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"*Mothers get really exhausted!*" The lived experience of pregnancy in extreme heat: Qualitative findings from Kilifi, Kenya

F. Scorgie [a,*], A. Lusambili [b,c], S. Luchters [b,d,e], P. Khaemba [b], V. Filippi [f], B. Nakstad [g,h], J. Hess [i], C. Birch [j], S. Kovats [k], M.F. Chersich [a]

[a] Wits Reproductive Health and HIV Institute (Wits RHI), Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa
[b] Institute for Human Development, Aga Khan University, Nairobi, Kenya
[c] Environmental Center, Leadership and Governance HUB, School of Business, Africa International University, Kenya
[d] Centre for Sexual Health and HIV AIDS Research (CeSHHAR), Harare, Zimbabwe
[e] Liverpool School of Tropical Medicine (LSTM), Liverpool, UK
[f] The Centre for Maternal, Adolescent, Reproductive, & Child Health (MARCH), London School of Hygiene & Tropical Medicine, London, UK
[g] Division of Pediatric and Adolescent Medicine, Institute of Clinical Medicine, University of Oslo, Oslo, Norway
[h] Department of Pediatric and Adolescent Health, University of Botswana, Gaborone, Botswana
[i] Emergency Medicine, Environmental & Occupational Health Sciences, and Global Health, University of Washington, USA
[j] School of Earth and Environment, University of Leeds, UK
[k] Centre on Climate Change and Planetary Health, London School of Hygiene & Tropical Medicine, London, UK

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ABSTRACT

Heat exposure in pregnancy is associated with a range of adverse health and wellbeing outcomes, yet research on the lived experience of pregnancy in high temperatures is lacking. We conducted qualitative research in 2021 in two communities in rural Kilifi County, Kenya, a tropical savannah area currently experiencing severe drought. Pregnant and postpartum women, their male spouses and mothers-in-law, community health volunteers, and local health and environment stakeholders were interviewed or participated in focus group discussions. Pregnant women described symptoms that are classically regarded as heat exhaustion, including dizziness, fatigue, dehydration, insomnia, and irritability. They interpreted heat-related tachycardia as signalling hypertension and reported observing more miscarriages and preterm births in the heat. Pregnancy is conceptualised locally as a 'normal' state of being, and women continue to perform physically demanding household chores in the heat, even when pregnant. Women reported little support from family members to reduce their workload at this time, reflecting their relative lack of autonomy within the household, but also potentially the 'normalisation' of heat in these communities. Climate change risk reduction strategies for pregnant women in low-resource settings need to be cognisant of local household gender dynamics that constrain women's capacity to avoid heat exposures.

1. Introduction

Under the highest greenhouse gas emission pathways, global mean temperatures will rise by at least 1.5 °C by 2050, with more than a 4 °C possible increase by 2100. Under 1.5 °C global warming, increases in the intensity and frequency of African hot extremes are "very likely" and under 4 °C warming, "virtually certain" (Ceccherini et al., 2017; Masson-Delmotte et al., 2021; Nangombe et al., 2019). Mortality from anthropogenic global warming is now geographically widespread and considered 'not trivial' (Vicedo-Cabrera et al., 2021). Heat-related morbidity is exacerbated by social, economic, age, and geographical vulnerabilities, forming high risk groups including the elderly, people with disabilities and pre-existing conditions, outdoor workers, and poor urban communities (Cissé et al., 2022; Kovats and Hajat, 2008; Wright et al., 2019). Those with limited socio-economic resources or in marginalised positions of power owing to social inequalities tend to have reduced adaptive capacity for coping with heat (Adger, 2006; Seebass, 2017; Singer et al., 2016). Gender is a key factor shaping both heat vulnerability and adaptability, particularly in low-income settings, as a result of women's high household work burdens and their limited access to land and education (Rao et al., 2019).

Evidence is accruing of the specific vulnerabilities of pregnant

* Corresponding author.
E-mail address: fscorgie@wrhi.ac.za (F. Scorgie).

