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Mapping research priorities related to maternal and infant nutritional health in the context of climate change in Pakistan: a mixed-methods study

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ABSTRACT

Objectives This study aimed to identify research priorities for maternal and infant nutrition in the context of climate change in Sindh, Pakistan, using an eco-social framework to examine structural, environmental and gendered inequalities.

Setting The study was conducted from March to May 2024 in Sindh province of Pakistan. Survey respondents were drawn from across Sindh province, while the priority-setting workshop and a focus group discussion were conducted with both male and female participants in Karachi and Matiari District, respectively.

Participants In total, 127 participants were engaged, including community members, doctors, female health workers, nurses, nutritionists, climate experts, advocates and researchers from across Sindh province of Pakistan.

Results Among survey respondents, 89% expressed extreme or very high concern about the impact of climate change on maternal and infant nutritional health. Across the survey and workshop, 'lack of awareness of proper nutrition' emerged as the top nutritional priority, while 'dehydration, weakness and exhaustion' ranked highest among maternal health concerns. Infant health priorities differed slightly: survey respondents prioritised 'heat exposure and low birth weight', whereas workshop participants highlighted 'heat waves and infant hospital admissions'. Participants also identified climate-resilient nutritional interventions and addressing the nutritional needs of pregnant women as critical research priorities. Focus group findings from Matiari District highlighted structural drivers of vulnerability, including flood-related displacement, disrupted agriculture, gendered labour burdens and limited social protection.

Conclusion Awareness and concerns about the increasing impacts of climate change and associated extreme weather events, including floods, extreme heat and changing weather patterns affecting food production, are increasing. However, understanding how these intersect with the everyday realities of affected people, places and communities remains significant for developing meaningful and equitable responses.

INTRODUCTION

Climate change is a pressing global challenge that threatens public health, disrupts food

WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ Evidence indicates that social protection interventions in Pakistan, such as cash transfers and subsidised healthcare, can improve maternal and child nutrition. However, access and equity gaps persist, particularly for vulnerable women in rural and remote areas.
- ⇒ Climate change worsens inequalities by threatening livelihoods, food security and access to healthcare, emphasising the need for culturally suitable, locally tailored, transformative climate-resilient solutions.

WHAT THIS STUDY ADDS

- ⇒ The study centres community voices rather than imposing a research agenda; it coproduces the most urgent research priorities that reflect local realities, taking into account communities' life situations, which exacerbate the impact of climate change-induced extreme weather events on their lives.
- ⇒ Healthcare professionals prioritise clinical outcomes (low birth weight). In contrast, community members and implementers prioritise access to health systems, providing empirical evidence on how the priority-setting process identifies multiple vantage points.
- ⇒ Participants' explicit connections between Pakistan's external debt burden, constrained state capacity for transformative climate resilience and community-level maternal vulnerability represent an underreported dimension of the climate-nutrition-health nexus.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- ⇒ The findings underscore the need to centre the voices of people, places and communities affected by climate change and extreme weather events, and to coproduce research priorities that reflect local realities and support the integration of local knowledge on maternal nutrition, climate adaptation and social support into community-driven policies and health systems that address the structural drivers of vulnerability.

systems and increases nutritional insecurity.¹ These impacts are disproportionately severe in low- and middle-income countries (LMICs),

such as Pakistan, where limited adaptive capacity hinders resilience against climate-induced 'shocks'.² In response, Pakistan is introducing mitigation strategies to address heat stress, floods, droughts and seawater intrusion.³ However, there is insufficient evidence and limited analysis of climate change projections for the area in question, Sindh, which prevents estimating the consequences, including those for nutrition and food security.

Rural communities and women remain among the most marginalised populations, experiencing structural inequalities linked to limited financial autonomy, restricted decision-making power within households and disproportionate exposure to climate-related adversities.⁴ In Pakistan, particularly in rural areas, women often face restricted mobility, dependence on male family members for healthcare access and limited control over household resources, all of which shape their ability to seek timely maternal healthcare. Climate-related events, including floods, extreme heat, water insecurity and displacement, further intensify these vulnerabilities by disrupting livelihoods, food security, sanitation and access to healthcare services. For women during pregnancy and childbirth, vulnerability is heightened due to increased physiological risks and dependence on accessible and continuous maternal healthcare.⁵ Although there are proven, simple and low-cost interventions across the continuum of reproductive healthcare, including family planning, prenatal, antenatal and postnatal care, maternal health-related targets in Pakistan continue to fall short of the Sustainable Development Goals.⁶ These persistent gaps cannot be understood only through biomedical or service-delivery perspectives, as maternal and infant health outcomes are shaped by intersecting social, environmental and gendered inequalities that are often exacerbated during climate-related shocks such as floods, heatwaves and displacement.

The downstream consequences of these compounded vulnerabilities are increasingly visible in child health outcomes. Recent clinical evidence from Pakistan illustrates this link directly: a retrospective analysis of paediatric malnutrition and acute diarrhoea in South Punjab found that nutritional status and clinical presentation together predicted the severity of diarrhoeal illness in malnourished children, underscoring how nutritional vulnerability and infectious disease burden compound one another in resource-constrained settings.⁷ This growing body of clinical evidence strengthens the rationale for the present study. If the downstream health consequences of maternal and infant malnutrition are already measurable in Pakistani paediatric populations, then upstream, preventive research identifying where climate-related nutritional risk originates and how it should be prioritised for intervention is both timely and necessary.

