GeoJournal (2023) 88:5397–5409
https://doi.org/10.1007/s10708-023-10916-4

Climate change and health in rural mountain environments: summary of a workshop on knowledge gaps, barriers, and opportunities for action

Margaret Mae Sugg · Sophia Ryan · Taylin Spurlock · Sara Duncan · Adam Hege · Matthew Chidozie Ogwu · Jennifer Tyson · Elizabeth Shay · Kelly Ann Renwick · Christine Hendren · Manan Roy · Jennifer D. Runkle

Accepted: 23 June 2023 / Published online: 2 August 2023

Abstract Climate change and its associated impacts on human health are serious and growing challenges. Yet, despite elevated health disparities, unique underlying vulnerabilities, and distinctive ecosystems, little research has been conducted in rural mountain environments to understand climate-health interactions. The climate change and health workshop in rural mountain environments was held at Appalachian State University in Boone, North Carolina, United States, to address these research gaps. Experts, community members, and students from diverse disciplines engaged in World Café brainstorms and open-ended discussions to highlight needs across seven research priority themes, which focused on rural southern Appalachia but are applicable to other rural mountain environments: (1) anticipating climate change-driven environmental changes specific to rural mountain environments; (2) identifying and reaching vulnerable populations; (3) building health care access security during weather disasters; (4) building mental health support security in the context of climate change; (5) vector-borne disease resilience; (6) building food security in the context of climate change; and (7) public education and conversations of climate change. This report summarizes the workshop findings and provides a template for future research at the intersection of climate and health, including but not limited to establishing multi-sector and interdisciplinary working groups with clear objectives, enhancing knowledge and understanding of key issues, as well as acting collaboratively and engaging with stakeholders to build resilience in rural mountain environments to address the effects of climate change on human health.

Keywords Climate change · Health · Climate-health · Rural · Rural mountain environments · The vulnerability of rural populations · Climate-health resilience

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10708-023-10916-4.

M. M. Sugg (✉) · S. Ryan · T. Spurlock · A. Hege · M. Ogwu · J. Tyson · E. Shay · K. Renwick · C. Hendren · M. Roy
Appalachian State University, Boone, NC, USA
e-mail: kovachmm@appstate.edu

S. Duncan
College of Health and Human Sciences, School of Health Sciences Western Carolina University, Cullowhee, NC 28723, USA

J. D. Runkle
North Carolina Institute for Climate Studies, North Carolina State University, 151 Patton Avenue, Asheville, NC 28801, USA

Introduction

Climate change is a significant threat to human health (Watts et al., 2018). The health impacts of climate

change are diverse, ranging from air pollution-related chronic diseases and allergic reactions like asthma and cardiovascular diseases to food and water-borne infections and extreme heat (Hathaway & Maibach, 2018; Okamoto-Mizuno & Mizuno, 2012; Sarfaty et al., 2016). The inequitable distribution of climate change impacts often amplifies existing vulnerabilities and health disparities through a complex set of direct and indirect mechanisms (Austin et al., 2020; Hayes et al., 2018).

Rural communities face unique challenges to climate change due to their distinctive barriers, including higher incidence of poverty, limited access to health care, higher dependence on government funds (Lal et al., 2011), and a higher share of individuals relying on the natural environment for their livelihoods (e.g., farming) (Bourque & Cunsolo Willox, 2014). Even less attention is paid to rural mountainous areas, often characterized by more rugged and small isolated communities. Limited examples include specific locations like the Hindu Kush (Ebi et al., 2007), Indigenous populations (Berry & Schnitter, 2022), or analysis of specific health outcomes like vector-borne diseases (Beniston, 2003).

A changing climate likely will increase mountain regions' exposure to extreme weather events, threatening livelihoods and infrastructure for rural populations (USGCRP, 2016). In the United States, the rural Appalachian mountains remains an understudied location with unique challenges and degrading health infrastructure (Pollard & Jacobsen, 2020). Located within the southeastern US, the area is facing more frequent and intense extreme weather events, including hurricanes, tornadoes, flooding, and rising temperatures (Carter et al., 2018), all of which impact human health negatively (Fuhrmann et al., 2016; Hetherington et al., 2021; Runkle et al., 2021; Sugg, 2018).

Further exacerbating the climate-health crisis in the southeast, nearly two dozen hospitals have closed their doors in rural Appalachia and mountain regions in the last decade (Kranitz & Foundation, 2020). The loss of hospitals in rural communities further endangers a vulnerable population (Pollard & Jacobsen, 2020). Additionally, as compared to urban communities, rural residents are more likely to have lower income and educational attainment, both of which increase the risk of poor health (Iglehart, 2018; Rural Health Information Hub, 2021; Wanless et al., 2010). The closing of rural hospitals means these residents must travel long distances to seek care; for low-income residents living in a system with limited access to public transportation, this virtually eliminates access to care. As the climate crisis worsens, whittling away at an already precarious health care system will likely result in a widening health care crisis.

