Sustainable Development

WILEY

Sustainable Development

RESEARCH ARTICLE OPEN ACCESS

Transformative Pathways for Strengthening Climate-Resilient Health Systems Among Indigenous Communities: Advancing Equity and Sustainability in Global Health

Chrishma D. Perera[1] | Eranga K. Galappaththi[1] | Carol Zavaleta-Cortijo[2] | Timothy D. Baird[1] | Korine N. Kolivras[1] | James D. Ford[3] | Michelle Dickson[4] | Kerrie Pickering[5] | Guangqing Chi[6] | Joana Bezerra[7] | Dhanya Vijayan[8] | Victoria Chicamana-Zapata[9] | Cecil Togarepi[10] | Kheminda G. Thilakarathne[11] | Martha M. Hangula[10] | Francis A. Akugre[12] | Richard Nuwagira[13] | Jonathan Nkalubo[14]

[1]Department of Geography, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, USA | [2]Intercultural Citizenship and Indigenous Health Unit (UCISI), School of Public Health and Administration (FASPA), Cayetano Heredia Peruvian University (UPCH), Lima, Peru | [3]Priestley Centre for Climate Futures, University of Leeds, Leeds, UK | [4]Poche Centre for Indigenous Health, Faculty of Medicine and Health, University of Sydney, Camperdown, New South Wales, Australia | [5]School of Public Health, University of Alberta, Edmonton, Alberta, Canada | [6]Environmental Demography Network, Department of Geography, Indiana University, Bloomington, Indiana, USA | [7]Rhodes University, Makhanda, South Africa | [8]Leibniz Center for Agricultural Landscape Research, Müncheberg, Germany | [9]University in Leuven, Leuven, Belgium | [10]University of Namibia, Windhoek, Namibia | [11]Rockhamton Base Hospital, Rockhampton City, Queensland, Australia | [12]University of Ghana, Accra, Ghana | [13]Uganda National Health Research Organization, Entebbe, Uganda | [14]Makerere University, Kampala, Uganda

Correspondence: Chrishma D. Perera (chrishmadp@vt.edu)

Received: 3 August 2025 | **Revised:** 3 December 2025 | **Accepted:** 10 December 2025

Keywords: climate-resilient health systems | Indigenous communities | Transformative pathways

ABSTRACT

Most climate-resilience health interventions are designed at the global level, with minimal attention to Indigenous communities' needs. The lack of consideration can lead to unintended harm and exacerbate health risks. This study aims to identify the capacities of Indigenous communities that can serve as transformative pathways in safely adopting global climate-resilient health approaches within Indigenous contexts, ensuring the aims of the Sustainable Development Goals, such as Good Health and Well-being (SDG3) and Reduced Inequalities (SDG 10). The World Health Organization's climate-resilient health systems approach was used as a starting point to identify the transformative pathways. We collaborated with the Indigenous Peoples' Observatory Network (IPON) and conducted key informant interviews ($n = 17$) with partners who maintain ongoing collaborations with Indigenous communities across 11 countries: Australia, Canada, Fiji, Ghana, India, Kyrgyzstan, Namibia, Peru, South Africa, Sri Lanka, and Uganda. The interview process was guided by two objectives: (i) to identify and examine how transformative pathways contribute to climate-resilient health systems and (ii) to provide recommendations for strengthening transformative pathways based on key informants' insights. We identified five transformative pathways to support the resilience of health systems to climate change risks: (i) government-community interactions, (ii) traditional medicine and spiritual beliefs, (iii) experience-based practices, (iv) community-based collective actions, and (v) community-based policies. Based on the key informant interviews, we provide three recommendations to enhance the identified transformative pathways: (i) Indigenous mentorship in knowledge, health education, and research, (ii) identify opportunities to develop an Indigenous inclusive health workforce, and (iii) enhance indigeneity in health policies.

1 | Introduction

Indigenous health is holistic, deeply spiritual, and intrinsically connected to the natural environment (Reid et al. 2019; Richmond and Ross 2009). Historical and ongoing processes of colonization, including industrialization and urbanization, have profoundly disrupted these reciprocal relationships, adversely affecting Indigenous health and well-being (Case 2019; Greenwood and Lindsay 2019; Malik and Ford 2025). Relocation from traditional territories due to development projects has often resulted in loss of access to land-based practices, sacred ceremonies, and traditional food systems practices that are foundational to Indigenous health (Cunsolo et al. 2020; Reid et al. 2019). Climate change has been the most recent and pressing driver that exacerbates the impacts of colonialism on Indigenous health and well-being (National Colloborating Center for Indigenous Health 2022; Redvers et al. 2023; Whyte 2017). These historical and structural inequities have contributed to the heightened risks facing Indigenous communities to climate-induced health impacts compared to non-Indigenous populations (Billiot and Mitchell 2019; Ford 2012; Lewis et al. 2020; Sauer et al. 2018).

The Intergovernmental Panel on Climate Change (2023) highlights that Indigenous populations are particularly susceptible to health risks induced by extreme climate events, such as flooding, droughts, and permafrost thawing. For example, First Nations communities in Canada have reported increased asthma conditions after extreme rainfall events (Furgal and Seguin 2006). In the Middle East, water scarcity in Indigenous Bedouin communities has intensified, raising the risk of dehydration and iron deficiencies (Mamo 2020). Additionally, Indigenous communities in the Arctic are facing higher rates of zoonotic disease spread due to more frequent freeze–thaw cycles (Durkalec et al. 2015; Jaakkola et al. 2018). Given the climate-related health risks that Indigenous communities face globally, there is an urgent need to focus on enhancing climate-resilient health within these communities (Middleton et al. 2020; Neufeld et al. 2022; Pointertner et al. 2022; Vecchio et al. 2022).

Health policies are crucial in enhancing communities' ability to respond to climate-induced health risks (Carmona et al. 2023; Neufeld et al. 2022). However, national and global health policies have historically overlooked the distinct values of Indigenous communities, often treating them as part of the general population, continuing colonial nature in policy making (Middleton et al. 2020; Saulnier et al. 2017). The insufficient attention to Indigenous communities in health policies has worsened intergenerational trauma and depression conditions rooted in the colonization and historical marginalization that these communities have endured (O'Neill et al. 2018; Redvers et al. 2023). For example, New Zealand's Health and Disability Services Act of 2001 aimed to reduce health inequalities, yet Māori communities continued to face limited recognition of their traditional healing practices in national healthcare frameworks (Lorgelly and Exeter 2023). Similarly, South Africa's National Health Act of 2003 failed to address the healthcare accessibility issues for Indigenous communities (Maphumulo and Bhengu 2019). The COVID-19 health policy responses are a recent example of Indigenous communities receiving minimal attention in global health policies (Galappaththi et al. 2023; Pickering et al. 2024).

Existing global health policy frameworks designed to enhance climate resilience have continued to overlook Indigenous communities' needs, reflecting a longstanding colonial pattern in health policies (Pratt 2019). For Indigenous communities, maintaining connections with the environment and culture is a key aspect of enhancing climate-resilient health (Redvers et al. 2023; United Nations 2002). However, these considerations have not been adequately addressed in global climate-resilient health policies, and if such policies continue to perpetuate colonial approaches, existing inequities will persist (Perera et al. 2025). For example, the World Health Organization's climate-resilient health systems approach, first introduced in 2016 and updated in 2023, aims to enhance health systems' resilience to a changing climate (Dorji et al. 2024; World Health Organization 2023). The most recent 2023 version is an expanded update of the previous edition, incorporating new sections on reducing greenhouse gas emissions within health systems (World Health Organization 2023). However, while both versions acknowledge communities as part of health systems, the updated framework still lacks specific consideration for Indigenous communities that are self-organized and contribute minimally to greenhouse gas emissions (Dannenberg et al. 2019; Perera et al. 2025; Pratt 2019; Schreuder and Horlings 2022).

Climate-resilient health systems must ensure equitable access and the meaningful inclusion of all communities. Therefore, special attention must be given to Indigenous communities facing intersecting challenges, including colonization, marginalization, and climate change (FAO 2021; Redvers et al. 2023; Pickering et al. 2024). Building on the World Health Organization's climate-resilient health systems approach, this study emphasizes that health professionals and policymakers need to recognize Indigenous strengths in developing global health frameworks (Kennedy et al. 2022). We considered the capacities of Indigenous communities to support climate-resilient health systems approach as *transformative pathways*. In this study, we will use the term Indigenous throughout to respectfully refer to *groups of people either officially recognized by the government as Indigenous or self-identifying as such, who maintain a strong connection to their surrounding natural resources* (Nursey-Bray and Palmer 2018; United Nations 2002). Further, we consider *safe adoption* as *modifying global-level health approaches to best align with Indigenous needs* (Chakanyuka et al. 2022). The term *harm* used in this study refers to *challenges Indigenous communities face from adopting global health responses* (Redvers et al. 2023). The study has two specific objectives: (i) to identify and examine how transformative pathways support the resilience considerations of the World Health Organization's climate-resilient health systems approach and (ii) to provide strategic recommendations for strengthening transformative pathways based on key informants' insights.

