (Z1)*

This statement sheds light on the challenges faced by resource-limited nations in balancing immediate development needs with long-term climate strategies.

In Nigeria, political instability and lack of public awareness were flagged as barriers:

> *"Because the policy is not stable, anything can happen. And there is a lack of public awareness and education." (N1)*

This reflects the broader issue of institutional instability and the critical role of public awareness in fostering accountability and action.

In Russia, the issue extends to resource mismanagement, with a participant observing:

> *"I think Russia has enough resources to do this, but governments don't pay enough attention to that." (R1)*

> *This highlights how even resource-rich nations can face challenges when government priorities and focus are misaligned.*

These insights illustrate that while public sector efforts are crucial, gaps in collaboration, resource allocation, and prioritization significantly hinder the development of effective climate-resilient strategies. Addressing these barriers requires stronger partnerships between governments, researchers, and community stakeholders to foster evidence-based policymaking and enhance public engagement.

- Religion

Religious beliefs play a pivotal role in shaping perceptions of climate change in several countries, often influencing how individuals interpret extreme weather events. In nations like Afghanistan, Nigeria, and Zambia, such events are frequently viewed through a religious lens and interpreted as manifestations of divine will or punishment. This perspective, deeply rooted in cultural and religious traditions, often shapes the understanding of natural phenomena.

For example, in Afghanistan, where Islam is the predominant religion, extreme weather is commonly perceived as a sign of divine displeasure. One participant shared:

> *"We are very religious people, and we trust in God. We say, Allah. So, if anything happens, we say it is a punishment from Allah. Most things are related to God, which can change our country's conditions. We relate it to God, especially for those in remote areas or those far from modern knowledge." (A1)*

Similarly, in Nigeria and Zambia, religious interpretations often frame climate change as a result of moral failings or a test from a higher power. In Nigeria, a participant reflected:

> *"When there is drought, they don't blame the government for the drought because it is seen as beyond the government's control. Instead, people attribute it to their cultural, social, or personal beliefs. For instance, a drought in my village might be seen as a consequence of our actions." (N2)*

In Zambia, a similar sentiment was noted:

> *"Some believe natural disasters are the will of God, a form of divine anger and punishment for human actions." (Z1)*

These perspectives illustrate how religious interpretations can limit essential climate awareness. In such contexts, the information environment is often shaped more by spiritual beliefs than by access to accurate and objective knowledge, making climate change appear distant, less urgent, or even unavoidable.

Conversely, education has the potential to transform these perceptions by addressing misconceptions about climate change. In some cases, the interplay between religious beliefs and education has led to shifts in understanding. For instance, a health professional in Nigeria recounted how increased education changed their perception of climate change:

> *"When I was young, religious leaders would gather to pray whenever there was low rainfall, attributing the lack of rain to moral failings. However, with increased education, I understood that climate change is not a punishment from God but a result of human activities like deforestation and industrial emissions." (N1)*

Such shifts underscore the importance of integrating climate education into religious and cultural frameworks. Fatalistic attitudes stemming from beliefs in divine punishment can impede proactive measures and community-driven initiatives. However, religious leaders and institutions, if engaged effectively, can become advocates for climate action by framing it as a moral responsibility and an act of stewardship of the Earth. This alignment of faith and education could foster more proactive responses to environmental challenges and help bridge the gap between spiritual beliefs and scientific understanding [42].

- Community activities

Community-driven initiatives play a crucial role in making climate change more tangible and actionable for the public. In Canada, grassroots climate protests have

emerged as powerful platforms for public engagement. As one activist emphasized,

> *"Protests are a common way for people to voice their concerns about climate change and urge the government to act" (C1).*

This direct citizen involvement helps transform abstract climate concepts into immediate, relatable issues.