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women to the health effects of high ambient temperatures (Roos et al., 2021). Heat exposure in pregnancy has been associated with a range of adverse maternal health outcomes (Kuehn and McCormick, 2017), including maternal hypertension and preeclampsia (Cil and Cameron, 2017; Part et al., 2022; Qu et al., 2021), gestational diabetes (Su et al., 2020), and poor mental health and anxiety (Flocks et al., 2013; Lin et al., 2017). High temperatures can also increase the risk of an early delivery, low birthweight, and stillbirths, as shown by a recent systematic review (Chersich et al., 2020). Theoretically, the physiological and anatomical changes that occur during pregnancy may affect protective mechanisms that facilitate thermoregulation and add to the heat burden generated by the growing foetus (Kuehn and McCormick, 2017; Lundgren et al., 2013). The aetiology of these outcomes is complex and not yet fully understood, however, owing largely to limitations in experimental and observational research (Samuels et al., 2022).

Most published studies to date on the impact of heat exposure on maternal health have focused on clinical, epidemiological, and public health outcomes (Asamoah et al., 2018; Bonell et al., 2022; Cil and Cameron, 2017). Social science research on this topic has been slow to catch up, but there is a growing literature on the experience of pregnancy and heat among outdoor and agricultural workers. Research with Hispanic and Haitian women working in horticulture in the United States, for example, documented their beliefs about how heat may cause dizziness, fainting and vomiting in pregnant women and agitation in the foetus. The women had little control over the working conditions that exacerbated these effects, however, and had received no training in heat protection strategies (Flocks et al., 2013). Heat stress in pregnancy has also been reported among Gambian women farmers, whose adaptive strategies to reduce these effects included taking regular breaks in the shade and reducing time spent on outdoor work, although women's ability to make these changes were limited by their socioeconomic and marital status (Spencer et al., 2022). And in their research on such themes in rural Uganda, MacVicar and colleagues noted the regional diversity of heat impacts on pregnancy and perinatal health, and called for more local studies characterising the place-specific experience of weather and season during pregnancy (MacVicar et al., 2017).

As the global climate continues to warm, there is an urgent need to understand the lived experience of being pregnant in the heat, particularly in low-income countries, and how to protect women through gender-sensitive adaptation policies and strategies (Adger et al., 2013). We still have a limited understanding of complex social drivers of exposure, health impacts (acute and long term), and individual-, household- and community-level coping strategies. Between 2020 and 2023, the CHAMNHA consortium (Climate, Heat, and Maternal and Neonatal Health in Africa) conducted qualitative research in Kilifi County in Kenya on community perceptions and experiences of high temperatures in pregnancy, childbirth, and the postpartum period. As with other countries in the Great Lakes Region, Kenya is projected to experience significant increases in heat stress exposures within the coming decades (Asefi-Najafabady et al., 2018; Russo et al., 2016).

In this article, we describe how pregnant women in a low-income rural community with limited access to healthcare are affected by seasonal heat and locate these experiences in the material contexts of local poverty and environmental degradation. We report on qualitative data collected from multiple sources: pregnant and postpartum women, as well as male spouses and mothers-in-law, community health workers, community leaders, and other environmental and health stakeholders in this region.

2. Methods

2.1. Study site

The study was carried out in the sub-counties of Kaloleni and Rabai, in Kilifi County in Kenya's Coast Province. The area has a tropical savannah climate with dry summer characteristics (Köppen-Geiger classification). Mean daily temperatures in the hot seasons range between 24 °C and 33 °C, although the year-round relative humidity of around 78% makes a temperature of 33 °C feel more like 47 °C (Meteoblue, 2023; US National Weather Service, 2023). The region has suffered a severe drought since 2019, with the Kenyan President declaring a national disaster in the area in September 2021 (Mutai, 2021).

Kaloleni and Rabai are among the poorest constituencies in the Coast Province. Approximately 70% of the population of Kilifi live below the poverty line, compared to the national rate of 47% (County Government of Kilifi: Kilifi County Department of Health, 2019). Most residents rely on subsistence agriculture and the keeping of livestock and make a living through casual labour in the tourism industry and informal trading. Many men from the region migrate to Mombasa, Kilifi, and other smaller coastal towns to seek wage employment (Parkin, 1991), and historically, have been economically dependent on men (Orchardson, 1986).