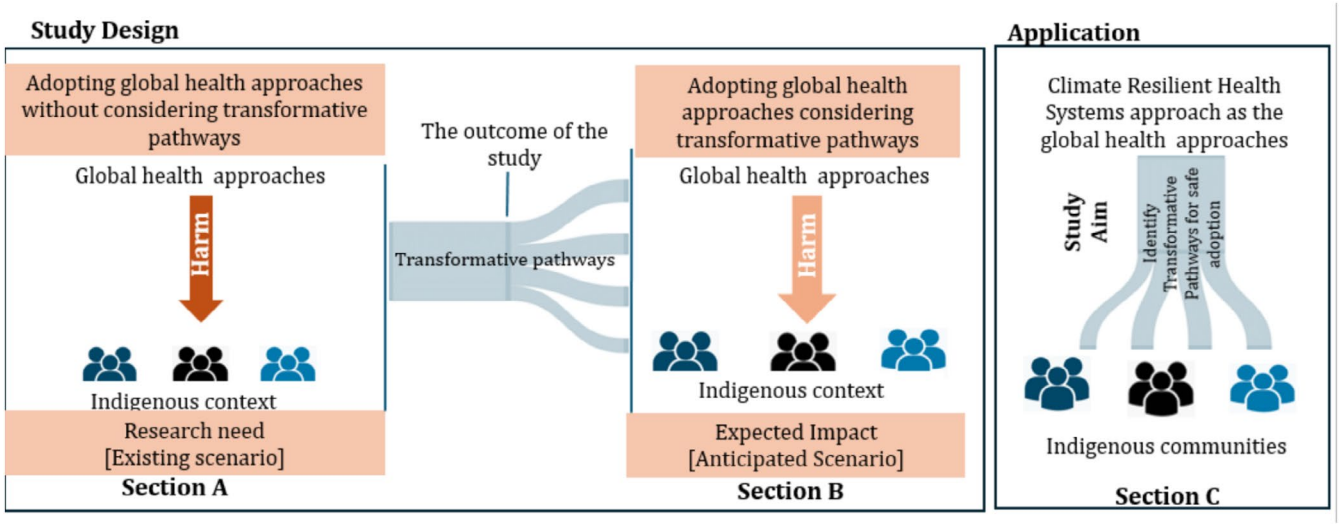

FIGURE 1 | Conceptual design and application of the design.

2 | Methods

2.1 | Study Design

We used a collaborative research approach to conduct this study. A collaborative research approach involves partnerships between two or more entities to conduct robust and impactful research (Turner and Baker 2020). In December 2023, we started to collaborate with the Indigenous Peoples Observatory Network (IPON), a network of Indigenous and non-Indigenous researchers. The IPON team includes medical doctors, researchers, government and non-governmental organization officers, graduate students, Indigenous knowledge holders, and community leaders from diverse Indigenous groups globally. The network is organized into six working groups, each focusing on a specific aspect of the research process: research questions, ethics, gender, policy, mentorship, and catalyzing research impacts. For this study, we closely collaborated with four working groups: research questions, ethics, policy, and catalyzing research impacts. Engaging with these groups ensured that the questionnaire, study design, and analysis reflected the priorities and ethical guidelines of participating Indigenous communities, and that research findings are disseminated in ways that are accessible and useful to the communities. The broader work of IPON focuses on Indigenous communities' health and food systems in the context of climate change.

We acknowledge that our positionalities shape the study's design, data collection, and analysis. As a collaborative research group of Indigenous and non-Indigenous scholars within the IPON, we approach this work through shared respect, relational accountability, and collective learning. We position ourselves as researchers committed to generating insights that inform policymakers in the design and implementation of equitable, culturally grounded health policies.

Our study design (Figure 1) was developed through collaborative discussions with IPON partners, where the World Health Organization's climate-resilient health systems approach was selected as a global health policy approach to develop transformative pathways. Section A of the diagram reflects the research needs where transforming health systems to strengthen climate change resilience among Indigenous communities was identified (Vidal-Cuellar et al. 2024; Zavaleta-Cortijo et al. 2023). The dark red arrow in section A shows possible harm when global health approaches designed for non-Indigenous contexts are applied to Indigenous communities. Our study introduces transformative pathways, leading to the anticipated scenario in section B. The light red arrow in section B shows that identifying transformative pathways can help reduce harm to Indigenous communities when adopting global health approaches developed for non-Indigenous contexts. Section C of the figure illustrates the application of the study design. The differently colored human clipart in sections A and B symbolizes distinct Indigenous groups with unique cultural and geographical characteristics.

2.2 | Data Collection

We selected key informant interviews as the primary data collection method for this study, leveraging the expertise of IPON partners. We conducted key informant interviews ($n = 17$) with IPON partners who maintain ongoing collaborations with Indigenous communities across 11 countries: Australia, Canada, Fiji, Ghana, India, Kyrgyzstan, Namibia, Peru, South Africa, Sri Lanka, and Uganda. A key informant is an individual with expertise on a specific topic (Akhter 2022). The experience of IPON partners signed up for the study is given in Table S1. IPON partners maintain ongoing observatories with Indigenous communities where they use different methods, such as interviews and community diaries, to gather information from community members. Key informant interviews were conducted via Zoom over 3 months, from March to May 2024, at times convenient for the participants, and each interview lasted approximately 45 min to 1 h. Prior to conducting the interviews, we obtained approval from the Institutional Review Board at Virginia Tech and adhered to the ethical guidelines provided by the board throughout the study. Further, we also adhered to the ethical

framework developed by the IPON (COVID Observatories Ethics Framework 2023). Table S4 outlines how each component of this framework was implemented throughout the study.

We used a topic guide (Table S2) comprising two components: (i) questions regarding climate change impacts on Indigenous communities' health and (ii) recommendations for strengthening Indigenous communities' capacities for health resilience. The topic guide was iteratively developed in close collaboration with IPON's Research Questions Working Group to ensure that the study addressed community-identified priorities and aligned with established ethical guidelines. All interviews were recorded after obtaining consent from key informants. Recorded interviews were transcribed manually from June 2024 to July 2024 as two components (e.g., climate change impacts on Indigenous communities' health and recommendations for strengthening climate resilience health for Indigenous communities). A senior member of the research team quality-checked the interview transcribed sheets. Quality checking was conducted by randomly selecting transcription sheets and verifying them against the respective recordings. Issues identified in quality checking were resolved through collaborative discussions. Table 1 outlines the extreme climate events frequently affecting Indigenous communities and the related health conditions reported by key informants as being influenced or worsened by these events.

2.3 | Data Analyses

We particularly examined whether participants' quotes, collected from the first section of the topic guide (Table S2), clearly indicate similar objectives as specified in the climate resilience considerations of the World Health Organization's climate-resilient health systems approach (Table S3). During the data analysis phase, we worked closely with the Policy Group of IPON, which includes policy professionals from both governmental and non-governmental sectors. Drawing on their previous experience conducting policy research with Indigenous communities during the pandemic, the group recommended analytical tools (e.g., NVivo), advised on the development of infographics to better communicate findings to policy audiences, and provided guidance to refine the manuscript's language to ensure it was accessible to both policy and academic readers.

To conduct theme-building activities for transformative pathways, we imported the transcribed sheets into the NVivo software and developed codes using manifest and latent content analysis. Manifest content analysis involves textual coding to identify themes based on surface information (Erlingsson and Brysiewicz 2017). Latent content analysis is a thematic analysis used to determine the deep meaning of a given content (Nicmanis 2024). After identifying transformative pathways, we developed definitions based on existing literature to accurately reflect each pathway's meaning. We then developed narratives to explain how identified transformative pathways support the four overarching resilience considerations outlined in the World Health Organization's climate-resilient health systems approach. To strengthen these narratives, we incorporated quotes from interviews with key informants. Based on data collected from the second section of the topic guide (Table S2), we developed recommendations. Transcribed recommendation sheets were transferred to NVivo software for thematic analysis, where we identified common themes across all countries. From these, we selected three themes with the highest frequencies. We shared our findings with IPON participants, incorporating their feedback to redefine themes, refine interpretations, and verify definitions.

3 | Results

3.1 | Transformative Pathways and Its Alignment With the Resilience Considerations of the World Health Organization's Climate-Resilient Health Systems Approach

We identified five transformative pathways: (i) government-community interactions, (ii) traditional medicine and spiritual beliefs, (iii) experience-based practices, (iv) community-based collective actions, and (v) community-based policies. Using existing literature, we developed definitions to accurately represent the meanings of each transformative pathway, as shown in Table 2.

We explored how the identified transformative pathways support the resilience considerations of the World Health Organization's climate-resilient health system approach. We found transformative pathways supporting three resilience considerations: (i) managing climate-related health risks, (ii) developing health system capacity, and (iii) long-term vision and adaptive management, as shown in Figure 2.