International organizations have similarly strengthened local climate action through targeted programs. UNICEF's work in Mongolia demonstrates how community education can build climate resilience, while WWF's initiatives in Nepal showcase effective approaches to environmental conservation and sustainable development. These efforts, combined with support from media outlets, government agencies, educational institutions, and religious organizations, create a comprehensive framework that helps reduce the psychological distance associated with climate change.

The success of these community activities lies in their ability to convert complex climate science into accessible, actionable information. By fostering a sense of collective responsibility, these initiatives motivate both healthcare professionals and the general public to participate in climate mitigation and adaptation strategies. Looking ahead, there's an opportunity to enhance these impacts by better integrating local and global efforts, and strengthening collaboration between community groups, healthcare providers, and policy makers.

Climate-resilient infrastructure

Climate-resilient infrastructure refers to energy, transportation, water, and telecommunications systems designed to withstand extreme weather events, thereby protecting lives, reducing losses, and supporting climate adaptation goals [43]. The robustness of such infrastructure plays a pivotal role in shaping individuals' PD from climate change, influencing their perceptions of spatial and temporal proximity to its impacts.

This relationship becomes evident when comparing African nations facing similar climate challenges. Despite shared environmental pressures, countries like Tanzania, Zambia, Nigeria, and Ethiopia show varying levels of psychological distance based on their infrastructure capacity. As a Tanzanian participant noted,

> *"In Africa, the degree of the effect of climate change varies from country to country" (T1)*

A Zambian participant reinforced this observation, stating:

> *"Countries with more robust systems are less affected by climate change compared to those with weaker systems." (Z1)*

The connection between infrastructure and climate resilience was further emphasized by a Ghanaian participant:

> *"Economic and modern development are crucial factors for a country's ability to withstand climate change." (G1)*

This evidence suggests that while climate threats may be geographically similar, infrastructure quality significantly influences perceived vulnerability and adaptive capacity. Strong infrastructure systems can reduce perceived immediacy of climate risks by demonstrating preparedness, while inadequate systems heighten feelings of vulnerability and increase psychological distance from climate action.

Global interconnectedness

The responses from health professionals highlight the recognition of climate change as a global phenomenon, characterized by interdependence and mutual influence among countries. While the impacts of climate change are localized and vary significantly from one region to another, the issue itself transcends borders and requires global attention. This interconnectedness suggests that perceptions of climate change are shaped not only by local experiences of extreme weather but also by broader global dynamics.

A participant from Russia emphasized the shared global nature of climate change, reflecting an individual perspective rather than representing the entire country:

> *"I'm not sure. I think it's a global problem, so climate change influences are equal to each country and city. I don't think Russia will be affected more compared to other countries." (R1)*

Similarly, a participant from Zambia acknowledged the universality of the issue:

> *"Although the degree of impact varies, climate change is a global issue, and no country can entirely avoid its effects." (Z1)*

In developed countries, where direct physical impacts of climate change may be less pronounced, global media coverage plays a significant role in shaping perceptions. A participant from Canada shared their perspective on how constant news and images of global climate impacts influence public consciousness:

> *"People in developed countries might not experience the physical effects of climate change directly, but they are still affected by the constant news and*

images of its impact globally." (C2)

The necessity of collaborative global efforts was underscored by a participant from Saudi Arabia:

"Climate change is a global issue, and efforts by individual countries alone are insufficient." (S1)

These perspectives underscore the importance of addressing climate change through a global lens while recognizing the diversity of local experiences and responses. Although individual health professionals offer valuable insights, their perspectives are not representative of entire nations. Instead, these narratives illustrate the shared challenges and the necessity of international collaboration to tackle climate change effectively. Recognizing the interconnected nature of climate change impacts can help foster more inclusive and globally coordinated mitigation strategies.

Behaviors of climate change

The study reveals that while the PD to climate change is generally short among the health professionals interviewed, their behavioral responses to climate change vary significantly. These variations suggest that different dimensions of PD interact to create complex patterns of engagement.