Research on climate change and health has expanded rapidly over the past decade, with growing attention to the consequences of extreme heat, flooding and other climate-related hazards for maternal and infant health in

LMICs. While this growing evidence base has improved understanding of climate-sensitive health risks, research priorities have largely been shaped by global scientific, funding and policy agendas. As a result, the lived experiences, local knowledge and everyday priorities of communities most affected by climate change have often remained peripheral to the process of setting research agendas. This risks producing evidence that identifies climate-related impacts without adequately addressing the social, economic and cultural conditions that determine vulnerability and the interventions communities themselves consider most meaningful.

In Pakistan, where climate change and its associated extreme weather events intersect with poverty, gender inequality, food insecurity and fragile health systems, maternal and infant nutritional health cannot be understood through environmental exposure alone. Moreover, people affected by climate change possess situated knowledge of how climate-related stresses interact with livelihoods, household decision-making, cultural practices and access to care. However, these perspectives are rarely used to inform national research priorities. Additionally, there remains a lack of inclusive research prioritisation processes that involve service users, healthcare providers, community members and policymakers, which limits the development of contextually relevant and sustainable interventions.⁸ Without such engagement, policy responses risk being externally driven, poorly targeted and disconnected from the realities of vulnerable populations and local health systems. This study therefore moves beyond documenting climate impacts to centre community voices in identifying research priorities. Through a mixed-methods, coproduced approach, it seeks to develop a community-driven research agenda that reflects local realities and aligns future research with the needs and priorities of those living with the consequences of climate change. Our main focus in the study is to ask, rather than only what climate change is doing to maternal and infant health, which questions people and communities affected by climate change believe researchers should be asking. This approach shifts priority setting from an expert-led exercise to a participatory process in which affected communities are recognised as producers of knowledge rather than merely sources of data to be extracted.

METHODS

Theoretical framework

This study draws on Eco-Social Theory, which emphasises the embodied links between social structures and environmental exposures, directing analytical attention to how inequities in climate vulnerability are produced and sustained across biological, community and societal levels.⁹ This framework informed the design of data collection tools: survey items and focus group guides were structured to capture multilevel exposures spanning individual, household, community and structural

domains, while the priority-ranking questions were designed to surface variation across participant groups. During thematic analysis, eco-social theory guided coding attention to structural and environmental drivers of nutritional vulnerability, as well as the embodied lived experiences of community members. The priority-setting exercises conducted with stakeholders and communities, drawing on previous relevant work (coauthor HS), included developing Global Midwifery Research Priorities¹⁰ and establishing maternal and perinatal health research priorities beyond 2015.¹¹

Study design

We adopted a sequential explanatory mixed methods design, underpinned by a pragmatist paradigm.¹² Quantitative survey data were first collected to identify broad patterns and priorities related to maternal and infant nutritional health amid climate change. The survey results informed the qualitative phase, including a priority-setting workshop and focus group discussion, which provided in-depth insights into lived experiences and local contextual nuances. The study was reported in alignment with the Good Reporting of Mixed Methods Study checklist (online supplemental file 1).¹³

Study setting

The study was conducted from March to May 2024 in Sindh province of Pakistan. Survey respondents were drawn from across Sindh province, while the priority-setting workshop and a focus group discussion were conducted in Karachi and Matiari District, respectively. Following the 2022 mega floods, the region experienced drought and seawater intrusion into farmland. Climate vulnerability in the region has exacerbated social and economic marginalisation of many communities.³

Data collection

Online survey

An online survey was developed using Qualtrics (Provo, UT, 2018) from March to April 2024. The semistructured questionnaire (online supplemental file 2) was developed based on a scoping review of the relevant literature. It was designed to capture the perspectives of health professionals and actors working at the intersection of climate change, nutrition and maternal and infant health across Sindh. Participants were recruited via mass email, personal email and WhatsApp. This convenient approach enables a broad reach within the target professional community; however, recruitment through digital channels may have introduced selection bias, potentially over-representing digitally connected participants. The survey was administered in English, appropriate for the intended professional participants. The survey included multiple-choice questions and a few open-ended questions to capture respondents' qualitative perspectives. No a priori sample size was determined, consistent with the exploratory priority-setting studies that rely on purposive and snowball sampling to maximise breadth of relevant

actor representation.^{14 15} The aim was to achieve diversity of perspectives within the study timeframe.

The survey was pretested with 15 participants, and refinements were made based on feedback. For example, in the 'Impact of extreme heat/extreme weather events on maternal and infant health and nutrition' section, the broad response option on breastfeeding was split into two specific options for clarity, and the rating scale instructions for section 7, 'Research priorities', were simplified for better readability. The redundant open-ended prompt in section 2, 'Awareness and concerns', was removed to reduce respondent burden.

Priority setting workshop

A half-day priority-setting workshop was held at Aga Khan University in Karachi. The workshop aimed to validate, expand, rank and contextualise the research priorities identified during the survey phase. The same priority-ranking questions were used across both components to ensure consistency and comparability. The workshop incorporated core elements of participatory priority-setting approaches, including transparent ranking criteria, multistakeholder deliberation and structured consensus-building, drawing on principles from established frameworks such as the Child Health and Nutrition Research Initiative (CHNRI) and the James Lind Alliance (JLA) priority-setting partnership process.^{14 15}

Focus group discussion

A focus group discussion was held in Matiari District, Sindh. Participants were purposively selected from rural areas of Matiari based on their lived experiences of climate-induced extreme weather events, to generate information-rich accounts relevant to the study focus.¹⁶ The session was audio-recorded, transcribed verbatim and translated where necessary. To enhance the qualitative rigour of the research, the team maintained reflexivity notes. These notes comprehensively documented the researchers' positionality, particularly one team member (SB) acknowledging their positionality as being perceived as an insider and an outsider,¹⁷ biases and perspectives, as well as the interpretive decisions made during the analytical process. This ongoing documentation enabled transparency and critical reflection, ensuring that the researchers' viewpoints were taken into account. Additionally, the team monitored theoretical saturation throughout the coding phase, iteratively assessing whether newly collected data added substantive insights to the existing themes. This approach enabled us to continuously refine our analysis and confirm that we had captured the full breadth of the data's implications before concluding the study.