Most people in the area identify as Giriama, one of the largest ethnic groups along the coastal hinterland of Kenya. Households are often multi-generational and patrilineal, with ultimate authority resting in a man. Upon marriage, a young woman is usually absorbed into the family of her husband, and for most household tasks and decisions, is expected to defer to him (Udvardy, 1992). Women gain status as they age, and older women are especially influential in guiding their daughters-in-law in matters relating to marriage, pregnancy, childbirth, and the raising of children, as part of their overall management of the household (Udvardy, 1992). Male partners in this setting seldom accompany their wives to healthcare facilities for maternal health services, but given their power within the household and broader community, they are the ultimate decision-makers when it comes to seeking healthcare (Lusambili et al., 2021). Child marriage is common in Kenya – as many as 1 in 4 young women are married or in union younger than 18 years of age (UNICEF, 2022).

Combined, maternity facilities in the two sub-counties see about 12,000 deliveries annually (County Government of Kilifi: Kilifi County Department of Health, 2019; Kenya National Bureau of Statistics, 2009). Few women routinely attend the nationally recommended four antenatal visits (County Government of Kilifi: Kilifi County Department of Health, 2019), owing to several factors, including affordability, distance to health facilities, and poor transport and communication networks. An estimated 44% of deliveries occur at home (Wakibi and Ngure, 2021).

Homesteads are made up of around 3 to 5 small houses clustered together. These are made of either mud and stick infill or of stones cut from locally sourced coral rocks. Ventilation is limited to a few small windows, and roofs are constructed from coconut leaf thatch (*makuti*) or corrugated iron. Few households have access to piped water and electricity, and many families rely on firewood, charcoal, and other expensive energy sources, such as kerosene (Momanyi et al., 2016). There are also outbuildings for livestock and a small planting area in which crops of maize, cassava, beans and other vegetables are grown. Drier conditions and more unpredictable rainfall in the past few years have severely impacted the ability of households to plan for crop planting and harvesting, threatening food security and triggering the distribution of food relief (Cheruiyot et al., 2022).

2.2. Study design

This qualitative study used a combination of in-depth interviews (IDIs), focus group discussions (FGDs) and key informant interviews (KIIs) to gather diverse perspectives on pregnancy and heat. Data were collected by trained research assistants between February and April 2021 using pre-prepared scripts and prompts. The study was approved by the ethics review boards of the London School of Hygiene and Tropical Medicine (LSHTM) in the UK and the Aga Khan University in Kenya, as well as from the National Commission for Science, Technology and Innovation (NACOSTI) and Kilifi County Office in Kenya.

2.2.1. In-depth interviews (IDI)

Following verification by healthcare providers at local facilities, women 16 years and older who were at least 28 weeks pregnant and postpartum women between 4 and 12 weeks after childbirth, were invited to participate in an IDI. The scope of these interviews covered women's felt experiences of heat and heat stress; their perceptions of risks associated with heat exposure during pregnancy and childbirth; how their activities of daily living and inter-personal relationships are affected; and coping strategies.

2.2.2. Focus group discussions (FGD)

To gather information on social norms and practices relating to heat, and to bring other voices into the picture, we recruited significant family members to participate in FGDs. Separate groups were held with mothers-in-law and male spouses from households where a woman had recently been pregnant. We also held FGDs with Community Health Volunteers (CHVs) with at least 2 years' experience of active involvement in community work. CHVs are widely trusted role-players in this setting, offering pregnancy and lactation support to women in the community, among other health promotion services.

Themes explored in the FGDs included: indigenous knowledge and beliefs about how heat affects pregnant women and the developing foetus; cultural expectations relating to pregnancy, and the role of men, mothers-in-law, and the broader community in supporting pregnant and postpartum women.

2.2.3. Key informant interviews (KII)

Community and religious leaders, together with officers in relevant ministries such as health, water, agriculture, and environment were invited to participate in KIIs. These interviews allowed us to tap into the knowledge and experience of key stakeholders familiar with the health and environmental challenges faced by communities in Kilifi County. Interviews covered: health issues that typically arise in the study communities during very hot weather and existing practices at community level to protect the health of pregnant women.