The climate change and health in rural mountain environments (CCHRME) workshop was held at Appalachian State University in the Spring of 2022 to address knowledge gaps at the intersection of climate and rural health in the southern Appalachians. The objectives of this workshop were (1) to convene researchers, experts, and early career professionals focused on the impacts of CCHRME; (2) to identify and prioritize research needs at the intersection of climate, rural health, and mountain environments; and (3) identify other stakeholders, faculty, and researchers needed to tackle these challenges. Following presentations from keynote speakers, participants broke into small groups and discussed additional gaps and solutions for implementation using a World Café method (Brown, 2005). Team science best practices for co-creating knowledge were applied by soliciting input from attendees in advance of the conference to communally generate the small group discussion topics. World Café discussions generated data that were analyzed using content analysis to summarize key concepts; all co-authors reviewed the findings. Results provide guidance on research needs and next steps for work at the intersection of climate and health in rural mountain environments using a cross-disciplinary perspective.

Methods

Region

All participants were from the southern Appalachian region encompassing Tennessee and North Carolina. This region is predominantly rural and, as part of the Appalachian region, has high poverty rates, unemployment, disability, and a lack of public health services. Higher mortality rates are found in this region, with death from chronic diseases like cancer, heart disease, stroke, and diabetes and higher rates of deaths of despair like overdose deaths and suicide.

Health disparities are further exacerbated by a low number of health care professionals and health care clinics (Smith, 2021). Specifically, regions like western North Carolina are located in primary care health professional shortage areas and are isolated due to limited infrastructure and longer commute times.

Workshop

Thirty participants, including administrators, university faculty, staff and students, and community members, attended a one-day workshop titled climate change and health in rural mountain environments (CCHRME) at Appalachian State University in the Spring of 2022. Attendees came from the region, representing different academic institutions (e.g., Western Carolina University, East Tennessee University), local stakeholders (e.g., Appalachian Voices, local public health officials), and experts (e.g., retired professionals). The workshop consisted of keynote speakers addressing the region's climate change and health-related issues and attendees discussing the knowledge gaps in rural climate change and health, specifically in mountainous environments.

Workshop discussion topics were identified in a pre-workshop survey that approximately half of the participants completed ($n=15$), where participants had the opportunity to describe their research interests and rank rural climate change-related issues.

World café methodology

The workshop discussion had two phases, beginning with morning keynote presentations that focused on research at both national and local scales. Participants then engaged in a World Café, a participatory tool that promotes constructive dialogue that fosters collaboration and qualitative data collection around critical research questions (Lohr et al., 2020). In addition, the World Café focuses on disciplined inquiry, possibility thinking, and the "cross-pollination of ideations" through evolving rounds of information exchange and sharing (Fouche and Light, 2010; Lohr et al., 2020). Unlike other qualitative methods, World Café facilitates a broad exploration of research topics and is ideal for identifying major themes and topics important to a group (Lohr et al., 2020). With the goal of seeding a community of research, co-creation of the direction of inquiry was prioritized by seeking attendee input to determine the seven topics of discussion at the core of this exercise. In this World Café, participants engaged across all seven key issues through a rotating brainstorm, where each participant identified critical knowledge gaps and questions for each topic. Following this initial brainstorm, attendees split into breakout groups, with participants dispersed throughout the seven pre-identified topics. These breakout group discussions lasted approximately an hour, with facilitators guiding conversations to ensure all voices were heard and all questions were answered. The workshop ended with each group sharing their conclusions and reflections from the organizers and keynote speakers (Fig. 1).

Data analysis

All discussion notes, break-out templates (Supplemental Fig. 1), and World Café artifacts (Fig. 1), both electronic and non-electronic, were compiled following similar methods of content analyses used in previous World Café dialogues (van Lierop et al., 2022). Content analysis identifies larger structures in text and other qualitative materials. This analysis was conducted to categorize key themes and concepts under three domains: knowledge gaps, barriers, and opportunities for action. Themes were compared and discussed to reduce biases and ensure consensus (Bengtsson, 2016; Graneheim & Lundman, 2004). These categories were then verified by a third team member and summarized. Preliminary findings were shared with co-authors for verification, and inputs were incorporated, resulting in a final list of themes and main findings.