Participants

In total, 127 individuals participated across the three study components: the online survey (n=88) (online supplemental file 3), the priority-setting workshop (n=24) and the focus group discussion (n=15). Participants included

community members, doctors, female health workers, nurses, nutritionists, climate change experts, advocates and researchers.

Data analysis

Qualitative data from open-ended survey responses and the focus group discussion were analysed thematically using the Braun and Clarke approach.¹⁶ The analysis followed a two-stage iterative process: (a) initial coding and theme development, and (b) refining the coding framework and validating emerging themes. The study's theoretical frameworks informed coding: eco-social theory directed analytical attention to structural, environmental and embodied dimensions of nutritional vulnerability, while intersectionality sensitised the team to gendered, occupational and geographic variation in experiences across participant groups. Quantitative survey data were analysed descriptively using Stata. Given the study's exploratory priority-mapping aims, quantitative data were analysed descriptively, consistent with established priority-setting approaches that prioritise breadth of stakeholders' perspectives over inferential analysis.

RESULTS

Quantitative component

Participants characteristics

A total of 127 individuals participated across the three study components: online survey (n=88), priority setting workshop (n=24) and focus group discussion (n=15). Survey respondents were predominantly aged 29–39 years (41%; n=36), female (65%; n=57) and held a master's degree (67%; n=59). Full demographic profiles are presented in

Priority rankings: survey and workshop

Of 88 survey respondents, 78 (89%) expressed concern about the impact of climate change on maternal and infant nutritional health; of these, the majority were extremely (39.74%; n=31) or very concerned (47.44%; n=37) (see [figure 1](#)).

Respondents ranked climate-related challenges across the nutritional, maternal and infant health domains in Pakistan. [Table 1](#) presents full ranking distributions; [table 2](#) compares survey and workshop rankings.

Nutritional and maternal priorities showed convergence across survey and workshop participants. 'Lack of awareness of proper nutrition' ranked first among nutritional challenges in both the survey and the workshop. 'Dehydration, weakness and exhaustion' were the top maternal challenges in both components. These areas of agreement suggest cross-stakeholder consensus on the most pressing nutritional and maternal concerns.

Infant health priorities showed divergence across survey and workshop participants. Survey participants ranked 'Increased heat exposure and low birth weight' first. Workshop participants, by contrast, ranked 'Heat waves increase hospital admissions of infants' as the top priority.

Research priority ratings across both components identified climate-resilient nutritional interventions and addressing the nutritional needs of pregnant women during climate change as the two most critical research areas, ranked equally important by approximately half of the participants (see [figure 2](#)).

Qualitative component

Characteristics of participants

Eleven women and four men participated in the session. Most of them represented the populations of local communities in the Matiari District (online supplemental file 3).

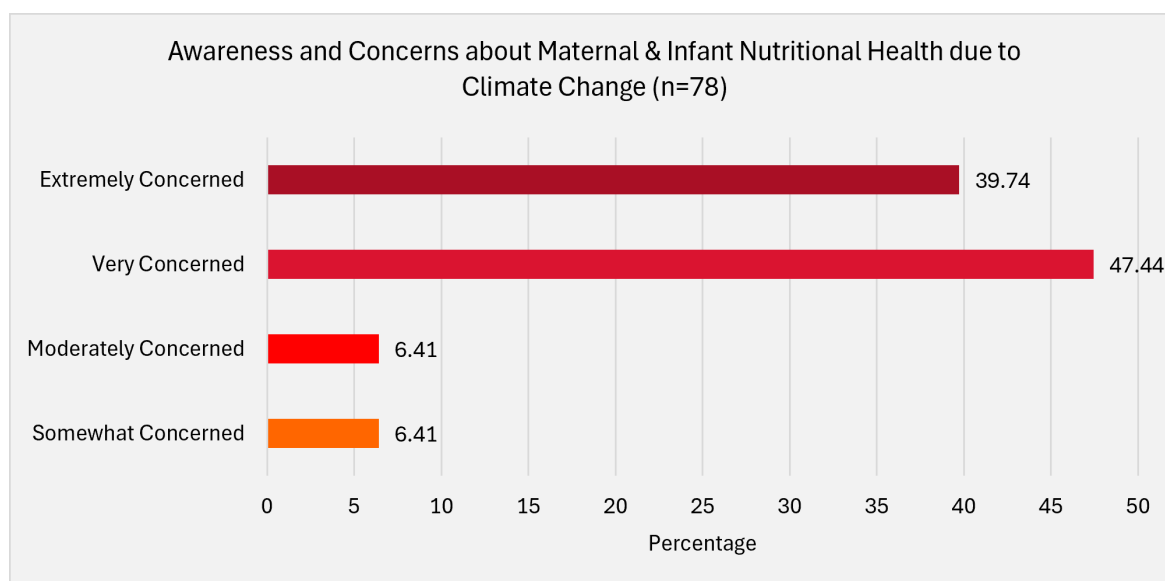


Figure 1 Awareness and concern about maternal and infant nutritional health due to climate change.