2.3. Data collection

All study participants were purposively sampled to match eligibility criteria. To identify them, we drew on existing community networks that the Aga Khan University has built up over many years. In addition, CHVs helped to recruit eligible participants from the waiting areas of dispensaries offering antenatal or postnatal services and from community settings where they worked.

All interviews and FGDs were carried out in a private room within local health facilities or government offices or under a tree outside a health facility. Snacks and drinks were provided at the interviewing venues, and each participant was reimbursed for their transport costs. Three research team members (two women, one man), with experience conducting public health and community research in Kilifi, were responsible for data collection. These were all social scientists trained to use open-ended, flexible topic guides to encourage dialogue with participants and allow for the emergence of unanticipated themes. Questions in the IDI, FGD, and KII topic guides were piloted in one FGD comprised of CHVs, a pregnant woman, and a breastfeeding woman, and thereafter amended to remove terminology that was confusing to participants.

FGDs and IDIs were held in Kiswahili, Giriama, and Rabai languages, while KIIs were held in Kiswahili and English; all were audio-recorded. The IDIs and KIIs took no more than 1 h, while FGDs lasted between one and two-and-a-half hours. All participants provided written informed consent for study participation and for audio-recording of the discussion or interview, including 'emancipated minors'. In Kenya, these are adolescents under the legal age of majority (18 years) and considered to have the legal capacity to provide informed consent by virtue of having assumed adult responsibilities, such as marriage or parenthood (National AIDS & STI Control Programme and Kenya Medical Research Unit, 2015). The lower age limit for emancipated minors is 15 years (Marsh et al., 2019).

2.4. Data analysis

All audio-recordings were transcribed and translated from local languages to English. Two interviewers and an off-site social scientist coded and analysed interview transcripts in NVivo v.12, using both Grounded Theory analysis (Glaser and Strauss, 1967) and thematic analysis (Braun and Clarke, 2006). Together, they developed a codebook following inductive open coding of a small sample of transcripts. After review and discussion of these initial codes, the codebook was consolidated and adjusted where necessary, and the remainder of the dataset was coded by the same team. A sample of transcripts was re-coded and then manually checked against the original coding to assess inter-coder reliability. A second tier of coding (axial coding) was then carried out by one member of the coding team (FS). This involved a close reading of the underlying data in each code, followed by a merging of redundant codes and a clustering of linked codes into broader categories. Text for the manuscript was developed by identifying key themes emerging in these categories and building linkages between them. In this article, we report only on findings related to pregnancy; data on heat experienced in the postpartum period are reported elsewhere.

3. Results

3.1. Socio-demographic profile of the sample

A total of 99 participants took part in the study (see Table 1). Ten pregnant women and 12 postpartum women participated in the IDIs.

Table 1
Socio-demographic profile of study participants (key informants not included).

	Pregnant & postpartum women (n = 22)	Male spouses (n = 20)	Mothers-in-law (n = 19)	Community Health Volunteers (n = 22)
Age				
16–25	14	2	0	1
26–35	6	5	1	3
36–45	2	10	2	8
Above 45	0	3	16	10
Median age	23.5	37	50	46.5
Marital status[a]				
Married	18	20	16	18
Widowed	0	0	2	3
Single	4	0	0	1
No. of children				
0–2	16	–	–	–
3 and above	6	–	–	–
Education				
No schooling	3	6	15	–
Primary school	9	4	3	–
High school and above	10	10	1	–
Employment status				
Formally employed	4	9	0	2
Casually employed	2	9	5	11
Unemployed	16	2	13	9
Retired	0	0	1	0
No. of household members[b]				
1–3	10	9	3	–
4–6	8	6	6	–
7 and above	4	4	10	–

[a] Data missing for 1 mother-in-law.
[b] Data missing for 1 male spouse.

These women were a median of 23.5 years old (the youngest was 17 years old) and evenly split between primary school- and secondary school-educated. Most were not in formal employment. Five of the 11 postpartum women had delivered their babies at home. Nine FGDs were held in total, with 6–9 participants per group. Three FGDs were held with male spouses aged a median of 37 years (n = 20). Most men were self-employed, and half had completed high school. Three FGDs were held with mothers-in-law (n = 19); most had no formal education and described their occupation as subsistence farmers. The male spouses and mothers-in-law were not from the same households as the women interviewed in IDIs.