The incidence and frequency of themes were analyzed within and across discussion group topics. Theme frequency was determined by counting the number of times any word or phrase relating to one of the identified themes was mentioned in the discussion notes, break-out templates, and World Café artifacts. This analytical method allowed for the identification of themes that were discussed more thoroughly in one topic compared to another and the identification of any ubiquitous themes across discussion topics. RStudio (Version 2002.02.03 Build 492) and R statistical software (Version 4.1.3 (2022-03-10)) were used to analyze participant responses, perform content analysis, and produce graphic images.

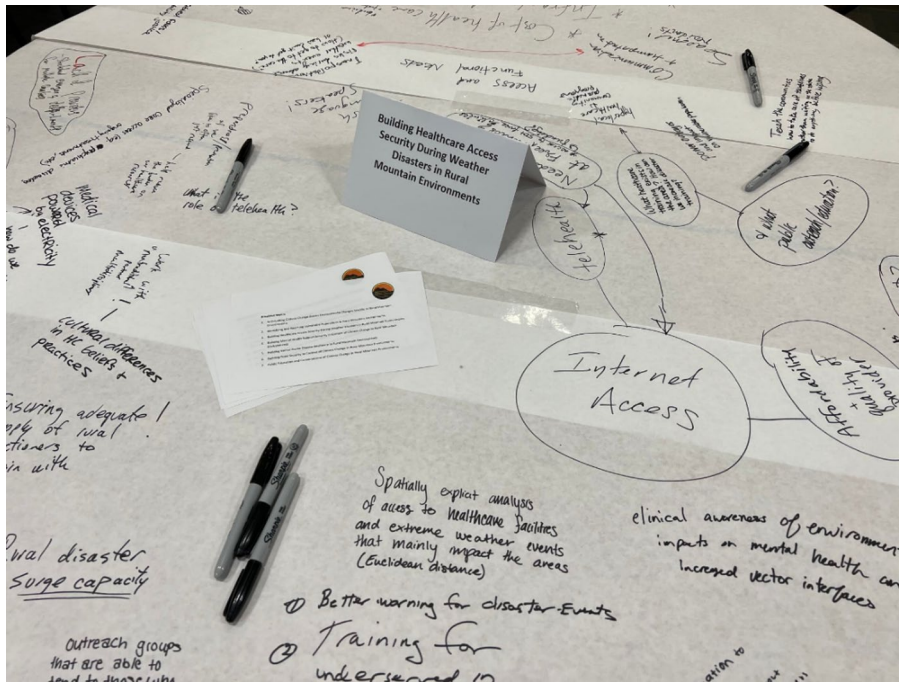

Fig. 1 Examples of artifacts from the workshop cafe that were integrated into the content analysis

Results

Pre-workshop survey

Fifteen of the thirty total participants completed an anonymous pre-workshop survey. Participants had diverse expertise, ranging from social work to sustainable development, geography, and public health. The survey consisted of twenty-one questions to identify their affiliation, their expectations for the workshop, and what topics they considered the most important research needs for climate and health in rural mountain environments. Results for ranked importance of topics are shown in Fig. 2. "Mental Health and Stress-Related Disorders" ranked as the most important research topic among all survey respondents (Fig. 2). Notable discrepancies existed among participants. For instance, seven participants ranked "Emergency Management and Disaster" as the most critical climate-health topic (the highest number of all subgroups), whereas 4 participants ranked it as the least important. Other topics were written in by participants, including "water and air pollution" and "rural economic development."

The survey also questioned which populations were most sensitive to climate change in rural mountain environments. Responses included the following: transient populations, maternal and child populations, low-income, communities of color, historically underserved populations, elderly, Spanish-speaking populations, and youth. In addition, many respondents considered the southern Appalachian region with unique underlying social determinants of health, including limited health care access and infrastructure challenges (e.g., restricted road networks due to high topography and limited broadband wireless access). Finally, some respondents recommended the immediate need for funding, preparedness activities, increased accessibility, education, and outreach programs that are not technologically dependent on supporting at-risk populations.

Seven key workshop focus areas emerged from this survey process; these were influenced by the ranking exercise, with the specific wording synthesized from participant responses to the open-ended questions: (1) anticipating climate change-driven environmental changes specific to rural mountain environments; (2) identifying and reaching vulnerable populations; (3) building health care access security during weather disasters; (4) building mental health support security in the context of climate change; (5) building vector-borne disease resilience; (6) building food security in the context of climate change; and (7) public education and conversations of climate change. These seven focal