Table 1 Results of online survey showing prioritisation of climate change-related nutritional, maternal and infant health challenges in Pakistan

	Ranks				
	1st	2nd	3rd	4th	5th
	N (%)	N (%)	N (%)	N (%)	N (%)
Nutritional challenges n=72					
Lack of awareness about proper nutrition	22 (30.56)	12 (16.67)	16 (22.22)	21 (29.17)	1 (1.39)
Limited availability and accessibility of food during climate change-related disasters	19 (26.39)	13 (18.06)	15 (20.83)	7 (9.72)	18 (25.00)
Limited access to healthcare/nutritional consultation during pregnancy	12 (16.67)	25 (34.72)	17 (23.61)	7 (9.72)	11 (15.28)
Food contamination and safety	14 (19.44)	13 (18.06)	13 (18.06)	17 (23.61)	15 (20.83)
Climate-related food insecurity	5 (6.94)	9 (12.50)	11 (15.28)	20 (27.78)	27 (37.50)
Maternal health outcomes (n=60)					
Dehydration, weakness and exhaustion	25 (43.10)	18 (31.03)	8 (13.79)	5 (8.62)	2 (3.45)
Access to food	18 (31.03)	6 (10.34)	6 (10.34)	15 (25.86)	13 (22.41)
Maternal mental health, such as maternal depression, maternal anxiety, worsened mood, etc.	10 (17.24)	12 (20.69)	12 (20.69)	8 (13.79)	16 (27.59)
Foetal development	4 (6.90)	13 (22.41)	18 (31.03)	13 (22.41)	10 (17.24)
Breastfeeding or access to safe and affordable alternatives to breast milk	1 (1.72)	9 (15.52)	14 (24.14)	17 (29.31)	17 (29.31)
Infant health outcomes (n=56)					
Increased heat exposure and low birth weight	16 (28.57)	13 (23.21)	12 (21.43)	6 (10.71)	9 (16.07)
Heat-related infant death	16 (28.57)	11 (19.64)	4 (7.14)	16 (28.57)	9 (16.07)
Extreme heat conditions increase the risk of stillbirth	15 (26.79)	13 (23.21)	16 (28.57)	6 (10.71)	6 (10.71)
Heat waves increase hospital admissions of infants	9 (16.07)	9 (16.07)	9 (16.07)	11 (19.64)	18 (32.14)
Heat waves increase stress in neonates	0 (0.00)	10 (17.86)	15 (26.79)	17 (30.36)	14 (25.00)

Identified themes

Several intersecting themes and sub-themes emerged from the focus group data, organised into four interconnected themes aligned with eco-social theory's focus on understanding the connections between social structures and environmental factors, highlighting how inequities in climate vulnerability are created and maintained across biological, community and societal levels. This analysis sheds light on these aspects, in particular, climate-related nutritional vulnerability among mothers and infants in Matiari. Themes including (1) climate disruption and health cascade effects, (2) flood-induced crisis and maternal health vulnerabilities, (3) gendered climate vulnerability and the triple burden and (4) economic vulnerability and structural inequities.

Climate disruption and health cascade effects

Participants described how shifting weather patterns, including delayed and extreme heat, unseasonal rainfall and recurrent floods, had unexpected health effects and disrupted agricultural cycles, with serious consequences for families, particularly pregnant and breastfeeding women.

Shifting weather patterns and maternal health

Participants understood climate change as a gradual shift in seasonal patterns affecting the agricultural calendar. These changes were perceived as a significant concern, producing unexpected and unforeseen health vulnerabilities for women and children. One participant pointed out both the absence of expected heat and the dangers of excessive temperatures:

As the climate has changed, usually in April it would be very hot, but now, because the temperature has not risen as before ... mosquitoes die from the heat, but now they don't because the heat isn't as intense... malaria is spreading (Female participant).

Participants noted a shift in weather patterns associated with adverse health outcomes, including heat stress, dehydration, fatigue and pregnancy complications. Families and communities struggle to cope with sudden environmental changes, and the risks are heightened for expectant mothers due to physically demanding labour in extreme temperatures. The participant said,

When the heat rises, whether she works at home or outside, she won't stop working, and this can affect her blood pressure or cause other issues. If the heat is intense and

Table 2 Comparison of priority rankings from online survey and workshop for climate change-related nutritional, maternal and infant health challenges in Pakistan

Challenges	Ranking in an online survey	Ranking in the priority workshop
Nutritional challenges		
Lack of awareness of proper nutrition	1st	1st
Limited availability and accessibility of food during climate change-related disasters	2nd	3rd
Limited access to healthcare/nutritional consultation during pregnancy	3rd	2nd
Food contamination and safety	4th	4th
Climate-related food insecurity	5th	5th
Maternal challenges		
Dehydration, weakness and exhaustion	1st	1st
Access to food	2nd	4th
Foetal development	3rd	2nd
Breastfeeding or access to safe and affordable alternatives to breast milk	4th	5th
Maternal mental health: maternal depression, maternal anxiety, and worsened mood.	5th	3rd
Infant challenges		
Increased heat exposure and low birth weight	1st	5th
Heat-related infant death	2nd	2nd
Extreme heat conditions increase the risk of stillbirth	3rd	4th
Heat waves increase stress in neonates	4th	3rd
Heat waves increase hospital admissions of infants	5th	1st

affects the mother, it will obviously affect the child as well... (Female participant)

Another woman added, ‘During unexpected heatwaves, many women continue working outdoors without adequate shade or water, which often results in dizziness and premature labour among pregnant women’. Families are often unprepared for extreme events such as flooding, leading to the closure of health facilities, especially in rural areas, and the destruction of critical infrastructure, such as roads, thereby affecting antenatal and postnatal care. As one participant explained,

In heavy rain and flooding, women are mainly unable to access healthcare facilities, even in an emergency. Not only

that, but during that time, there is no access to food or clean water, both of which are crucial for pregnant women (Female participant).