Three FGDs were held with CHVs, two with women (n = 14), and one with men (n = 8). A total of 16 key informants were interviewed, including Public and Community Health Officers from the Ministry of Health, Environmental Officers, Reproductive Health Officers, Nutrition Officers at county and sub-county levels, along with traditional birth attendants, chiefs, and religious leaders.

3.2. *"The sun is hotter and will hit you harder": The lived experience of heat stress in pregnancy*

Locally, climate change was conceptualised and lived very much as a local reality – with local causes and effects – rather than an abstract event happening far away. The most obvious signs of a changing climate, for the people we spoke to, were higher temperatures, lengthier periods of extreme heat, and dramatically reduced rainfall. Most participants attributed these changes to deforestation caused by factories and buildings encroaching on areas previously covered with dense vegetation. The felling of trees to make space for this construction or to produce charcoal or firewood – a source of household energy and income – led to environmental degradation, as large areas of land were *"becoming like a desert"* (FGD Male CHV, Kaloleni; Participant 7). Cloud cover was seen as a protective barrier between the sun and the earth's surface that was being weakened by changing rainfall patterns. A female CHV from Rabai told us that, *"the older people are saying the heat has 'descended' down because there are no clouds"* (FGD Female CHV, Rabai 2; Participant 7) – leaving humans and animals increasingly exposed and vulnerable to the heat.

Most participants were initially surprised when asked to share their perceptions and experiences of heat, possibly because heat was largely normalised as a feature of the physical environment outside of the individual locus of control. As our interviews progressed, however, a picture began to form of how burdensome the day-to-day lived experience of heat in this community has become for residents – and particularly for women. Pregnant and postpartum women in the study described a host of physical and mental effects of heat exposure during pregnancy, and most agreed that – compared to non-pregnant women – these symptoms were usually worse for pregnant women, who "*feel abnormal heat*". One woman in Ndatani, who was expecting her third child, claimed:

> *The one who is not expectant is free, she has not carried any extra weight, she can walk freely since she is flexible* (IDI Pregnant Women, Ndatani 1).

As this quote suggests, the apparent discrepancy between pregnant and non-pregnant women's experiences of heat was mostly explained in terms of the increased body mass of pregnancy (*"she is heavy"*).

Overall, our analysis suggests that the effects of heat exposure in pregnancy – as described by the participants in our study – may be clustered into groups of linked symptoms. The first cluster relates to the direct physical sensation of heat applied to the skin and to heat-related skin conditions. Physical discomfort was one of the most frequently mentioned effects of experiencing pregnancy in the heat. Women described their bodies as *"burning", "really hot", "scorched"* and *"hit by the hot sun"*. A Reproductive Health Coordinator in Kaloleni said she had heard pregnant women complaining about feeling *"a fire sensation on the body*" (KII SRH Officer, Kaloleni 1), and experiencing a discomfort so intense, it became a kind of out-of-body sensation – as one CHV put it, *"this body feels like it is not mine"* (FGD Female CVH, Rabai 2; Participant 1). Skin conditions such as heat rash (*harara*) and pruritus were also frequently mentioned, and linked to the formation of tiny blisters, mostly on the stomach, back and thighs. A pregnant woman in Kaloleni explained:

> *There are things that develop on our body when it is hot … like small pimples that itch so much, and they usually appear during the hot seasons … in Giriama language we call them 'blisters'* (IDI Pregnant Women, Kaloleni).

Women found these conditions especially troublesome, with one pregnant woman in Rabai commenting "*when it is very hot, I feel very itchy and sometimes I scratch myself"* (IDI Pregnant Women, Chilodi, Rabai 1). A postnatal woman who had recently birthed her third child recalled that when moving around and walking long distances when pregnant, *"because of the extreme heat, there is more friction on your body that causes the rashes*" (IDI Postnatal Women, Rabai 1).