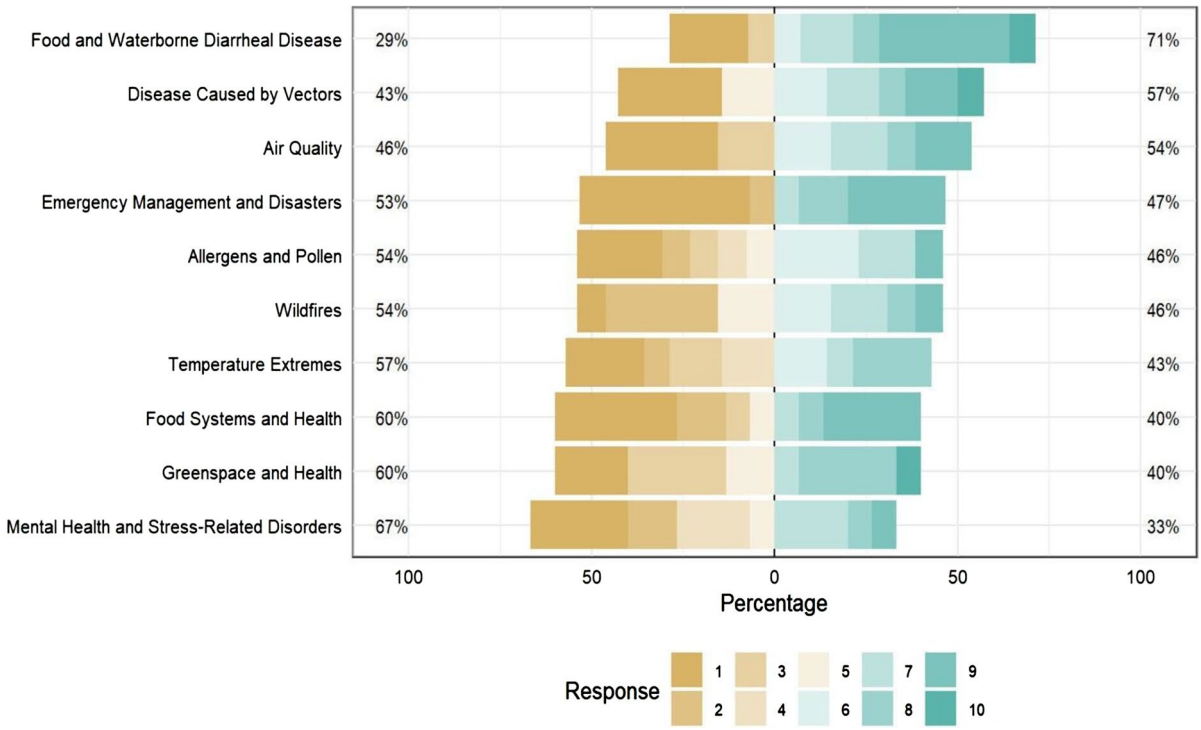

Fig. 2 Likert plot analysis of questions 3–13. A response of 1 demonstrates high importance and a response of 10 demonstrates lower importance. Questions are internally ranked by the positive and negative response percentage. Positives (high importance) ranking the answers as places one through five, and negative (low importance) being six through ten. The questions are then sorted with the most negative responses on top and the most positive on the bottom, essentially ranked from least to most important

areas were utilized in the World Café portion to stimulate conversation and provided verbal, electronic, and non-electronic materials for content analysis.

Content analysis

From the discussion of the seven focus areas during the World Café portion of the workshop, 261 individual topics were evaluated to determine research gaps and barriers. Content analysis of these topics identified eight themes or common groups related to climate change and health (Supplemental Table 1): (1) physical phenomena, (2) industry, (3) resilience, (4) migration, (5) community, (6) disparity, (7) preparedness, and (8) politics and policy. Word clouds of the content analysis are found in Figs. 3 and 4

Focus area: anticipating climate-driven environmental changes specific to rural mountain environments

Participants identified preparedness, specifically the need for localized climate assessments, as a critical knowledge gap in anticipating climate change-driven environmental changes in rural environments. More specifically, they highlighted the need for local (i.e., county-level or multi-county level) climate assessments rather than state climate assessments. Participants also noted that one model does not necessarily