This shows that disrupted weather patterns, directly and indirectly caused by climate change, harm women’s health and well-being, exacerbating vulnerabilities in their communities.

Climate change and agriculture

Participants highlighted that climate change has severely disrupted agricultural cycles, resulting in lower crop yields and worsening nutritional outcomes for mothers and children. Shifts in seasonal patterns, such as delayed rainfall, unseasonal cold and unexpected heat, are a ‘double burden’ for both crops and health. As one participant explained:

Right now (April), the weather is cool, but it is not suitable for crops, as they need more heat to prepare for harvesting. After harvesting, it will get hotter; it is no use for crops, but many women and children will fall sick (Female participant).

Community participants observed that unpredictable weather has made traditional planting and harvesting schedules unreliable. For instance, a male focus group participant said, ‘When rain arrives too late or too early, staple crops such as rice and wheat fail to mature properly, reducing household food supplies’. Another added that ‘similarly intense heat following the rainy season often damages vegetables and pulses, further shrinking dietary diversity’.

Food scarcity, combined with higher prices for vegetables and grains, forces families to reduce meal portions or skip protein-rich foods. A female participant said that ‘pregnant women are eating less or not eating proper nutritious food because it has become expensive, and crops keep failing due to changing weather’. Female health workers and community midwives were of the view that such conditions increase the risk of anaemia, low birth weight and other pregnancy-related complications.

Flood-induced crisis and maternal health vulnerabilities

Participants recalled Pakistan’s 2022 mega floods as a convergence of crises, including displacement, income loss, water contamination and health service disruption, which particularly affected maternal and child health. The floods created vulnerabilities that endured long after the immediate emergency, as emphasised by many participants.

When the flood came, all our crops were destroyed. Houses were also destroyed, and we didn’t receive the wages that were due for our work. And if there are pregnant women, we mostly meet them in the evenings or at night because they also do outdoor and household work and have children. And their nutritional needs were not met at all (Male participants).

Community members explained that it was not only the flood but also prolonged moisture and stagnant water that had a greater impact; for instance, the mosquito

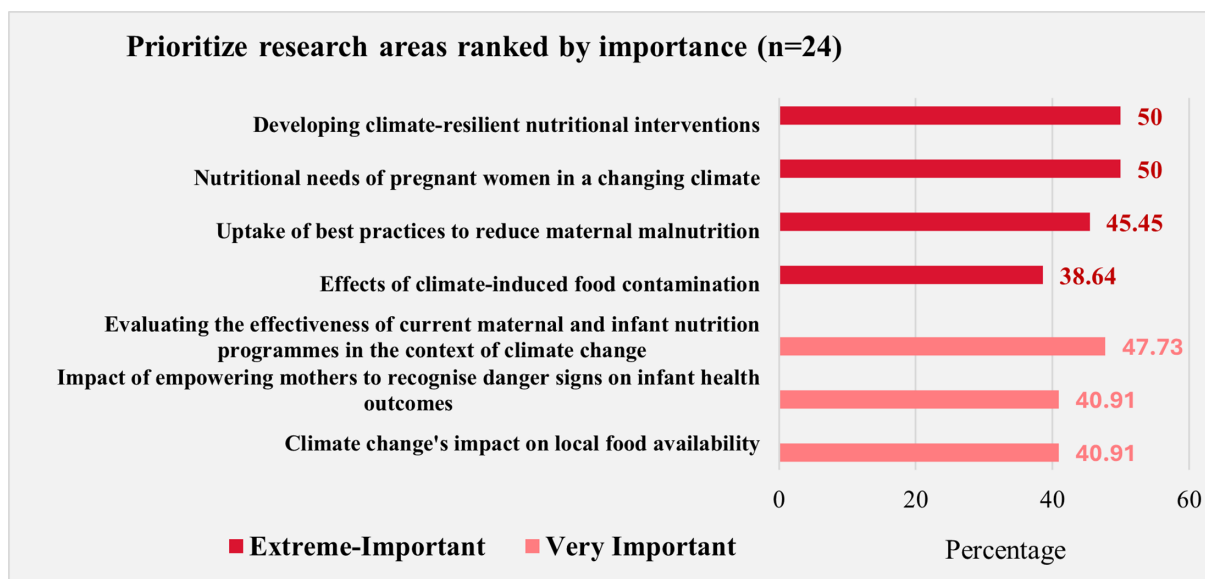


Figure 2 Key research areas ranked by importance in maternal and infant nutritional health impact by climate change.

population increased, thereby increasing malaria risk. Some participants' survey comments suggested that flooding also disrupted the food supply chain, leading to food shortages and malnutrition, which have been particularly harmful for pregnant women and infants who need proper nutrition for healthy development. A community midwife observed:

Because of climate change, the floods and other factors have had a particularly bad impact on our area. When there were displacements and migrations, when people's homes were destroyed, when there was nothing for people to eat, these negative impacts affected all of us, especially pregnant and breastfeeding women. Mothers, children, and adolescent girls were affected more because there was a lack of food, no proper shelter for displaced families, and due to stagnant flood water, there were more diseases (Female participant).