A second cluster of symptoms concerns the impact of heat on the body's hydration. Women reported excessive perspiration in the heat and described how challenging it was to bathe frequently enough in a situation of water scarcity. The consequence, for one woman, was that "*the husband will start complain about you stinking"* (IDI Postnatal Women, Chilodi, Rabai 2). There was also some concern among key informants that excessive perspiration could cause dehydration. A nurse who served as a sub-county Reproductive Health Officer commented that when checking up on women attending ANC services, she would find that *"their faces look flushed, lips are dry. To me, I feel it is like they get dehydrated"* (KII SRH Officer, Rabai 1). Pregnant women themselves complained of *"dryness of the mouth",* and one postnatal woman recalled a struggle to quench her thirst in the heat when pregnant. She had increased her water intake, but "*the thirst would not go away*" (IDI Postnatal Women, Lenga, Rabai 1). The mothers-in-law spoke of the body having "*decreased blood"* in the heat and believed this resulted from perspiration that left *"little water in the body"* (FGD Mothers-in-Law, Ndatani; Participant 5).

Thirdly, heat was described as impacting on the body's circulatory system and the interplay between heart and brain, which was considered especially problematic in pregnancy. Pregnant and postpartum women, male spouses, and CHVs expressed the belief that heat during pregnancy caused hypertension. One woman, pregnant with her second child, said, *"when there is extreme heat, my temperature or blood pressure will shoot up as well"* (IDI Pregnant Women, Boyani, Rabai 1). For those who reported hypertension in pregnancy, this symptom was experienced in the body as a *"very fast heartbeat"*. Heat made women *"crave for a cold drink"*, as drinking cold liquids apparently helped *"to cool down your heart as it could be beating more faster"* (IDI Pregnant Women, Boyani, Rabai 1). Another woman explained, *"You will feel the speed of your heartbeat increases and you feel like finding something cold to cool your body"* (IDI Pregnant Women, Ndatani 1). Such was the need for cold beverages, according to one Reproductive Health Officer, that pregnant women allegedly favoured these over nutritious food – "*some do not buy even those greens [vegetables], they buy the cold water*" (KII SRH Officer, Kaloleni). Key informants spoke about observing pregnant women being *"breathless"* in the heat and saying that "*the baby gets up to the lungs*" (KII SRH Officer, Rabai). In a similar vein, CHVs recalled hearing pregnant women complain that *"their chests are heating up"* (FGD Female CHV, Rabai; Participant 5) when it was hot.

We were told that if women's bodies were not cooled down and their heartbeat slowed, immediate consequences included confusion, dizziness (*kisunzi*) and fainting. One pregnant woman described this dizziness in terms of her brain "*moving on very high speed*" when she walked in the sun without an umbrella or cloth to shade her (IDI Pregnant Women, Kaloleni). Indeed, several participants made reference to the dangers of walking long distances in the sun. A mother-in-law from Ndatani

described how:

> … *you feel hot in the chest and you pant (kuhema). You are not able to walk, you can't see well ahead because you feel dizziness, you are about to fall down* (FGD Mothers-in-law, Ndatani; Participant 2).

Importantly, there was some concern that heat-related hypertension could result in miscarriage and preterm birth: a female CHV explained that in the heat, "*you can deliver a baby who has not reached its time"* (FGD Female CHV, Rabai 1; Participant 5). Several CHVs shared painful memories of women in their communities losing their babies in the hot seasons and attributed this to heat-induced hypertension. One female CHV in Rabai described how the heat could make blood pressure rise even in women who had no previous history of hypertension.

> *You get a woman has given birth to two or three children and she didn't have a problem of pressure [before]. But during the hot season … she will tell you that she had left in the morning to go look for water, she has been hit by the hot sun, heat, so when she gets to her house, when you visit her, she tells you that … she has really burnt, she is really hot. So, you tell her that she should rush to the hospital. And on reaching the hospital, when she is checked for pressure, her pressure is high …* (FGD Female CHV, Rabai 2; Participant 7).

A final cluster of symptoms centred around women's mental well-being, which was threatened by disturbed sleep and restlessness, especially when temperatures remained high after sundown. A male spouse in Rabai recalled how he had observed his own pregnant wife struggling to sleep in the heat, noting that "*at night she may be throwing her hands as if she is dying*" (FGD Male Spouses, Rabai; Participant 6). Given that houses were often poorly ventilated and corrugated iron roofs trapped the heat inside, several pregnant women spoke about wanting to sleep outside at night. Others rejected this strategy, saying they would be bothered by insects and that it was unsafe for women to sleep outside at night.