Section A of the figure presents the four overarching resilience considerations in the World Health Organization's health systems approach, each represented by a distinct color. The colors were chosen randomly. The pathways linking sections A and B show transformative pathways, and pathways are color-coded in correspondence with its respective resilience considerations. For instance, government-community interactions align with the resilience consideration of "Managing climate-related health risks". However, the collected data provides limited insight into how transformative pathways support the resilience consideration, "Promote whole-of-society Action". Table 3 presents narratives and quotes that explain how transformative pathways contribute to the resilience considerations outlined in the World Health Organization's Climate-Resilient Health System approach.

3.2 | Recommendations to Strengthen Transformative Pathways

The narratives developed in Section 3.1 provide evidence of how transformative pathways support resilience considerations within the climate-resilient health systems approach. However, we found insufficient evidence to support the fourth resilience consideration, promoting whole-of-society action, highlighting the need for further improvements in the identified transformative pathways. To that end, based on the insights provided by key informants, we offered three recommendations on how health professionals and policymakers can support the improvements of transformative pathways, as outlined below.

TABLE 1 | Climate and health conditions reported among Indigenous communities as reflected by key informants.

Country	Indigenous community	Identification as Indigenous (Government [G], Self-identification [SI])	Extreme climate events, which were frequently reported among Indigenous communities	Health conditions perceived to be affected or exacerbated by climate events among Indigenous communities
Australia	Aboriginal and Torres Strait Islander	G	Floods, bushfires	Low life expectancy, cardiovascular diseases
Canada	Inuit	G and SI	Rapid snow, intensified rainfall	Tuberculosis, mental health issues
Fiji	iTaukei	SI	Cyclones, floods, and droughts	Typhoid, diabetes, overweight
Ghana	Dagaaba	G	Droughts	Cerebral spinal meningitis
India	Kurichya	G and SI	Floods	Asthma, malnutrition
Kyrgyzstan	At-Bashy Rayon	SI	Floods, landslides	Cardiovascular disease, malnutrition
Namibia	San	G	Droughts	Tuberculosis, diabetes, low life expectancy, and infant mortality
Peru	Shawi	G and SI	Extreme temperatures, floods	Anemia, malnutrition
South Africa	Xhosa	SI	Droughts	Diabetes, arthritis, asthma
Sri Lanka	Vedda	G and SI	Droughts	Chronic kidney disease, anemia, dermatological issues
Uganda	Batwa	G	Droughts	Diarrheal diseases, poor oral health

TABLE 2 | Identified transformative pathways definitions and examples.

Identified transformative pathways	Definition and references used	Examples
Government community interactions	Collaboration between governments and communities to achieve common objectives (Osborne et al. 2021; Wang and Ran 2023)	Food-sharing programs co-developed by governments and communities.
Traditional medicine and spiritual beliefs	Application of knowledge and practices related to plants, animals, and the natural environment to treat or manage diseases while incorporating cultural beliefs, worldviews, and spiritual perspectives (Fokunang et al. 2011; Niemiec et al. 2020; Redvers et al. 2023)	Use of medicinal plants and healing rituals by Indigenous communities.
Experience-based practices	Application of previous experiences to cure or manage health conditions (Li et al. 2019; Morley et al. 2024)	Elders apply past experiences to guide community health care.
Community-based collective actions	Group of individuals voluntarily working together to tackle a community issue or achieve shared benefits for the community (Osborne et al. 2021; Schiavo 2021)	Community associations and advisory councils.
Community-based policies	Policy interventions that directly or indirectly address communities' needs, desires, and intentions (Castillo et al. 2019; Selje et al. 2024).	Policies are shaped through community consultations to improve access to culturally appropriate healthcare.

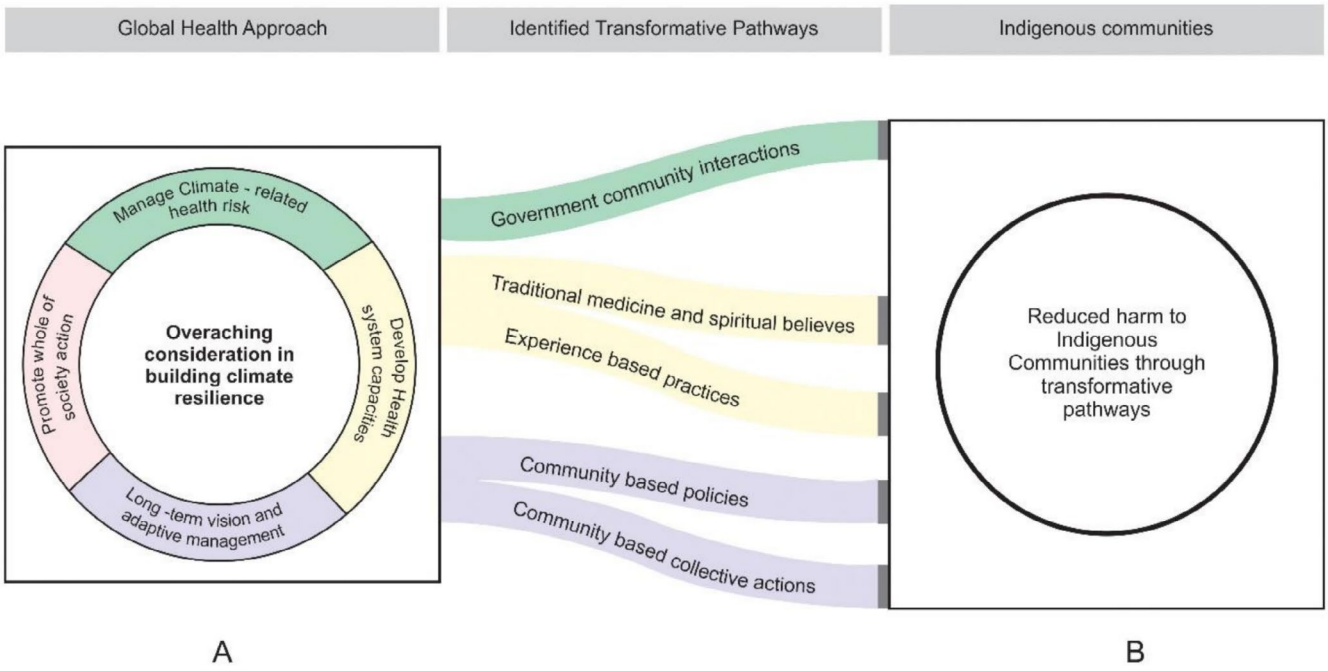

FIGURE 2 | Interactions of resilience considerations in the World Health Organization health systems approach and transformative pathways in this study.

3.2.1 | Indigenous Mentorship in Knowledge, Health Education, and Research

Indigenous mentorship plays a crucial role in health research and education. Insights from key informants confirm that Indigenous knowledge of traditional medicine, spiritual beliefs, and experience-based practices remains largely undocumented. Therefore, it is essential to document these practices ethically. Documentation must involve Indigenous Peoples as mentors to ensure that information about traditional medicine,

TABLE 3 | Narratives and key informant quotes explaining how transformative pathways support resilience considerations outlined in the World Health Organization's Climate-Resilient Health System approach.

Transformative pathways	Narrative	Quotes
Resilience consideration: Manage climate-related health risks		
Government-community interactions	Evidence for government-community interactions enhancing the health resilience of Indigenous communities was found among communities in Namibia and Peru. Food and medical aid are primarily distributed through these interactions. For example, Namibia's food parcel system was developed through long-term government-community engagement, providing San communities with a monthly food parcel, even during periods of low income caused by extreme climate events such as droughts. Shawi Indigenous communities in Peru engage with government officials whenever opportunities arise. Since Shawi lands are prone to intense rainfall, community leaders often collaborate with government stakeholders to secure medicines and other essential supplies. These interactions have strengthened the Shawi communities' capacity to respond to climate-induced health challenges.	"*There are connections with the government, especially the Ministry of Gender Equality, Poverty Eradication, and Social Welfare, which provides food parcels for marginalized communities. The food they [marginalized communities] receive is 20 kg of maize meal per household, two bottles (750 mL) of cooking oil, and two cans of tinned fish*" *[Key informant 1: lecturer from Namibia]* "*Community leaders [Shawi leaders] are working with governments and municipalities in activities like distributing medicine during climate and health emergencies*" *[Key informant 14: research assistant from Peru]* Quotes regarding government-community interactions highlight the importance of strengthening these relationships to enhance communities' climate health resilience.
Resilience consideration: Develop health system capacity		
Traditional medicine and spiritual beliefs	Indigenous communities in Kyrgyzstan, Vedda in Sri Lanka, and Dagaaba in Ghana have often used traditional medicine and spiritual beliefs to enhance Indigenous health resilience. Indigenous groups in Kyrgyzstan use bee honey as a traditional medicine to treat coughing and nausea. Vedda communities in Sri Lanka use *Atalantia ceylanica* as an immunity booster and pray to God for protection from diseases. Similarly, Dagaaba communities in Ghana also seek divine protection and rely on traditional healers who are known for curing diseases.	"*Bee honey is the most used traditional medicine among Indigenous communities in Kyrgyzstan. They [Indigenous communities] use it as a medicine for cough. It [Bee honey] is a good remedy when coughs spread during floods and other climate events*." *[Key informant 6: professor working with Indigenous communities in Kyrgyzstan]* "*Vedda communities in Sri Lanka steam boil water with Atalantia ceylanica as an immunity boost, and in health emergencies, they [Vedda] pray to yakas [the devil] and Kalu Bandara Deviyo [a deity in traditional Vedda history] to protect them [Vedda]*" *[Key informant 08: medical doctor from Sri Lanka]* "*We [Dagaaba] have people who can cure. If anyone in the community is sick, they [who are sick] can go to the healer's house and get healed. The person who can heal has the superpowers to cure the patient. However, this [healing by village healers] is not a formal process. We [Dagaaba] often pray, requesting God to protect us [Dagaaba] from diseases*." *[Key informant 3: researcher from Ghana]* Quotes regarding traditional medicine and spiritual beliefs highlight the importance of enhancing health systems' capacities and awareness of Indigenous communities' traditional practices.