Some participants reported that, due to flooding, they lost crops, resulting in a loss of both food and income and limiting families' ability to afford nutritious diets essential for maternal and foetal health. A participant, who was a social worker, recalled:

The loss of income from heavy rain and flooding meant our food and crops were destroyed, so we didn't have any income. So, of course, we could not buy the nutritious food, so pregnant women were affected. And another very important thing is that there were premature births because pregnant women were stressed during the flooding. And there were no safe roads or any paths to access the healthcare facilities. So, women had deliveries in their homes, maybe at seven months, premature babies. They should have been in a hospital, but they couldn't get to one. So, babies had very low birth weight; some weighed only 1 kilogram (Male participants).

These participants' accounts illustrate how repeated flooding creates multiple issues, increasing vulnerabilities

that lead to a crisis impacting their livelihood, health and well-being.

Gendered climate vulnerability and the triple burden *Working hard to survive*

Both men and women labour intensively to survive under the compounded pressures of poor socioeconomic conditions, which are partly exacerbated by climate change. Families often work collectively to meet basic nutritional needs, as one male participant explained, 'to have food on the table/eat something'. However, pregnant women often bear a disproportionate burden during climate extremes because of their overlapping roles as agricultural workers, caregivers and homemakers. This intensifies during crises yet remains invisible, particularly in broader climate discussions. To illustrate this, a female health worker described women's relentless daily schedule:

Their daily routine starts with the Fajr (dawn) prayer; they milk buffaloes or cows, prepare breakfast, feed the children, do the children's chores, clean the house, and then go to the fields. Staying continuously standing in the field also causes health issues for them. They go to work in the fields with the mindset that they have to earn the day's wage no matter what... Then they also cut a lot of grass from the fields, and they have to carry the bundle home... Then, in the afternoon, they come home to cook for their family members, like mother-in-law, father-in-law, and children, and after that, they go back to the fields. In the rush of work, their own nutritional needs are neglected (Female participant).

Further emphasising the risks during pregnancy, another female health worker explained:

For pregnant women, I would say that, now that it is the wheat-harvesting season, every pregnant woman, whether 40 days into pregnancy or 3 or 4 months pregnant, is focused on cutting or gathering wheat so they can eat it later.

They are not going for their check-ups, they are not getting their tests done, they are not going to the hospital because these three or four days are the wheat season (Female participant).

Women's routines, from dawn until late at night, involve agricultural work, household tasks, childcare and elder care, leaving little time for rest. Support from male family members is often limited due to their long work hours. Participants pointed out the lack of mental health services and the prevalence of unrecognised issues like stress and anxiety. They also connected women's heavy workloads to climate-related crises, showing how environmental shocks worsen existing vulnerabilities.

Lack of social welfare

Participants emphasised the hardships women endure to support their families, noting the absence of adequate national welfare support as a critical gap. In particular, maternity leave and financial support for pregnant women in informal or agricultural work remain largely unavailable. Families' health and survival often depend on the labour of both women and men; without alternative support during pregnancy or postpartum periods, women's absence from work can generate additional financial and emotional stress for the entire household, while compromising maternal well-being. A local researcher highlighted the limitations of existing programmes:

We have heard there are social welfare programmes like Benazir Income (Pakistan's national social protection programme) and Mumtaz (Mother and Child Support Programme) (MCSP), but they don't support all women, and women face many challenges from registration to obtaining cash or other support through such programmes. There are many reasons, but the major one is that men run most of these programmes from top to bottom, so it is challenging, even culturally restricted, for many women even to go and ask for help from men (Female participants).

Women who were unable to access cash transfers during critical periods were forced to continue physically demanding work while pregnant or caring for newborns. A participant shared, in one case, *'a woman skipped her postnatal check-ups because she had to continue harvesting crops to feed her family, as no financial support was available to replace her labour'*.

Economic vulnerability and structural inequities

Poverty and climate vulnerability

Participants highlighted that poverty functions both as a cause and a consequence of climate vulnerability, creating a difficult-to-break cycle. Many families depend on subsistence agriculture yet often produce crops they cannot afford to consume themselves. Instead, they are compelled to sell the harvest to meet immediate cash needs, only to repurchase the same food at higher prices, leaving little room for savings or dietary diversity. As one participant observed, *'It is expensive. Even those who produce it can't afford to consume it... They have to give it to the market,*

get money, and then buy the same food again' (Male participant).

Most participants view climate-related disruptions as further increasing this cycle of dependence on unstable markets and low income. For instance, a female participant said, *'Floods, heatwaves, and heavy rainfall destroy crops, reduce crop yields, and erode household assets, thereby reinforcing poverty and increasing malnutrition, particularly among women and children'*. The financial precarity limits access to healthcare, nutritious food and other essential services, making families more vulnerable to both immediate shocks and long-term health consequences.

Global health inequality and unfair debt systems

Within the context of global climate change, participants drew a direct connection between Pakistan's external debt and the state's limited capacity to provide public relief. The burden of debt was seen not only as an economic constraint but also as a structural barrier to climate resilience and health equity. For example, a male participant demanded that *'Foreign governments, especially Western, should write off Pakistan's debt instead of giving Pakistan peanuts in charity'*. This sentiment reflects a broader frustration with the global financial systems, which participants perceived as perpetuating dependency rather than enabling recovery. A male participant emphasised the role of international diplomacy, suggesting: *'The UK could press the International Monetary Fund (IMF) to cancel Pakistan's debt'*.