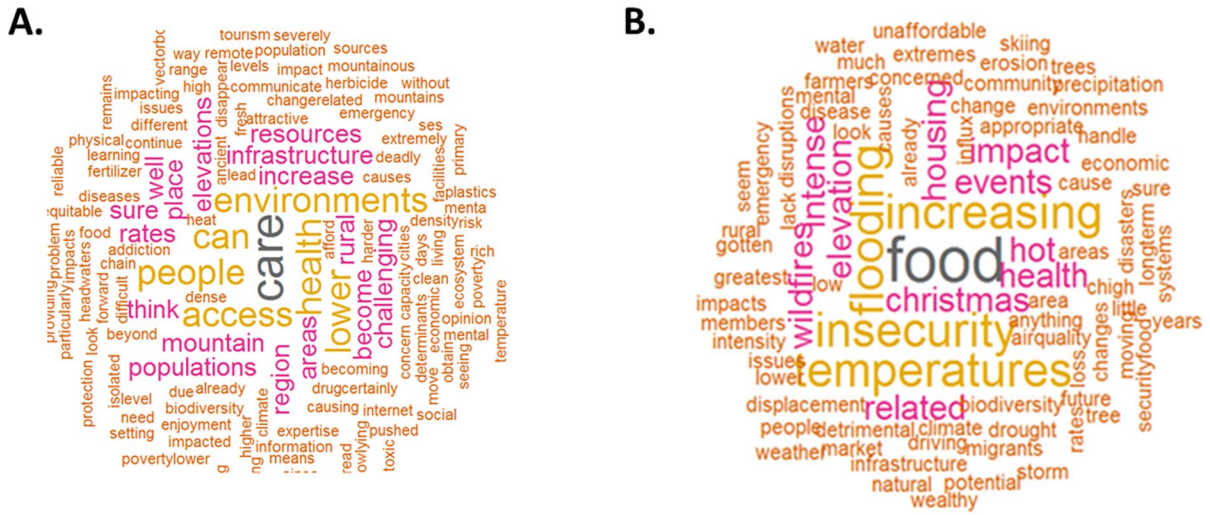

Fig. 3 Word cloud of survey results for the following questions: **A** How is the vulnerability of Western North Carolina and other rural mountain environments to climate change and health different from other locations? **B** What are the greatest climate change-related threats to Western North Carolina?

Fig. 4 Word cloud of world cafe results. Health (36), community (27), food (25), change (22), local (22), climate (21), populations (17), access (16), mental (16), rural (15), communities (13), social (13), education (12) were the most commonly mentioned terms

apply to all communities in rural mountain environments, and multiple contexts (e.g., rural and isolated, rural communities with health care access) should be considered when identifying climate threats to these populations.

Barriers to addressing this issue include a lack of resources to conduct these assessments and limited publicly accessible local data. High-resolution, spatiotemporal data is required and often not available in mountain environments where climate and ecological conditions can change rapidly with altitude, slope, and aspect of the mountain ranges (Schneiderbauer et al., 2021). Other barriers to addressing research gaps relate to limited climate action policy,

including a lack of research and discussion regarding rural mountain communities in the United States (with more focus on coastal, urban, and international communities) and limited funding for rural mountain environment research. Physical phenomena (e.g., plant patterns, nighttime temperatures, and flooding) were the most frequently mentioned theme in this discussion, with 27 phrases identified as related to physical phenomena (Table 1). This frequency suggests that, in addition to preparedness, politics, and policy, understanding the unique physical environment in rural areas is related to barriers to understanding climate-health interactions.

Focus area: identifying disparities and reaching populations

Participants in rural mountain communities identified several factors contributing to health disparities, including geographical location, racism, poverty, poor health, lack of access to broadband internet, and living in mobile homes. However, identifying populations most in need of climate mitigation and adaptive resources is challenging since the definition of 'vulnerable' changes as the climate changes and across different rural contexts. For example, women may be considered vulnerable; however, in some settings, they are a source of social connectedness and/or resilience.

The amplification or compounding nature of these disparities in the context of climate change is not well understood in rural mountain environments. A central barrier to addressing this issue isthe assumption that rural mountain communities are not susceptible to climate change impacts. These communities are often neglected for coastal regions, which experience sea-level rise and more intense tropical cyclones. Additional barriers include the juxtaposition of wealthy second homeowners and poor residents and the lack of direct funding or divisions for rural communities from federal funding agencies like the National Institutes of Health.

Rural mountain communities have existing strengths and capacities, particularly residents with strong social ties and a cultural framework around self-sufficiency and independence. Existing systems may inhibit reaching and adequately serving the needs of these populations, yet programming and interventions are possible through pre-defined groups (e.g., churches and community facilities). Structural barriers also exist for reaching rural populations across state borders and the cultural history of resource extraction, which may increase distrust from larger organizations and governmental agencies.