(Continues)

TABLE 3 | (Continued)

Transformative pathways	Narrative	Quotes
Experienced-based practices	The evidence we gathered on experience-based practices among Indigenous communities highlights an essential consideration for strengthening health system capacities. For instance, the Batwa Indigenous communities follow a two-step curing process for diseases, with village health officers relying on their expertise to determine whether patients require hospital care or can be treated within the community during health emergencies. Similarly, the Kurichya communities in India and the Vedda communities in Sri Lanka have developed experience-based practices, such as increasing daily water intake and hanging plant leaves on doorsteps to boost immunity.	"*During rain, the terrain erodes and damages roads, limiting the Batwa's ability to reach a hospital during health emergencies. As a result, Batwa health officers started determining whether a patient needed to be sent to the hospital or if the health condition could be treated locally.*" *[Key informant 4: A research manager from Uganda]* "*As a practice, Vedda communities in Sri Lanka hang leaves of Azadirachta indica to repel germs and infections.*" *[Key informant 17: professor working with Vedda communities in Sri Lanka]* "*They [Kurichya] use their [Kurichyas'] experience in treating diseases. Using a lot of turmeric and drinking water has been their [Kurichya'] practice. They [Kurichya] believe in their [Kurichya'] experience and practices first and only go to a medical center for treatments only if necessary.*" *[Key informant 7: research scientist working with the Kurichya community in India]* Quotes on experience-based practices highlight the importance of health systems identifying and respecting the knowledge Indigenous communities have gained through experience.
Resilience consideration: Long-term vision and adaptive management		
Community-based collective actions	We found evidence for community-based collective actions of Indigenous communities with long-term vision and adaptive management. The Kurichya communities in India employ an informal communication strategy to share emergency information within their community effectively. This system has strengthened their ability to respond to climate-related health challenges, such as coordinating evacuations during floods and managing disease outbreaks. Similarly, the iTaukei communities in Fiji have developed a community-based disaster management plan to address flooding events and prevent the spread of related diseases. Community discussions were conducted to update iTaukei disaster management plan, enhancing emergency response capacities.	"*However, one of the things about the community is that the interaction within the community is powerful. If one person knows any information, they always communicate effectively with everyone. So, the mobilization of information and knowledge is very strong.*" *[Key informant 7: research scientist working with the Kurichya community in India]* "*iTaukei in Fiji has a community-based disaster management plan. In any emergency [Floods, health outbreaks], they [iTaukei] call a village meeting and discuss how to update and adjust the disaster management activities to better respond to the emergency.*" *[Key informant 9: researcher working with iTaukei communities in Fiji]* These quotes highlight the importance of prioritizing community-based approaches to enhance climate-resilient health.

(Continues)

TABLE 3 | (Continued)

Transformative pathways	Narrative	Quotes
Community-based policies	We found evidence that community-based approaches provide the most effective support for Indigenous communities, offering a valuable example for health professionals and policymakers to enhance their long-term vision and adaptive management within climate-resilient health systems. Aboriginal communities in Australia are particularly vulnerable to extreme climatic events such as rainfall flooding, rising sea levels, and wildfires. These environmental challenges have contributed to frequent health issues, including rheumatic fever, rheumatic heart disease, poor eye health, and trachoma. The government is enhancing community involvement by revising the national policy on Aboriginal affairs to address these concerns. Similarly, the Shawi people in Peru played a role in designing the country's national Intercultural Health Policy, helping to integrate Indigenous perspectives into the framework. While further efforts are needed to strengthen Shawi's participation in health policy development, their involvement remains crucial.	"*In Australia, the national Aboriginal policy only addressed national-level concerns. Given the differences between Aboriginal communities located in different areas of the country, the national Aboriginal policy did not provide benefits for all Aboriginal communities. Therefore, when revising the policy, the government has prioritized attention to different Aboriginal groups in the country.*" *[Key informant 16: Professor working with Aboriginal communities in Australia]* "*Like a decade ago, we [Shawi] had intercourse and intercultural health policy. There were Indigenous officers in the policies. However, there is still a lot to do because Indigenous peoples are essential to the development of intercultural health policy. Their [Shawi] contribution in intercourse or intercultural health does not cover all health needs of Indigenous Peoples*" *[Key informant 15: Medical doctor and a researcher from Peru]* Quotes on community-based policies highlight the importance of increasing Indigenous inclusion and participation in policymaking.

spiritual beliefs, and experience-based traditional practices is not altered during documentation. Ethical documentation of Indigenous knowledge will ensure its preservation for future generations and prevent knowledge from being lost with the passing of Indigenous ancestors. Documentation will empower future generations to apply Indigenous knowledge in treating diseases. Further, documented knowledge will provide an essential guideline that health professionals and policymakers need to adapt existing global health interventions for Indigenous communities.

> "Documentation of Indigenous knowledge is one possible aspect of preserving it. But, if we [health professionals, governance level authorities] ever do it, most importantly, we [health professionals, governance level authorities] need to do it with Indigenous Peoples, under their [Indigenous Peoples'] supervision and with their [Indigenous Peoples'] consent. Indigenous mentorship will guide us to document knowledge accurately."
>
> [Key informant 4: research manager from Uganda]

Key informants recommend that current approaches to Indigenous health education need to be enhanced. Indigenous culture, traditions, and healing techniques receive minimal attention in health studies curricula at schools and colleges. Incorporating chapters on Indigenous culture and healing techniques into school textbooks and college-level courses is therefore encouraged. However, in doing so, educators need to understand that Indigenous knowledge has a distinct epistemology and methodology from Western sciences. Enriching Indigenous studies in school and college curricula could inspire future generations to engage more deeply with Indigenous Peoples' traditional ways of treating diseases. Indigenous mentors need to be more effective facilitators in integrating Indigenous health knowledge into school and college curricula.

> "We [health professionals, governance level authorities] must create more opportunities to learn about Indigenous peoples and their health knowledge. Including chapters on Indigenous peoples' health in school textbooks and college-level courses are good starting points."
>
> [Key informant 1: lecturer from Namibia]

Based on insights from key informants, Indigenous communities must be engaged throughout the research process to benefit from it. Working with communities in this way will enable the community's needs to be the focus of research, rather than the researchers.

> "We [Researchers] must move beyond traditional ways of doing research. We [Researchers] may conduct more

> transdisciplinary research. Involving communities from the beginning till the end of research is vital. We [Researchers] need to start from the community level."
>
> [Key informant 17: professor working with Indigenous communities in Sri Lanka]

3.2.2 | Identify Opportunities to Develop Indigenous Inclusive Health Workforce

The results highlight the importance of including Indigenous Peoples in the health workforce. Having community members in the health workforce will help bridge the gap between the health systems and the community. Indigenous representatives can help healthcare providers understand the cultural needs of community members. They can interpret and speak their language, and their presence provides comfort and support to community members, encouraging them to seek help earlier. Providing comprehensive training on different aspects of healthcare (e.g., disease detection, emergency services, and primary care) is essential in fostering an Indigenous-inclusive health workforce. We found that individuals from Indigenous communities are employed in government hospitals in countries such as Sri Lanka, where they support the medical staff. Identifying opportunities to promote an inclusive Indigenous health workforce could bridge the gap between Indigenous communities and health professionals.

> "...That attendant [Indigenous individual] is still working in the hospital. He is doing good service. Likewise, we [Health professionals] can select dedicated people and train them. They [trained Indigenous individuals] can go to their communities and help their communities. Like what our attendant [Indigenous individual] does, they [trained Indigenous individuals] can send community members who require special care to the hospital. We can call them healthcare educators."
>
> [Key informant 8: medical doctor from Sri Lanka]

We documented a strategy to provide healthcare access through nurses. However, this access can be interrupted when nursing officers take leave or are transferred to other locations. This disruption to healthcare services can be largely remediate by training community members. Providing continuity of care through this mechanism, community-level recruitment will enhance community resilience and help manage challenging health conditions without relying on community nursing and midwifery services.