Participants linked these macroeconomic constraints to everyday struggles, particularly food insecurity. They described how reduced crop yields from climate shocks, such as floods and heatwaves, were compounded by systemic poverty and rising costs, making food inaccessible to many rural households.

INTEGRATION OF FINDINGS

The quantitative priority rankings and qualitative findings converge on a central insight consistent with eco-social theory: in this context, maternal and infant health vulnerabilities arise from the interaction of environmental, social, cultural and biological factors operating across multiple levels. The most urgent challenges, including nutritional awareness, dehydration and heat exposure, cannot be understood or addressed at the level of individual behaviour alone. Focus group narratives re-situate these priorities within wider structural conditions shaped by climate-related disruptions to food systems, inadequate access to healthcare, gendered divisions of labour, poverty and limited social protection. In this context, 'lack of nutritional awareness' reflects not simply an individual knowledge deficit but a manifestation of information poverty embedded within broader systems of social and institutional exclusion. Similarly, the divergence in infant health priorities between survey respondents and workshop participants reflects differing structural standpoints, with clinical actors emphasising

biomedical risks. In contrast, community participants centre on everyday lived realities and survival pressures. An eco-social perspective suggests that these forms of knowledge are not contradictory but interconnected, and that both are necessary for developing contextually grounded and equitable policy responses.

DISCUSSION

This study provides unique insights into the lived experiences of those working in maternal and infant health in Sindh, Pakistan, through an eco-social lens that centres the interconnections between environmental exposures, social conditions and health outcomes across multiple levels. The participants represented individuals in frontline services (micro system), academic practices and research (meso system) and policy development and strategy (macro system). The majority (78 of 88) expressed extreme or very high concern that nutritional awareness was a priority risk for pregnant women, alongside access to nutritional support. The impact of low nutritional awareness may be linked to other key concerns for pregnant women, including dehydration, weakness, exhaustion and limited access to food due to environmental factors. Participants recognised that, based on their research, heat-related infant mortality and low birth weight are significantly increasing.⁹ Previous studies emphasise the need for further research on the effects of heat exposure on infant health, indicating that extreme temperatures can lead to adverse outcomes, including low birth weight and even death.¹⁸ The study participants viewed the gradual shift in climate as more significant than the environmental ‘shocks’ caused by recurring flooding. Pest control and access to drinking water remain ongoing challenges. These instabilities and the broad range of anxiety-inducing climate impacts are understudied and challenging to measure at the local level.¹⁹ This is because the localised experiences of

household communities are absent from current assessments of the climate risks to lives and livelihoods. Moreover, when interpreted through eco-social theory and an intersectional lens, the findings reveal that nutritional vulnerability among pregnant and breastfeeding women in Sindh is not primarily a product of individual knowledge deficits but of structurally produced and environmentally embedded inequities operating simultaneously across biological, household, community and policy levels. Figure 3 outlines micro, meso and macro factors that intersect and influence communities’ health and well-being in changing climatic conditions in Pakistan.

Macro perspectives

Household poverty and precarity are well-recognised and long-standing macroeconomic risks acknowledged internationally. Low yields have a ‘multiplier effect’ on the cost of living, and an estimated 60% of Pakistan’s population relies on agriculture.²⁰ Threats to long-term food security persist nationally, driven by reduced agricultural productivity.²¹ Agrarian communities are disproportionately affected, and rural populations experience entrenched social and health inequities, with limited access to health-care and nutrition.⁴

LMICs owe huge debts that grow twice as fast as those of rich countries, and countries such as Malawi have poverty rates of 71.20% because debt payments divert funds from health services. However, countries that maintained strong local agricultural communities reduced poverty more effectively than those focused on mining or large plantations, suggesting that solutions to climate-health problems should strengthen community knowledge, local food systems and traditional ways of caring for pregnant women and infants.^{22–24}

Gender equality is a strategic ambition to alleviate poverty in Pakistan, but the lack of progress is increasing the vulnerability of poor communities.²⁵ This is evident

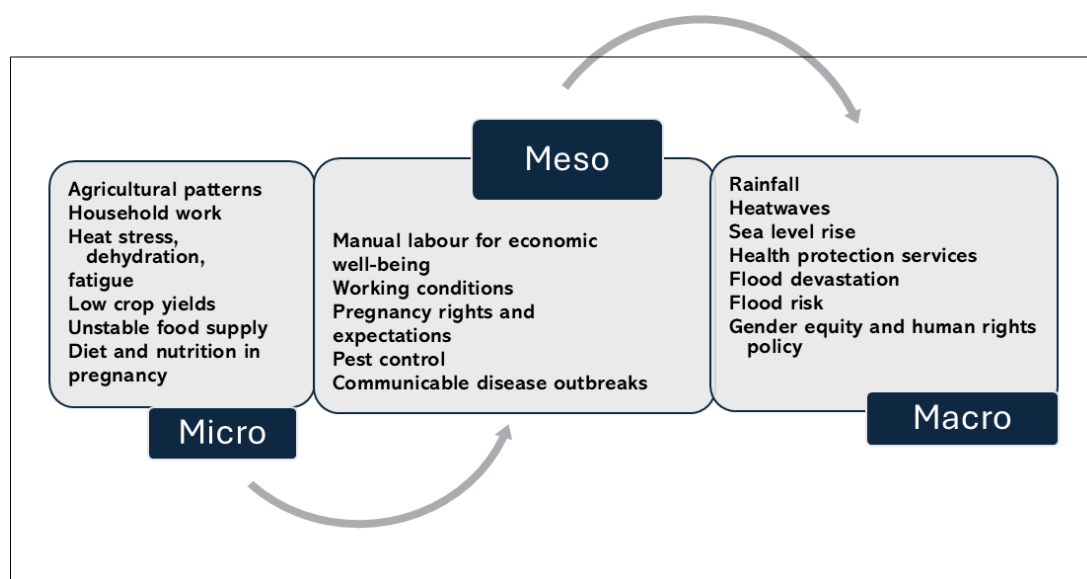


Figure 3 Intersecting micro-meso-macro factors.