Women's wellbeing in the heat was also affected by mood changes: pregnant women were said to *"become too irritable and moody"* (KII Community Health Officer, Kaloleni). Older women spoke of their daughters-in-law feeling *"otherwise"* at the end of a long hot day, and *"lacking peace in her body"* (FGD Mothers-in-law, Rabai; Participant 2), while an Environmental Officer noted that *"she will be harsh to the children and the husband. If you ask about something minor, she responds harshly"* (KII Environmental Officer 1). Women's increased irritability was also linked to the discomfort of sexual intercourse in the heat while heavily pregnant. As one CHV put it,

> … *the conjugal rights, the men don't get it because of the discomfort. So here you are, feeling too hot with the baby inside and … One time, a woman came and complained, [saying] 'I feel like I am suffocating and here he is.' So, they are irritable* (FGD Female CHV, Rabai; Participant 3).

3.3. *"A burden in the household": Gender and kinship in a time of climate change*

As with other maternal health outcomes, the experience of heat stress during pregnancy is shaped by the social circumstances in which these pregnancies unfold. In rural Kilifi, one of the most influential principles structuring daily life is the gendered division of labour. Household labour – the chores and subsistence agricultural work required to sustain families – is considered the domain of women, especially those of childbearing age. More precisely, these tasks are performed by women in their marital home, as part of the 'duties' of a daughter-in-law, underlining the obligatory nature of this work. At a minimum, this labour involves cleaning the house, collecting firewood and water, preparing meals for household members, doing laundry, and taking care of children, while also taking responsibility, alongside men, for planting and maintaining subsistence crops.

An important dimension to the household labour of women in Kilifi is that much of the work is undertaken outdoors. An Assistant Chief in one of the sub-counties noted that women work "*in direct sunlight: the collection of water, firewood, laundry and digging is all done in the sun"* (KII Chief 1). Out of all the household chores assigned to women, the search for and transporting of water back to the home was singled out by many participants as the most onerous. Households with sufficient income or the ability to borrow cash from neighbours and kin bought water from the owners of water tanks, where these existed, or from men who delivered water on motorcycles or on bicycles at KES40 ($0.30) per jerrycan. But many households lacked the financial means to do so, and the scarcity of water for household use was at the forefront of everyone's minds. Taps, wells, and streams were drying up, along with the natural water reservoirs shared with animals, forcing women to walk even further in search of clean water.

Importantly, women were expected to continue these and other household chores even in the final stages of pregnancy. Only in the immediate post-delivery period (estimates ranged from seven to fourteen days), was there some allowance for rest, before "*you resume your duties as normal."* One Chief told us,

> *It is very hard to see a pregnant woman sitting at home. They have to do their duties as normal. There is no difference between when you are pregnant and when you are not* (KII Chief 1).

Aside from the economic necessity for women to continue doing household chores until delivery, the expectation that they do so was reinforced by the notion that pregnancy is a 'normal' and healthy state of being: "*most of the time they say pregnancy is not a sickness, so you should be able to do all your work",* as one participant put it (KII Community Health Officer K1). Being active in pregnancy was also believed to result in a shorter and easier labour, as activity "*enhances the baby to come out with ease*" (KII Chief 2).

But these gendered expectations around household labour were difficult for women to meet when the heat induced lethargy and made them feel "*lazy*", "*tired"*, "*weak"*, and generally unwell. Furthermore, food insecurity and inadequate nutrition – heightened by the drought – contributed to women having less energy for household work when temperatures were high, which in turn meant that tasks often took longer to complete. The consequences for women's overall productivity in the household were captured by an Environmental Officer in Rabai:

> *These pregnant mothers are usually challenged because they feel hot and tired every time because of the heat. So, it affects their household chores negatively. She feels like going to sleep instead of working … she does not do the work she should be doing in the house* (KII Environmental Officer 1).