> "They [iTaukei] have a good zone nurse. She [zone nurse] treats conditions like foot ulcers associated with Diabetes. They [iTaukei] do not get to see her [zone nurse] very often as she [zone nurse] comes once a month. If they [iTaukei]get sick, they [iTaukei] get onto the bus and go into the clinic."
>
> [Key informant 9: researcher working with iTaukei in Fiji]

> "They [Vedda in Dambana] were having a midwifery service. So, without reaching the hospital, they [Vedda] can manage deliveries within communities at their [Vedda] homes. If we [government medical officers] can train them [Vedda], they can help their communities and contribute to even better midwifery services."
>
> [Key informant 8: medical doctor from Sri Lanka]

3.2.3 | Enhance Indigeneity in Health Policies

Indigeneity refers to characteristics of natural life and sociocultural traditions that shape Indigenous identity (Peltier and Ansloos 2021). As shared by the key informants, most Indigenous communities are passive recipients of national-level health policies. There was limited evidence for Indigenous communities' involvement in health policy design and implementation. A lack of belonging is a common concern among many Indigenous communities represented by our key informants. One way to address this is to actively involve Indigenous individuals in health policy discussions and create inclusive spaces where they can freely express their traditions and concerns. The inclusion of Indigenous Peoples should not be nominal; instead, their participation should be fully listened to and incorporated.

> "In meetings, they [San] feel marginalized. So, they [San] do not express how they feel. We must create a safe environment for them to be expressive."
>
> [Key informant 2: lecturer from Namibia]

> "They [Inuit] would say most of this engagement [Inuit engagement in policy] is very tokenistic. Yes, Inuit are there [policy process], and they [Inuit] are invited to the table. But they [Inuit] are not fully heard. Their [Inuit] experiences are not fully addressed or taken into consideration. They [Inuit] must be invited and heard fully."
>
> [Key informant 13: A professor working with Inuit in Canada]

Providing policy provisions at the community level is essential for enhancing Indigenous health policies. Key informants indicated that Indigenous considerations in national-level health policies are often aimed at achieving global recognition and attracting funding for development projects (e.g., funds from non-governmental organizations). Implementing national-level health policies that maximize benefits for Indigenous communities is essential. Engaging more with Indigenous communities, understanding community needs, and developing national policies tailored to address the needs of Indigenous communities will enhance Indigeneity and maximize benefits to Indigenous communities.

> "They [national level policy makers] always add a point that it [policy process] should be participatory and Indigenous communities should be involved.

> However, that is it, only in the lines. However, within healthcare, it is not written. There are no clear policies that Indigenous Peoples should invoke."
>
> [Key informant 7: research scientist working with the Kurichya community in India]

> "What we [Policymakers] are trying to do nationally in our country is stop making decisions about us [Aboriginal and Torres Strait Islander people], instead making those [national level health policies] with us [Aboriginal and Torres Strait Islander people], and ask us what will work in this context [Aboriginal and Torres Strait Islander people community level]? What policy do you think we should implement to better serve the community? What does the health system look like for your [Aboriginal and Torres Strait Islander] community? That is the way forward for enhancing Indigeneity in national health policies."
>
> [Key informant 16: Professor working with Aboriginal and Torres Strait Islander people in Australia]

4 | Discussion

This study highlights the importance of integrating Indigenous communities' capacities into global climate-resilient health system approaches. The study conceptualizes these capacities as *transformative pathways*, emphasizing the need for systemic change to minimize harm in implementing global health interventions within Indigenous communities. Through collaboration with IPON, the study identified five transformative pathways, examined how those pathways support the World Health Organization's climate-resilient health system approach, and provided recommendations to strengthen transformative pathways.

The five transformative pathways identified in this study contribute to the growing body of literature on climate change and Indigenous health systems (Perera et al. 2025; Redvers et al. 2023; Vidal-Cuellar et al. 2024). The transformative pathway *government-community interactions* supports findings by Schreuder and Horlings (2022), who found that strong collaboration between governments and communities enhances Indigenous communities' capacity to respond to extreme climate events. However, Tran et al. (2024) and McGowan et al. (2021) emphasize that the effectiveness of *government-community interactions* is contingent upon sustained trust-building efforts. Studies by Greenwald et al. (2022) and Casanova-Perez et al. (2022) show that health institutions often perpetuate discrimination against marginalized groups due to historical colonization, suggesting that *government-community interactions* may not always function as a practical, transformative pathway.

Transformative pathways, *traditional medicine, spiritual beliefs, and experience-based practices* are fundamental or foundational components of Indigenous knowledge systems (United Nations 2015). Redvers et al. (2023) emphasize that Indigenous medicines and belief systems are central to Indigenous ontologies, shaping community health, wellness, and resilience. Similarly, the identification of *experience-based practices* as a transformative pathway is supported by the findings of Mussi (2021) and Carmona et al. (2023), who highlight the importance of incorporating Indigenous experiences into global climate interventions, such as the preparation of Intergovernmental Panel on Climate Change reports.

Community-based collective actions are another transformative pathway that leverages Indigenous communities' strengths to address climate health risks. Identifying *community-based collaborative actions* as a transformative pathway aligns with Schramm et al. (2020), which shows the effectiveness of such actions in implementing new interventions (e.g., climate-ready tribe initiative) among Indian tribal communities. However, our identification of *community-based policies* as a transformative pathway is challenged by previous studies, including Bansal et al. (2023), Galappaththi et al. (2023), and Pickering et al. (2024), which indicate that in the past, Indigenous communities have often been passive recipients of global health policies, with limited consideration of Indigenous communities' specific needs. To be effective, their engagement must be active throughout the policy-making process.

Our identification of transformative pathways' contribution to resilience considerations of the World Health Organization's climate-resilient health systems aligns with previous studies. Identifying *government-community interactions* transformative pathways supporting the resilience consideration *managing climate resilience health risks* aligns with a study by Austin et al. (2016), which emphasizes cross-sector collaboration as an important consideration in identifying health risks. Similarly, conducting a study on risk management in Mexico City, Cid et al. (2024) highlight the need to mobilize institutional capacities at local levels through collaborative networks. We found that the resilience consideration of *developing health systems' capacity* can be facilitated through integrating transformative pathways *traditional medicine, spiritual beliefs, and experience-based practices*. However, persisting structural challenges hinder such integration. Kwame (2021) highlights that power imbalances between Western, biomedical, and traditional health systems often undermine Indigenous healing practices, restricting their formal recognition and integration into mainstream healthcare. Similarly, Abimbola et al. (2019) emphasize that institutional biases and regulatory restrictions impede efforts to integrate traditional and *experience-based practices* into health system development.

The World Health Organization's human rights-based approach to health policy development (WHO 2024) complements our finding of *community-based collective actions* and *policies* contributing to the resilience consideration of *long-term vision and adaptive management*. As Sanchez-Soriano et al. (2024) and Norris et al. (2008) emphasize, integrating community-based approaches is essential for ensuring the long-term sustainability of health systems. Similarly, Clark et al. (2024) found that community-driven initiatives enhance health resilience by fostering localized responses to climate-related

health risks and long-term adaptation strategies. However, the transformative pathway of *community-based policies* requires further refinement to strengthen climate resilience, as Ford et al. (2022) highlight in their examination of the intersection of climate change and COVID-19 in Indigenous communities. Limited evidence for transformative pathways contributing to climate-resilient health systems' resilience consideration of *whole-of-society action* is likely due to Indigenous communities' historical marginalization and their limited integration into Western medicine, as reflected by Carrie et al. (2015) and Horrill et al. (2018).

The recommendations from this study are intended to support Indigenous communities globally, extending beyond the community's experiences reported in this study. The first recommendation, *Indigenous mentorship in knowledge, health education, and research*, was a successful approach in youth mentorship programs in Canada and the Australian Indigenous mentoring program, as presented by Sanchez et al. (2023). The second recommendation *to identify opportunities to develop an inclusive Indigenous health workforce* complements the findings of O'Loughlin et al. (2021), which show the essential need to enhance inclusivity for Indigenous Peoples in workplaces. The third recommendation of the study *enhancing indigeneity in health policies* aligns with previous studies by Hindmarch and Hillier (2022), which suggest that Indigenous ontologies play a crucial role in policy development and reimagining global health.

The involvement of IPON significantly strengthened the study design, analytical steps, and dissemination of findings back to communities. IPON's extensive connections with Indigenous communities worldwide provided a platform for knowledge co-production and comparative learning, enabling the integration of diverse, place-based evidence on climate and health. This collaboration enhanced both the validity and relevance of the findings and advanced Indigenous climate health research by fostering cross-community dialogs, highlighting shared priorities, and promoting culturally grounded approaches to resilience. International health policy formulation requires robust evidence to develop policies, programs, and frameworks that effectively serve diverse Indigenous communities. Given the limited documented information on climate-related health risks for Indigenous peoples, collaboration with IPON facilitated the collection of evidence-based data through key informant interviews in different global contexts, providing critical insights to better inform health policymakers. Moreover, IPON guided the research team in disseminating findings in ways that are accessible to diverse communities, including through multiple languages and the development of infographics.