in the disproportionate impact of climate change on maternal and infant nutrition, highlighting how environmental changes exacerbate malnutrition and health disparities,²⁶ and in the critical relationship between maternal nutritional status and child growth outcomes, indicating that poor maternal health is significantly associated with stunting and wasting in children in Pakistan.²⁷ These negative health outcomes necessitate further research into mitigation and adaptation strategies that include social justice, community interventions, regional governance and policy to reduce gender inequality.

Meso perceptions

Climate change continues to undermine social determinants of health and disproportionately affect the most vulnerable populations, including women and infants in poor communities. Social protection plays a key role in mitigating the impacts of climate change at a regional level. However, many are least prepared for the climate crisis they face; for example, 91.30% of people in the 20 most climate-vulnerable countries lack any form of social protection coverage.¹

Our findings indicate that a lack of awareness of proper nutrition, crop damage and water contamination remains a critical barrier, as noted in prior studies.^{8 28} These findings suggest that, at the microsystem level, household poverty and health literacy urgently need to be addressed to enable young women to receive further guidance on how to live and work in their communities during pregnancy. Aziz and Anjum emphasise the need to integrate cultural and gender perspectives into climate adaptation strategies, which is crucial for addressing the specific vulnerabilities of women in rural contexts.²⁹

Micro perspectives

Risks associated with extreme heat and floods significantly affect women's physical and mental well-being. Challenges related to pregnancy preparedness, newborn care and strenuous agricultural work tend to exacerbate these health risks. Failing to connect community health awareness and the health system with climate action is a missed opportunity to improve maternal and infant health outcomes.³⁰ This knowledge gap among health-care providers underscores the need to improve education and training to mitigate the impact of climate change on maternal health.³¹

Existing local interventions

There are social protection programmes, including the Benazir Income Support Programme (BISP) and the Sindh Social Protection Agency; however, these are neither fair nor accessible to many vulnerable women.^{32 33} Thus, strengthening these initiatives can reduce health inequalities by ensuring that maternal and infant health services reach the most disadvantaged. Recent evidence from Sindh and similar contexts supports this. For example, a cluster-randomised controlled trial in Dadu District found that larger cash transfers reduced wasting

at 6 months, and that all cash and voucher-based intervention modalities improved height-based growth at both 6 months and 1 year among children under five and their mothers.³⁴ Evaluations of the Sehat Sahulat Programme indicate high patient satisfaction and reduced financial burden for low-income households, while also highlighting administrative and awareness challenges that constrain equitable access.³⁵ The 'Enough Food Model' and other food security initiatives similarly show promise in improving maternal nutrition among food-insecure and low-resource populations.³⁶ Our study findings resonate with these studies and suggest that equitable welfare interventions, including cash transfers, free or subsidised healthcare, nutrition-focused programmes and support for food security, combined with strong administrative design, monitoring and awareness, are key to narrowing maternal/infant health inequalities in settings like Sindh.

Strengths and limitations

This study's strength lies in its participatory, multistakeholder design, which deliberately incorporated perspectives across micro, meso and macro system levels from community members with direct lived experience of climate extremes to researchers, implementers and policymakers. Several limitations require acknowledgement. First, the English-language survey may have further limited participation by community-level groups, though this was partially mitigated by the Sindhi- and Urdu-facilitated focus group discussion. Second, the absence of a priori sample size determination, while consistent with exploratory priority-setting methodology, limits claims about statistical representativeness and precludes meaningful subgroup comparisons across participant categories. Third, the priority-setting workshop, while procedurally informed by established CHNRI and JLA frameworks, was not conducted under a full formalised protocol, limiting direct comparability with formally structured priority-setting exercises. Fourth, findings are contextually specific to Sindh province and should be generalised to other climate-vulnerable settings with appropriate caution, though the structural dynamics identified gendered labour burden, food system disruption and social protection exclusion resonate broadly across South Asian agrarian contexts.

Policy and implementation implications

Our findings point to a few intersecting priorities for policy action. First, maternal nutrition programmes must be redesigned as climate-transformative resilient interventions that account for seasonal agricultural calendars, flood displacement cycles and health exposure patterns in their delivery models and targeting criteria. Second, social protection programmes must address the structural barriers that currently exclude the most vulnerable women through gender-responsive administration, community-based registration and integration with existing maternal health platforms such as the Lady Health Workers Programme (LHWs). Third, healthcare

provider training must incorporate climate-health linkages, equipping frontline workers, LHWs and Community Midwives to identify and respond to climate-related nutritional risks during antenatal and postnatal care. These recommendations are feasible within the existing health system in Sindh, though their implementation requires sustained policy-level commitment and intersectoral coordination.

CONCLUSION

This study concludes that the value of eco-social approaches lies in aligning interventions with community priorities. Improving nutrition for pregnant women is critical in agrarian contexts characterised by climate uncertainty. Health systems must address the intersecting disadvantages faced by marginalised populations and support coproduced interventions grounded in everyday realities.

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