Table 1 The codes (e.g., physical phenomena) that correspond to the most frequent themes of the workshop. Codes were determined from individual topics (Supp. Table 1) derived from a content analysis of workshop materials and discussion

Codes	Anticipating climate change-driven environmental changes specific to rural mountain environments	Identifying and reaching vulnerable populations	Building health care access security during weather disasters	Building mental health support security in context of climate change	Building vector-borne disease resilience	Building food security in the context of climate change	Public education and conversations of climate change
Physical phenomena	27	0	5	3	10	9	1
Industry	8	5	1	3	2	11	6
Resilience	10	4	11	17	14	5	3
Migration	6	1	2	2	3	2	0
Community	1	21	2	5	5	11	19
Vulnerability	7	40	25	20	2	10	8
Preparedness	8	18	27	22	30	13	14
Politics and policy	4	5	4	4	2	13	15

In this focus area, disparity was the most frequently mentioned theme, with 40 instances (Table 1). Community and preparedness were also mentioned often, ranging between 18 and 21 times. Knowledge gaps in identifying and reaching rural populations relate to the theme of vulnerability, specifically 'who is vulnerable?', 'how will this change with climate change?' and 'How can rural communities better connect and collaborate with decision-makers and regional leaders inside and outside of the community?'. The questions relating to defining and identifying 'vulnerability' raised during the discussion are at the forefront of public health and climate change research; where the term 'vulnerable' is overtly vague and can inhibit the identification of specific populations that are disproportionately impacted by climate change as a result of systemic policies that reduce adaptive capacities.

Focus area: securing health care access during weather disasters

Participants identified health care system preparedness, notably community-specific solutions, as a critical knowledge gap in building health care access during weather disasters. Many health care access solutions, such as telehealth, are not always viable in rural mountain communities as access to the internet is not guaranteed, and extreme weather can cause power outages for extended periods of time. Situationally-specific health care access solutions for different climate hazard scenarios are needed to build health care access security during weather disasters for rural communities.

In addition to being key in identifying knowledge gaps and barriers to understanding, disparity and preparedness were also the most frequently mentioned themes in this topic, 25 and 27 times, respectively (Table 1). Specific research directions highlighted by participants included (1) analyses to understand better current capacities, (e.g., What health care training exists in the area? How can we increase disaster training?) and (2) spatially explicit analysis of access to health care facilities and extreme weather events to identify locations that need more immediate targeted interventions.

Focus area: building mental health support security

Participants identified understanding how climate change impacts mental health as the another key knowledge gap. In particular, participants identified stigma, data availability and accuracy, and poor understanding of the pathology of mental illness as barriers to building mental health support security. An additional barrier is the persistent lack of mental health care access in rural mountain regions, which may be exacerbated by more frequent and severe climate-change-caused natural disasters, which correspond to the theme of disparity and physical phenomena, respectively. Participants highlighted the need for collaboration between psychologists and environmental health researchers to understand the mental health impacts of climate extremes, as well as advance understanding of how existing disparities (e.g., food insecurity) may exacerbate poor mental health outcomes in the context of climate change. Participants considered climate action focusing on safeguarding the mental health and well-being of residents hit hardest by climate change as a potential climate and health intervention strategy targeting youth in rural communities.

Focus area: building vector-borne disease resilience

Effective communication and education regarding vector-borne diseases and their habitats were identified as key knowledge gaps relating to the themes of preparedness and policy. Barriers to addressing this issue include a lack of awareness and limited vector-borne disease-related policies (e.g., relating to housing codes), which correspond to the themes of disparity and politics and policy. Preparedness was by far the most mentioned theme while discussing 'building vector-borne disease resilience', receiving 30 mentions during the discussion (Table 1). Participants identified immediate research needs to understand how changes in the built or natural environment will alter the reproduction of vector-borne carriers and spreaders.

Focus area: building food security

Participants identified the need for localized assessments, specifically among historically marginalized communities, and a better understanding of how

climate change will interact at the intersection of food insecurity, poverty, and housing insecurity in rural mountain communities. Food security was noted as a key knowledge gap in building climate change resilience for rural geographies. The main barrier identified is the lack of data on rural mountain communities (Schneiderbauer et al., 2021), which corresponds to the themes of disparity and preparedness. The discussion around food security in the context of climate change was distributed evenly across many themes. Physical phenomena, disparity, industry, politics, community, and preparedness, were all mentioned between 9 and 13 times (Table 1). Identified research needs included understanding how the effects of extreme weather events (e.g., floods/heavy precipitation events) affect local food supply and how concurrent crises (e.g., climate change, poverty, and housing insecurity) are compounding food insecurity issues.

Focus area: public education and conversations about climate change

Participants identified how to best communicate with diverse populations as the key knowledge gap regarding public education and conversations on climate change in rural communities, which relates to the theme of politics and policy. Communication may need to be community-specific, with language changing depending on the communities' needs, priorities, and knowledge. Participants discussed key barriers to addressing this issue, which are deeply connected to the politicization of public education and climate change educational content. Fighting misinformation and capitalizing on existing social networks (e.g., churches, schools) are vital in crafting communication strategies in rural mountain communities. Rural communities typically receive news later than urban areas due to isolation and lack of widespread internet access. Barriers to understanding fall into the themes of politics and policy and disparity. Community, preparedness, politics, and policy were the most common discussion themes in 'public education and conversations of climate change' (Table 1). Participants identified the need to understand how public education institutions in a rural environment can influence the public conversation surrounding climate change across the state.