While collaboration with IPON significantly strengthened the study and provided critical evidence to inform policy, this study has certain limitations. First, 17 key informant interviews cannot fully represent the global Indigenous population. While key informants provided valuable insights informed by their expertise and, in some cases, their lived experiences as Indigenous representatives, these accounts offer an important but partial lens into community realities. Their perspectives may not fully capture the collective and diverse voices of the broader communities they represent, as key informant interviews often reflect expert or intermediary interpretations rather than direct, community-level narratives. Second, terms such as 'harm' and 'safe adoption' were defined using Western scholarly literature, though the meanings of these concepts may differ in Indigenous contexts. Third, the study does not provide methodologies for operationalizing the identified transformative pathways. Future research should address these gaps by fostering collaborations with global organizations, such as the World Health Organization and the Indigenous Peoples Unit of the Food and Agriculture Organization, to recruit a more diverse range of Indigenous participants. Additionally, exploring Indigenous frameworks for defining and quantifying harm is a crucial research direction. Further studies should also aim to co-design and co-produce implementation plans for transformative pathways with Indigenous communities that respond to their context-specific needs. By recognizing Indigenous communities as key facilitators of climate resilience and health, this study serves as a reference for policymakers and health professionals in developing more Indigenous-inclusive, climate-resilient health approaches.

5 | Conclusion

This study provides a novel contribution to the discourse on climate-resilient health systems by conceptualizing Indigenous communities' capacities as *transformative pathways*. While previous research has largely explored Indigenous health vulnerabilities, this study highlights Indigenous communities' strengths in shaping global climate health resilience efforts. The study identifies five transformative pathways that strengthen climate-resilient health systems.

- *Government-community interactions* improve climate-resilience health by fostering collaboration.
- *Traditional medicine and spiritual beliefs* highlight the importance of integrating Indigenous healing practices into formal health systems.
- *Experience-based practices* demonstrate how Indigenous knowledge, developed through lived experiences, supports responding to climate-induced health risks.
- *Community-based collective actions* empower communities to create local solutions for climate health resilience.
- *Community-based policies* emphasize the need for Indigenous participation in policymaking to ensure culturally relevant and effective health strategies.

The evidence-based narratives demonstrate that transformative pathways align with three of the four resilience considerations of the World Health Organization's climate-resilient health system approach. The absence of Indigenous-specific values in health systems and persistent structural barriers and institutional biases have led to insufficient evidence supporting the resilience consideration *whole-of-society action*. This study proposes three key recommendations to strengthen transformative pathways: (i) building Indigenous mentorship in knowledge, health education, and research, (ii) identifying opportunities to develop an inclusive Indigenous health workforce, and (iii) enhancing indigeneity in health policies. Recognizing Indigenous

communities as key facilitators of climate resilience, this study provides critical insights for developing Indigenous-inclusive, climate-resilient health policies and practices. To advance these efforts, policymakers and researchers must actively engage with Indigenous leaders, integrate Indigenous knowledge into health frameworks, and dismantle systemic barriers that hinder Indigenous participation in decision-making.

Author Contributions

Chrishma D. Perera: conceptualization, data collection, formal analysis, data curation, visualization, writing – original draft. **Eranga K. Galappaththi:** conceptualization, supervision, funding acquisition, writing – review and editing. **Carol Zavaleta-Cortijo:** supervision, funding acquisition, writing – review and editing. **Timothy D. Baird:** supervision, writing – review and editing. **Korine N. Kolivras:** supervision, writing – review and editing. **James D. Ford:** funding acquisition, writing – review and editing. **Michelle Dickson:** validation, writing – review and editing. **Kerrie Pickering:** validation, writing – review and editing. **Guangqing Chi:** validation, writing – review and editing. **Joana Bezerra:** validation, writing – review and editing. **Dhanya Vijayan:** validation, writing – review and editing. **Victoria Chicamana-Zapata:** validation, writing – review and editing. **Cecil Togarepi:** validation, writing – review and editing. **Kheminda G. Thilakarathne:** validation, writing – review and editing. **Martha M. Hangula:** validation, writing – review and editing. **Francis A. Akugre:** validation, writing – review and editing. **Richard Nuwagira:** validation, writing – review and editing. **Jonathan Nkalubo:** validation, writing – review and editing.

Acknowledgments

We sincerely appreciate the research participants from the Indigenous Peoples Observatory Network (IPON) and the Indigenous communities represented by key informants. We also acknowledge Joana Bezerra, International Coordinator of IPON at the inception of this study, for administrative support, and Dr. Robert Marten, Unit Head at the Alliance for Health Policy and Systems Research, World Health Organization, for his contributions to conceptualizing the study and for providing feedback on earlier versions of the manuscript.

Funding

C.D.P. received summer funding from the Institute of Creativity, Arts and Technology, Virginia Polytechnic and State University, USA (ICAT) at Virginia Tech, acquired by E.K.G. During the development of this manuscript, C.Z.-C. received funding support from the University of Leeds (UK) to Universidad Peruana Cayetano Heredia (Peru) in 2024, a consultancy with the University of Alberta (Canada) in 2025, and the UK Natural Environment Research Council (NERC) through the Climate, Environment, and Health (CEH-2) program. IPON received funding through the New Frontiers in Research Fund (NFRF) and the Belmont Forum Grant Award Number 2537403.

References

Abimbola, S., L. Baatiema, and M. Bigdeli. 2019. "The Impacts of Decentralization on Health System Equity, Efficiency, and Resilience: A Realist Synthesis of the Evidence." *Health Policy and Planning* 34, no. 8: 605–617. https://doi.org/10.1093/heapol/czz055.

Akhter, S. 2022. "Key Informants' Interviews." In *Principles of Social Research Methodology*, edited by M. R. Islam, N. A. Khan, and R. Baikady, 389–403. Springer Nature. https://doi.org/10.1007/978-981-19-5441-2_27.

Austin, S., R. Biesbroek, L. Berrang-Ford, J. Ford, S. Parker, and M. Fleury. 2016. "Public Health Adaptation to Climate Change in OECD Countries." *International Journal of Environmental Research and Public Health* 13, no. 9: 889. https://doi.org/10.3390/ijerph13090889.

Bansal, S., T. Sarker, A. Yadav, I. Garg, M. Gupta, and H. Sarvaiya. 2023. "Indigenous Communities and Sustainable Development: A Review and Research Agenda." *Global Business and Organizational Excellence* 43, no. 4: 65–87. https://doi.org/10.1002/joe.22237.

Billiot, S., and F. M. Mitchell. 2019. "Conceptual Interdisciplinary Model of Exposure to Environmental Changes to Address Indigenous Health and Well-Being." *Public Health* 176: 142–148. https://doi.org/10.1016/j.puhe.2018.08.011.

Carmona, R., G. Reed, S. Thorsell, et al. 2023. "Analysing Engagement With Indigenous Peoples in the Intergovernmental Panel on Climate Change's Sixth Assessment Report." *Npj Climate Action* 2, no. 1: 29. https://doi.org/10.1038/s44168-023-00048-3.

Carrie, H., T. K. Mackey, and S. N. Laird. 2015. "Integrating Traditional Indigenous Medicine and Western Biomedicine Into Health Systems: A Review of Nicaraguan Health Policies and Miskitu Health Services." *International Journal for Equity in Health* 14, no. 1: 129. https://doi.org/10.1186/s12939-015-0260-1.

Casanova-Perez, R., C. Apodaca, E. Bascom, et al. 2022. "Broken Down by Bias: Healthcare Biases Experienced by BIPOC and LGBTQ+ Patients." *American Medical Informatics Association Annual Symposium Proceedings* 2021: 275–284.

Case, E. 2019. "I Ka Piko, to the Summit: Resistance From the Mountain to the Sea." *Journal of Pacific History* 54, no. 2: 166–181. https://doi.org/10.1080/00223344.2019.1577132.

Castillo, E. G., R. Ijadi-Maghsoodi, S. Shadravan, et al. 2019. "Community Interventions to Promote Mental Health and Social Equity." *Current Psychiatry Reports* 21, no. 5: 35. https://doi.org/10.1007/s11920-019-1017-0.

Chakanyuka, C., J.-D. R. Bacsu, A. DesRoches, et al. 2022. "Indigenous-Specific Cultural Safety Within Health and Dementia Care: A Scoping Review of Reviews." *Social Science & Medicine* 293: 114658. https://doi.org/10.1016/j.socscimed.2021.114658.

Cid, A., J. M. Siqueiros-García, M. Mazari-Hiriart, A. Guerra, and A. M. Lerner. 2024. "Mobilizing Institutional Capacities to Adapt to Climate Change: Local Government Collaboration Networks for Risk Management in Mexico City." *Npj Climate Action* 3, no. 1: 20. https://doi.org/10.1038/s44168-024-00102-8.

Clark, E. C., S. Baidoobonso, K. A. M. Phillips, et al. 2024. "Mobilizing Community-Driven Health Promotion Through Community Granting Programs: A Rapid Systematic Review." *BMC Public Health* 24, no. 1: 932. https://doi.org/10.1186/s12889-024-18443-8.