For example, in Malaysia, although health professionals perceive climate change as close in terms of social and spatial distance, high uncertainty about its impacts often leads to fewer proactive behaviors. In Saudi Arabia, Tanzania, and Zambia, participants reported engaging in climate-protective behaviors despite perceiving climate change as more distant spatially. These actions are often driven by social connections to the issue or community-level initiatives. However, participants noted limited involvement in public advocacy and policymaking, often attributed to systemic constraints or fewer opportunities.

In Canada, participants described limited active climate action despite perceiving PD as relatively short. Climate change is often framed as an issue driven by grassroots activism, with health professionals focusing on advocacy to prompt government and corporate action. As one participant noted:

"There are many protests to raise awareness about climate change. People take these issues seriously and want to take action." (C1)

In Mongolia and Russia, health professionals emphasized individual efforts, such as conserving electricity and adopting green transportation, over collective advocacy. This approach may stem from skepticism about the efficacy of large-scale actions. A participant from Mongolia shared:

"If climate change will lead to the destruction of the Earth, then actions are ultimately futile." (M3)

In Ethiopia, participants holding administrative and policy-making roles demonstrated more systemic engagement with climate change mitigation. Their efforts often included developing multi-sectoral strategies aimed at reducing climate vulnerabilities. A policy administrator explained:

"I took part in developing a multi-sectorial strategy to mitigate the effects of climate change in places that are regularly affected." (E2)

The professional roles of health professionals emerged as a key factor influencing their contributions to climate change mitigation and advocacy. Participants highlighted distinct approaches based on their responsibilities: Clinical practitioners described a heightened awareness of climate-induced health challenges, often driven by direct patient interactions. Public health officials emphasized their roles in community education and advocacy, using their platforms to raise awareness and mobilize local action. Policymakers and administrators reported engaging in systemic strategies to address climate challenges, though some acknowledged barriers to broader collaboration.

For instance, a public health official in Nigeria described their active role in community initiatives:

"I have participated in public discussions on climate change, contributing ideas and supporting initiatives that raise awareness and prompt action." (N1)

Conversely, in Saudi Arabia, participants in administrative roles often cited limited engagement in public advocacy despite growing interest in climate change issues:

"I haven't actively engaged in any public discussions, activities, or policy-making processes related to climate change. However, my interest in the subject has grown significantly after extensive reading on climate change." (S1)

While these findings provide meaningful insights into the perspectives of the participants, it is critical to acknowledge that they reflect individual viewpoints rather than comprehensive national or global trends. The data serve as exploratory observations to illuminate specific challenges and opportunities within different contexts. By emphasizing the diversity of roles and regional dynamics, this study highlights the importance of tailoring climate strategies to align with the unique capacities and contexts of health professionals. This approach can amplify their contributions to climate mitigation

and foster broader engagement in addressing this global challenge.

Conclusion

Recent systematic reviews have challenged simplified conceptualizations of psychological distance in climate change research. Our study contributes to this theoretical debate by examining how multiple contextual factors shape health professionals'perceptions of climate change across diverse settings. Specifically, we investigated how information environments (media platforms, public sectors), cultural and religious beliefs, and infrastructure development levels influence psychological distance perceptions. This multi-layered analytical framework helps illuminate how psychological distance operates within specific sociocultural contexts.

This study highlights the complex interplay between PD and health professionals' perceptions of climate change across diverse global contexts. Contrary to the prevailing academic perspective, PD related to climate change in developing countries is not consistently marked by disengagement or lack of urgency [5, 9]. Health professionals in the surveyed African countries demonstrate significant awareness and proactive measures in sectors such as agriculture, environment, industry, and education. This finding highlights opportunities for broader engagement in these regions [44]. These insights challenge certain Western-centric narratives that often portray developing countries as less engaged in addressing climate issues [45–47]. The distinctions between developing and developed countries, as well as variations within regions such as Africa, Asia, and North America, underscore the need for a nuanced understanding of inter- and intra-country differences. Recognizing these variations is essential for accurately measuring PD and developing tailored strategies to guide climate change behavior.