Discussion

Climate change is a threat multiplier that amplifies already existing unequal health disparities in rural mountain communities. The ruralness of many mountain communities and the lack of published science on the connectedness of climate and health in these environments further complicate this problem. The Climate Change and Health in Rural Mountain Environments workshop held at Appalachian State University in the Spring of 2022 identified key knowledge gaps at the intersection of climate change and health in the southern Appalachian mountains. The workshop identified research needs, barriers to climate resilience, critical linkages, and opportunities for advancing place-based climate action. The results presented here provide guidance on future directions from a cross-disciplinary perspective that can leverage input from local governments, academic faculty, interdisciplinary researchers, funding agencies, community stakeholders, students, and resource managers.

Key findings and research needs

Past research has identified infectious and vector-borne diseases (Byrd et al., 2020; Kipp et al., 2019), worsening mental health (Bourque & Cunsolo Willox, 2014; Houghton et al., 2017; Padhy et al., 2015), job loss (Ogwu, 2019), and food and water insecurity (Gutierrez & LePrevost, 2016; Kipp et al., 2019) as some of the key climate change-exacerbated health concerns affecting rural populations. However, our work provides further guidance to research needs for this rural Appalachian region.

This workshop identified key research gaps and barriers across seven significant themes (1) anticipating climate change-driven environmental changes specific to rural mountain environments; (2) identifying disparity and reaching populations; (3) building health care access security during weather disasters; (4) building mental health support security in the context of climate change; (5) building vector-borne disease resilience; (6) building food security in the context of climate change; and (7) enhancing public education and conversations around climate change impacts. In the short term, the scientific community must begin addressing research gaps to highlight the unique challenges in mountain and rural environments (Schneiderbauer et al., 2021). The

establishment of multi-sector working groups with clear objectives to meet these challenges is needed, paired with funding to support climate change solutions and challenges to local climate action. This workshop resulted in a working group of participants who will seek out funding opportunities to address fundamental research needs and questions with a specific focus on the southern Appalachian mountains.

Opportunities for action

Opportunities for action fall into two categories; (1) advancing cross-discipline and cross-professional collaboration and (2) engaging with local decision-makers and community representatives. Multi-section and multi-disciplinarian collaboration were emphasized in every discussion as a necessary next step in building local climate resilience strategies across all seven discussion topics. Cross-discipline collaboration (e.g., clinical psychologists and geographers) will enhance understanding of these key issues and allow for the identification of intersecting problems and solutions. Many cross-disciplinary collaborations relating to health exist in the southern Appalachians (Byrd et al., 2020; Handwerger, 2021; Nelson et al., 2020; Sugg et al., 2021), and others emerged from this workshop, which provides a strong base to build future collaborative efforts. Furthermore, collaborating across professions, such as between farmers and educators, creates avenues for sharing place-specific expertise, especially among professionals who work in and with the natural environment. Continued utilization of existing collaborations between research institutions, community organizations, and public K-12 schools is essential. There is a rich opportunity to draw upon and implement team science methods to enable productive and mutually beneficial collaborations spanning these boundaries.

Engagement with local politics, faith-based organizations, and community events were frequently mentioned as an avenue for action across all seven discussion topics. Given the unique health disparities present in rural mountain communities, the development of place-based policies will have wide-reaching impacts. As such, there is the opportunity for stakeholders to engage with their local communities to promote climate change education, local food security, and health care access solutions, among others, that work for their communities. Health leaders play a unique role in advancing awareness and population-based protections to safeguard the health and well-being of residents in rural communities in a changing climate. The need for more localized climate and health disparity assessments and high-quality fine-scale spatiotemporal data was frequently mentioned as barriers to achieving understanding; a barrier that is common across rural mountain environments (Schneiderbauer et al., 2021). Specific local hazard mitigation plans are needed across multiple scales (e.g., city, county, state), and an inventory of current plans is a necessary first step to further situate knowledge risk gaps. Local action considering climate change impacts can address these issues by promoting policies that benefit communities and help further knowledge of climate change-related disparities. Opportunities for action were synthesized in a final conceptual figure as a guide for future research, outreach, and collaboration in an effort to improve the understanding of climate and health in rural mountain locations (Fig. 5).