COVID Observatories Ethics Framework. 2023. "Figshare." https://doi.org/10.6084/m9.figshare.24081627.v1.

Cunsolo, A., S. L. Harper, K. Minor, K. Hayes, K. G. Williams, and C. Howard. 2020. "Ecological Grief and Anxiety: The Start of a Healthy Response to Climate Change?" *Lancet Planetary Health* 4, no. 7: e261–e263. https://doi.org/10.1016/S2542-5196(20)30144-3.

Dannenberg, A. L., H. Frumkin, J. J. Hess, and K. L. Ebi. 2019. "Managed Retreat as a Strategy for Climate Change Adaptation in Small Communities: Public Health Implications." *Climatic Change* 153, no. 1–2: 1–14. https://doi.org/10.1007/s10584-019-02382-0.

Dorji, T., K. Rinchen, A. Morrison-Saunders, D. Blake, V. Banham, and S. Pelden. 2024. "Understanding How Indigenous Knowledge Contributes to Climate Change Adaptation and Resilience: A Systematic Literature Review." *Environmental Management* 74: 1101–1123. https://doi.org/10.1007/s00267-024-02032-x.

Durkalec, A., C. Furgal, M. W. Skinner, and T. Sheldon. 2015. "Climate Change Influences on Environment as a Determinant of Indigenous Health: Relationships to Place, Sea Ice, and Health in an Inuit

Community." *Social Science & Medicine* 136: 17–26. https://doi.org/10.1016/j.socscimed.2015.04.026.

Erlingsson, C., and P. Brysiewicz. 2017. "A Hands-On Guide to Doing Content Analysis." *African Journal of Emergency Medicine* 7, no. 33: 93–99.

FAO. 2021. *The White/Wiphala Paper on Indigenous Peoples' Food Systems*. FAO. https://doi.org/10.4060/cb4932en.

Fokunang, C., V. Ndikum, O. Tabi, et al. 2011. "Traditional Medicine: Past, Present and Future Research and Development Prospects and Integration in the National Health System of Cameroon." *African Journal of Traditional, Complementary, and Alternative Medicines* 8, no. 3: 284–295. https://doi.org/10.4314/ajtcam.v8i3.65276.

Ford, J. D. 2012. "Indigenous Health and Climate Change." *American Journal of Public Health* 102, no. 7: 1260–1266. https://doi.org/10.2105/AJPH.2012.300752.

Ford, J. D., C. Zavaleta-Cortijo, T. Ainembabazi, et al. 2022. "Interactions Between Climate and COVID-19." *Lancet Planetary Health* 6, no. 10: e825–e833. https://doi.org/10.1016/S2542-5196(22)00174-7.

Furgal, C., and J. Seguin. 2006. "Climate Change, Health, and Vulnerability in Canadian Northern Aboriginal Communities." *Environmental Health Perspectives* 114, no. 12: 1964–1970. https://doi.org/10.1289/ehp.8433.

Galappaththi, E. K., C. D. Perera, I. P. Dharmasiri, et al. 2023. "Policy Responses to COVID-19 in Sri Lanka and the Consideration of Indigenous Peoples." *Environmental Science & Policy* 144: 110–123. https://doi.org/10.1016/j.envsci.2023.03.008.

Greenwald, A. G., N. Dasgupta, J. F. Dovidio, J. Kang, C. A. Moss-Racusin, and B. A. Teachman. 2022. "Implicit-Bias Remedies: Treating Discriminatory Bias as a Public-Health Problem." *Psychological Science in the Public Interest* 23, no. 1: 7–40. https://doi.org/10.1177/15291006211070781.

Greenwood, M., and N. M. Lindsay. 2019. "A Commentary on Land, Health, and Indigenous Knowledge(s)." *Global Health Promotion* 26, no. 3_suppl: 82–86. https://doi.org/10.1177/1757975919831262.

Hindmarch, S., and S. Hillier. 2022. "Reimagining Global Health: From Decolonisation to Indigenization." *Global Public Health* 18, no. 1: 2092183. https://doi.org/10.1080/17441692.2022.2092183.

Horrill, T., D. E. McMillan, A. S. H. Schultz, and G. Thompson. 2018. "Understanding Access to Healthcare Among Indigenous Peoples: A Comparative Analysis of Biomedical and Postcolonial Perspectives." *Nursing Inquiry* 25, no. 3: e12237. https://doi.org/10.1111/nin.12237.

Intergovernmental Panel on Climate Change. 2023. *Climate Change 2021–The Physical Science Basis: Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. 1st ed. Cambridge University Press. https://doi.org/10.1017/9781009157896.

Jaakkola, J. J. K., S. Juntunen, and K. Näkkäläjärvi. 2018. "The Holistic Effects of Climate Change on the Culture, Well-Being, and Health of the Saami, the Only Indigenous People in the European Union." *Current Environmental Health Reports* 5, no. 4: 401–417. https://doi.org/10.1007/s40572-018-0211-2.

Kennedy, A., A. Sehgal, J. Szabo, et al. 2022. "Indigenous Strengths-Based Approaches to Healthcare and Health Professions Education–Recognising the Value of Elders' Teachings." *Health Education Journal* 81, no. 4: 423–438. https://doi.org/10.1177/00178969221088921.

Kwame, A. 2021. "Integrating Traditional Medicine and Healing Into the Ghanaian Mainstream Health System: Voices From Within." *Qualitative Health Research* 31, no. 10: 1847–1860. https://doi.org/10.1177/10497323211008849.

Lewis, D., L. Williams, and R. Jones. 2020. "A Radical Revision of the Public Health Response to Environmental Crisis in a Warming World: Contributions of Indigenous Knowledges and Indigenous Feminist Perspectives." *Canadian Journal of Public Health* 111, no. 6: 897–900. https://doi.org/10.17269/s41997-020-00388-1.

Li, S., M. Cao, and X. Zhu. 2019. "Evidence-Based Practice: Knowledge, Attitudes, Implementation, Facilitators, and Barriers Among Community Nurses—Systematic Review." *Medicine* 98, no. 39: e17209. https://doi.org/10.1097/MD.0000000000017209.

Lorgelly, P. K., and D. J. Exeter. 2023. "Health Reform in Aotearoa New Zealand: Insights on Health Equity Challenges One Year on." *Applied Health Economics and Health Policy* 21, no. 5: 683–687. https://doi.org/10.1007/s40258-023-00823-7.

Malik, I. H., and J. D. Ford. 2025. "Understanding the Impacts of Arctic Climate Change Through the Lens of Political Ecology." *WIREs Climate Change* 16, no. 1: e927. https://doi.org/10.1002/wcc.927.

Mamo, D. 2020. *The Indigenous World 2020*. International Work Group for Indigenous Affairs. https://iwgia.org/en/resources/publications/305-books/4512-the-indigenous-world-2020.html.

Maphumulo, W. T., and B. R. Bhengu. 2019. "Challenges of Quality Improvement in the Healthcare of South Africa Post-Apartheid: A Critical Review." *Curationis* 42, no. 1: e1–e9. https://doi.org/10.4102/curationis.v42i1.1901.

McGowan, V. J., S. Buckner, R. Mead, et al. 2021. "Examining the Effectiveness of Place-Based Interventions to Improve Public Health and Reduce Health Inequalities: An Umbrella Review. Examining the Effectiveness of Place-Based Interventions to Improve Public Health and Reduce Health Inequalities: An Umbrella Review." 21, no. 1: 1888. https://doi.org/10.1186/s12889-021-11852-z.

Middleton, J., A. Cunsolo, A. Jones-Bitton, C. J. Wright, and S. L. Harper. 2020. "Indigenous Mental Health in a Changing Climate: A Systematic Scoping Review of the Global Literature." *Environmental Research Letters* 15, no. 5: 053001. https://doi.org/10.1088/1748-9326/ab68a9.

Morley, C., K. Jose, S. E. Hall, et al. 2024. "Evidence-Informed, Experience-Based Co-Design: A Novel Framework Integrating Research Evidence and Lived Experience in Priority-Setting and Co-Design of Health Services." *BMJ Open* 14, no. 8: e084620. https://doi.org/10.1136/bmjopen-2024-084620.

Mussi, F. 2021. "Land and Storytelling: Indigenous Pathways Towards Healing, Spiritual Regeneration, and Resurgence." *Journal of Commonwealth Literature* 58, no. 3: 660–676. https://doi.org/10.1177/00219894211031716.

National Colloborating Center for Indigenous Health. 2022. *Climate Change and Indigenous Peoples' Health in Canada*, 12–20. National Colloborating Center for Indigenous Health.

Neufeld, H. T., L. M. Nilsson, and R. G. Jones. 2022. "Indigenous Peoples' Health and Well-Being in a Changing Climate." In *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, 1054–1055. Cambridge University Press.

Nicmanis, M. 2024. "Reflexive Content Analysis: An Approach to Qualitative Data Analysis, Reduction, and Description." *International Journal of Qualitative Methods* 23: 16094069241236603. https://doi.org/10.1177/16094069241236603.