Given the multifaceted nature of climate change, its manifestations vary significantly not only between countries but also within regions of the same country. As a global issue, climate change is disseminated through media and international interactions, shaping perceptions across diverse contexts [19, 34]. Consequently, the measured PD may not always align with local climate change experiences, as it is shaped by a complex interplay of factors [8, 9]. The diversity of the participant pool, encompassing health professionals from 12 countries across four continents, provides valuable comparative insights into how psychological distance (PD) is perceived in different contexts. These findings highlight the importance of considering regional and cultural factors when designing climate communication strategies. Future assessments of PD should therefore incorporate a broader range of dimensions to better guide behavior and interventions tailored to specific contexts.

Findings from this study suggest some progress in awareness and understanding of climate change among health professionals since the 2009 Copenhagen Climate Change Conference (COP15) [48]. The information environment has played a crucial role in raising awareness, but relying solely on media and communication channels is insufficient to reduce PD and inspire climate action. Efforts must address the broader structural and contextual factors influencing engagement, as identified in this study.

Our findings illustrate how health professionals effectively serve as opinion leaders in climate discourse, demonstrated through their roles in community education and policy advocacy across multiple countries. For example, Ethiopian health administrators developed multi-sectoral climate strategies, while Canadian public health officials mobilized community action. These empirical observations, supported by previous research [27], highlight health professionals' unique capacity to bridge the gap between scientific knowledge and public understanding." Additionally, this study highlights the potential of health professionals to serve as influential societal opinion leaders, particularly in bridging the gap between public understanding and climate policy [28]. By leveraging their professional expertise and social authority, these individuals can play a pivotal role in translating scientific knowledge into actionable strategies that resonate with both policymakers and the public [49]. Empowering health professionals to transition from individual-level actions to collective initiatives could significantly amplify their impact on climate change advocacy. Future initiatives should prioritize targeted strategies to support and mobilize health professionals, equipping them with the tools and platforms necessary to effectively engage in climate discourse and drive meaningful change within their communities.

Limitations

This study has a few limitations that should be acknowledged. First, with only 18 participants (12 males, 6 females) and uneven representation across countries and professional roles, with participants unevenly distributed across Africa (9), Asia (7), North America (2), and Europe (1), the findings are exploratory and intended to provide initial insights rather than broad generalizations. The gender imbalance in the sample further limits the diversity of perspectives. Future research with larger, more gender-balanced, and geographically diverse samples would be beneficial for confirming these trends. Second, while the mixed-methods

approach allowed for a rich exploration of PD among health professionals, the lack of formal member checking meant participants did not have the opportunity to review and confirm the researchers' interpretations. Incorporating member checking in future studies could enhance the robustness of qualitative findings. Lastly, the time gap between the questionnaire completion and interviews (January–June 2024) may have influenced participant responses, as exposure to climate-related events and information may have evolved during this period. These findings, reflecting a specific point in time, highlight the dynamic nature of climate awareness and the need for ongoing research as perspectives and policies continue to develop.

Abbreviations

PD Psychological distance
COP15 Copenhagen Climate Change Conference

Supplementary Information

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Supplementary Material 1

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Authors' contributions
Sanmei Wen and Jing Su conceived the idea for the study. Sanmei Wen and HongXin Chen conducted the data analysis. Sanmei Wen and Jing Su contributed to subsequent drafts and all authors were involved in the final draft. Sanmei Wen and Jing Su was responsible for supervision. Jing Su acts as guarantor for the final manuscript.

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

Declarations

Ethics approval and consent to participate
This study received ethics approval from the Tsinghua University Science and Technology Ethics Committee. All participants received a summary of the research and provided written informed consent prior to beginning the survey. The methods and procedures in this study were carried out in accordance with the Declaration of Helsinki and relevant guidelines and regulations.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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