As understanding of the specific climate threats to rural mountain populations increases, more research is needed to examine the effectiveness of interventions promoting climate and health resilience. Specific interventions include but are not limited to (1) improved access to broadband internet for educational, economic, and potential health access (i.e., telehealth), (2) providing education on health risks associated with climate change and how individuals can protect themselves (Barua et al., 2014). For example, studies could evaluate the impact of programs that aid in community-based disaster preparedness, programs that aid lower-income populations in rural areas, and the promotion of climate-resilience economic benefits.

Although not represented in the themes, participants also spoke of important next steps for this work, including addressing the potential for an influx of climate refugees (e.g., coastal populations that move inland), utilizing women networks as a means to promote resilience, including historically neglected groups and focusing on improving communication to local communities with an emphasis on humility and compassion.

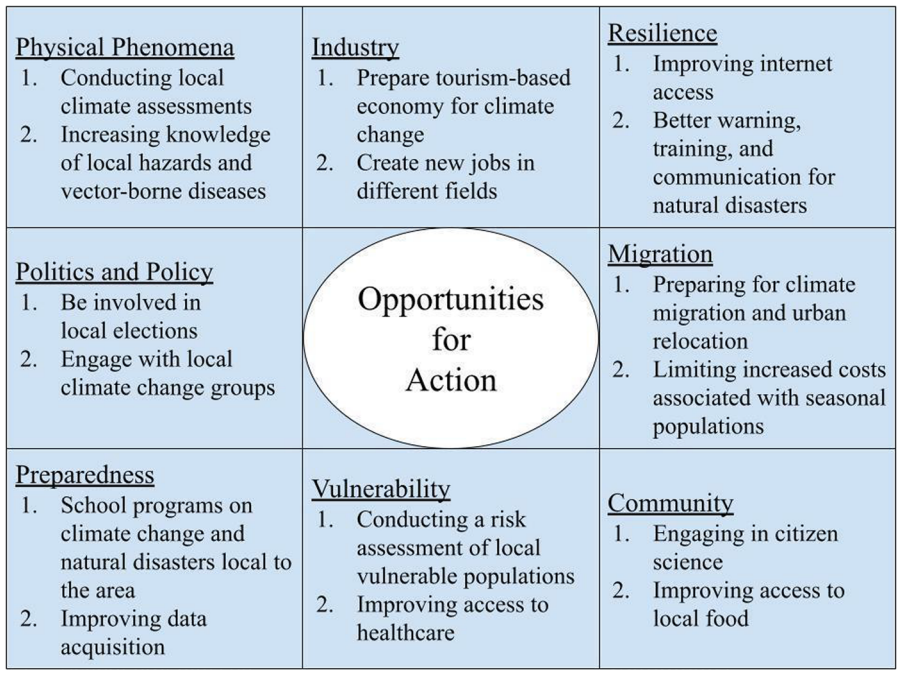

Fig. 5 Conceptual framework of opportunities for action at the intersection of climate and health in rural mountain environments

Limitations

This workshop and associated analysis had several notable limitations. First, the participants were restricted to specific organizations, and therefore, the results may not be generalizable to the entire population of the southern Appalachian region. Second, our results were limited to select findings from the workshop cafe format and, therefore, were limited to the discussion within one day among a few participants. Lastly, our workshop did not include participants from tribal communities and other underrepresented communities (e.g., homeless, farm workers, etc.) in the southern Appalachian region. While our work provides a unique perspective on climate change and rural health disparities, there is a need for additional research to capture more diverse voices and perspectives across a larger participant sample.

Conclusions

Climate and health research is predominantly focused on urban and/or coastal environments, with little focus on rural and mountain environments. Multi-sectoral plans and comprehensive research are required in the face of climate-related changes in these environments. Specifically, basic research, funding, and datasets at a local level are needed to evaluate climate-health vulnerability. Across longer time scales, cross-disciplinary collaboration can be leveraged to assess the complex, multi-factorial problems across the different sectors and vulnerable populations within rural and mountain environments. Mitigation efforts and place-based interventions occur locally, where community organizations, local politicians, and social bonds can be leveraged for policy on climate action. This workshop provides a guide for the next steps for understanding and influencing climate-health interactions among stakeholders, academics, and residents in rural mountainous regions.

Funding This work was supported by the Faculty Early Career Development Program (CAREER) award (grant #2044839) from the National Science Foundation, the National Institue of Environmental Health Sciences grant (#1R15ES033817-01), and support from the Appalachian State University's Blue Cross NC Institute for Health and Human Services (IHHS) and Research Institute for Environment, Energy, and Economics (RIEEE).

Data availability All data is available upon reasonable request to the corresponding author.

Declarations

Conflict of interest There are no conflicts.

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