Niemiec, R. M., P. Russo-Netzer, and K. I. Pargament. 2020. "The Decoding of the Human Spirit: A Synergy of Spirituality and Character Strengths Toward Wholeness." *Frontiers in Psychology* 11: 2040. https://doi.org/10.3389/fpsyg.2020.02040.

Norris, F. H., S. P. Stevans, B. Pfefferbaum, K. F. Wyche, and R. L. Pfefferbaum. 2008. "Community Resilience Is a Metaphor, Theory, Set of Capacities, and Strategy for Disaster Readiness." *American Journal of Community Physciology* 41, no. 1–2: 127–150. https://doi.org/10.1007/s10464-007-9156-6.

Nursey-Bray, M., and R. Palmer. 2018. "Country, Climate Change Adaptation and Colonisation: Insights From an Indigenous Adaptation Planning Process, Australia." *Heliyon* 4, no. 3: e00565. https://doi.org/10.1016/j.heliyon.2018.e00565.

O'Loughlin, R. A., V. L. Kristman, and A. Gilbeau. 2021. "Inclusion of Indigenous Workers in Workplace Mental Health." *Equality, Diversity and Inclusion: An International Journal* 41, no. 3: 340–351. https://doi.org/10.1108/EDI-07-2020-0176.

O'Neill, L., T. Fraser, A. Kitchenham, and V. McDonald. 2018. "Hidden Burdens: A Review of Intergenerational, Historical and Complex Trauma, Implications for Indigenous Families." *Journal of Child & Adolescent Trauma* 11, no. 2: 173–186. https://doi.org/10.1007/s40653-016-0117-9.

Osborne, C., L. Mayo, and M. Bussey. 2021. "New Frontiers in Local Government Community Engagement: Towards Transformative Place-Based Futures." *Futures* 131: 102768. https://doi.org/10.1016/j.futures.2021.102768.

Peltier, S., and J. Ansloos. 2021. "Indigeneity: Critical Implications of Indigenous Identity on Indigenous Child and Youth Mental Health." In *The Palgrave Encyclopedia of Critical Perspectives on Mental Health*, edited by J. N. Lester and M. O'Reilly, 1–10. Springer International Publishing. https://doi.org/10.1007/978-3-030-12852-4_27-1.

Perera, C. D., E. K. Galappaththi, C. Zavaleta-Cortijo, T. D. Baird, and K. N. Kolivras. 2025. "A Conceptual Framework to Improve Climate-Resilient Health Among Indigenous Communities." *Environmental Science & Policy* 168: 104069. https://doi.org/10.1016/j.envsci.2025.104069.

Pickering, K., E. Galappaththi, J. Ford, et al. 2024. "Fiji's Policy Response to COVID-19 and the Integration of Indigenous Voices." *Environmental Science & Policy* 158: 103791. https://doi.org/10.1016/j.envsci.2024.103791.

Pointertner, H. O., D. C. Roberts, E. S. Poloczanska, et al. 2022. "Intergovernmental Panel on Climate Change: Summary for Policymakers." In *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment*. Cambridge University Press.

Pratt, B. 2019. "Inclusion of Marginalized Groups and Communities in Global Health Research Priority-Setting." *Journal of Empirical Research on Human Research Ethics* 14, no. 2: 1–10. https://doi.org/10.1177/1556264619833858.

Redvers, N., P. Aubrey, Y. Celidwen, and K. Hill. 2023. "Indigenous Peoples: Traditional Knowledges, Climate Change, and Health." *PLOS Global Public Health* 3, no. 10: e0002474. https://doi.org/10.1371/journal.pgph.0002474.

Reid, P., D. Cormack, and S.-J. Paine. 2019. "Colonial Histories, Racism and Health—The Experience of Māori and Indigenous Peoples." *Public Health* 172: 119–124. https://doi.org/10.1016/j.puhe.2019.03.027.

Richmond, C. A. M., and N. A. Ross. 2009. "The Determinants of First Nation and Inuit Health: A Critical Population Health Approach." *Health & Place* 15, no. 2: 403–411. https://doi.org/10.1016/j.healthplace.2008.07.004.

Sanchez, J., J. Maiden, E. Barton, et al. 2023. "Factors That Sustain Indigenous Youth Mentoring Programs: A Qualitative Systematic Review." *BMC Public Health* 23, no. 1: 429. https://doi.org/10.1186/s12889-023-15253-2.

Sanchez-Soriano, M., P. M. Arango-Ramírez, E. I. Perez-López, and I. A. García-Montalvo. 2024. "Inclusive Governance: Empowering Communities and Promoting Social Justice." *Frontiers Political Science* 6: 1478126. https://doi.org/10.3389/fpos.2024.1478126.

Sauer, J., L. Berrang-Ford, K. Patterson, et al. 2018. "An Analysis of the Nutrition Status of Neighbouring Indigenous and Non-Indigenous Populations in Kanungu District, Southwestern Uganda: Close Proximity, Distant Health Realities." *Social Science & Medicine* 217: 55–64. https://doi.org/10.1016/j.socscimed.2018.09.027.

Saulnier, D. D., K. Brolin Ribacke, and J. Von Schreeb. 2017. "No Calm After the Storm: A Systematic Review of Human Health Following Flood and Storm Disasters." *Prehospital and Disaster Medicine* 32, no. 5: 568–579. https://doi.org/10.1017/S1049023X17006574.

Schiavo, R. 2021. "What Is True Community Engagement and Why It Matters (Now More Than Ever)." *Journal of Communication in Healthcare* 14, no. 2: 91–92. https://doi.org/10.1080/17538068.2021.1935569.

Schramm, P. J., A. L. Al Janabi, L. W. Campbell, J. L. Donatuto, and S. C. Gaughen. 2020. "How Indigenous Communities Are Adapting to Climate Change: Insights From the Climate-Ready Tribes Initiative. This Analysis Examines How Indigenous Communities Are Adapting to Climate Change." *Health Affairs* 39, no. 12: 2153–2159. https://doi.org/10.1377/hlthaff.2020.00997.

Schreuder, W., and L. G. Horlings. 2022. "Transforming Places Together: Transformative Community Strategies Responding to Climate Change and Sustainability Challenges." *Climate Action* 1, no. 1: 24. https://doi.org/10.1007/s44168-022-00024-3.

Selje, T., L. A. Schmid, and B. Heinz. 2024. "Community-Based Adaptation to Climate Change: Core Issues and Implications for Practical Implementations." *Climate* 12, no. 10: 155. https://doi.org/10.3390/cli12100155.

Tran, L. T., H. Wardle, S. Colledge-Frisby, et al. 2024. "The Prevalence of Gambling and Problematic Gambling: A Systematic Review and Meta-Analysis." *Lancet Public Health* 9, no. 8: e594–e613. https://doi.org/10.1016/S2468-2667(24)00126-9.

Turner, J. R., and R. Baker. 2020. "Collaborative Research: Techniques for Conducting Collaborative Research From the Science of Team Science (SciTS)." *Advances in Developing Human Resources* 22, no. 1: 72–86. https://doi.org/10.1177/1523422319886300.

United Nations. 2002. *United Nations Permanent Forum on Indigenous Issues (UNPFII)*. United Nations. https://social.desa.un.org/issues/indigenous-peoples/unpfii.

United Nations. 2015. *Transforming Our World: The 2030 Agenda for Sustainable Development*, 35–38. United Nations. https://www.un.org/sustainabledevelopment/development-agenda/.

Vecchio, E. A., M. Dickson, and Y. Zhang. 2022. "Indigenous Mental Health and Climate Change: A Systematic Literature Review." *Journal of Climate Change and Health* 6: 100121. https://doi.org/10.1016/j.joclim.2022.100121.

Vidal-Cuellar, C. L., V. Chicmana-Zapata, I. Arotoma-Rojas, et al. 2024. "Pathways to Strengthen the Climate Resilience of Health Systems in the Peruvian Amazon by Working With Indigenous Leaders, Communities, and Health Officers." *BMJ Global Health* 8, no. Suppl 3: e014391. https://doi.org/10.1136/bmjgh-2023-014391.

Wang, H., and B. Ran. 2023. "Network Governance and Collaborative Governance: A Thematic Analysis on Their Similarities, Differences, and Entanglements." *Public Management Review* 25, no. 6: 1187–1211. https://doi.org/10.1080/14719037.2021.2011389.

WHO. 2024. *Human Rights*. WHO. https://www.who.int/health-topics/human-rights#tab=tab_2.

Whyte, K. 2017. "Indigenous Climate Change Studies: Indigenizing Futures, Decolonizing the Anthropocene." *English Language Notes* 55, no. 1: 153–162. https://doi.org/10.1215/00138282-55.1-2.153.

World Health Organization. 2023. *Operational Framework for Building Climate Resilient and Low Carbon Health Systems*. World Health Organization. https://www.who.int/.

Zavaleta-Cortijo, C., J. D. Ford, E. K. Galappaththi, et al. 2023. "Indigenous Knowledge, Community Resilience, and Health Emergency Preparedness." *Lancet Planetary Health* 7, no. 8: e641–e664.

Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Data S1:** Supporting information.