Reduced productivity during pregnancy appeared to impact on interpersonal relations and generate tensions in the household. A pregnant woman said when her husband returns home and finds that she "*hasn't done all that he expected or told [her] to do*", misunderstandings and conflict arise (IDI Pregnant Women, Chalani 1). As indicated above, a woman who is less active during her pregnancy – someone who "*just sits"* – is not favourably viewed and could even lead to other household members viewing her as a burden.

> *Now if you cannot make a meal for yourself, can you make a meal for the other person? The level of activity for pregnant women, not because you are sick but now due to the heat stress, you cannot even perform your duties … the fatigue is too much. You cannot do any physical activity. Then you become a burden in the household* (KII Environmental Impact Officer 1).

A number of participants dismissed the likelihood that pregnant women could recruit others for additional support. One religious leader said, *"they will continue working as normal without resting because who else will work for you?"* (KII Religious Leader 1), and a TBA explained that support for women was often patchy, right up until they go into labour.

Getting such support here in our area is so poor … Some of them will be supported continuously until they deliver. However, some will continue with their daily chores, [you] even find them going to fetch firewood, or even working in the farm today, and hear in the following day that they have given birth. That commonly happens (KII TBA 1).

It appeared to be more acceptable for women to source this support once the baby had been born, rather than during pregnancy. When asked whether neighbours and family members might come to a house where a woman is pregnant to offer help, one pregnant woman said, *"No, maybe after you have delivered, that is when they can carry water for you as they come to see the baby. But when you are pregnant, you do it yourself! [laughter]"* (IDI Pregnant Women, Boyani, Rabai 2). A male CHV in Kaloleni highlighted this contrast in the support offered to women:

There is a difference which I have observed … For the postnatal women, they are likely to get help. But for the pregnant woman, she encounters so many problems. She is the one to do everything for herself. The postnatal woman can receive help even from the neighbours. One will bring her firewood, another one will bring her water. She gets some help, a "boost". But the one who is still pregnant, will be forced to use the little money ("kile kichishilingi kichishilingi") she has kept … to look for somebody with a bicycle or motor bike … in order to be brought water there (FGD Male CHV, Kaloleni; Participant 2).

Overall, while men and mothers-in-law generally expressed sympathy with the plight of pregnant women struggling in the heat, the extent to which this sympathy translated into concrete actions to help reduce women's workload was unclear. A few women in the study described receiving help from their husbands with heavier tasks such as collecting firewood and water. But in general, there are strong social norms in these communities that discourage men from doing domestic work, particularly tasks such as cooking, laundry and taking care of young children, which are distinctly feminised. One of the Chiefs we interviewed identified this as a problem in the community.

It's not easy. In our community I think it is very hard to find men taking responsibility … Even if he is learned and you stay in a big homestead that includes extended families, it will be very hard for the man to come and chip in because when they do so, [other people] claim that the man is overpowered by his wife. They do not see the importance of a man offering a hand when the woman is pregnant (KII Chief 1).

For many men, their availability to share the burden of this work with their wives was limited anyway, as they were often out seeking work or doing casual labour. And much like the obligatory 'duties' of young wives, the assistance provided by mothers-in-law was framed as an obligation that flowed from kinship relations – specifically, the filial relationship with their sons, and by extension, with their new 'daughters'. As one mother-in-law put it, *"you will have to do them [duties] as their mothers, because she is unable"* (FGD Mothers-in-law, Rabai; Participant 2). Another reasoned, *"you cannot avoid her since she is a wife to your son, you need to help her"* (FGD Mothers-in-law, Kaloleni; Participant 5). Support from mothers-in-law appeared to be mostly forthcoming only when it was clear that the pregnant women had exceeded their capacity for physical activity in the heat, but not before. One mother-in-law explained how *"maybe she is exhausted so she cannot do the duties, you will have to do them by yourself"* (FGD Mothers-in-law, Rabai; Participant 5).

And yet there was no escaping the observation that performing physical labour in the heat could be harmful for pregnant women. In some of our participants' narratives, this harm was acknowledged. There were multiple reports of women becoming dizzy and fainting in the heat. Some men had witnessed their pregnant wives *"collapsing because of hot temperatures, overworking"*; one commented *"mothers get really exhausted"* (FGD Male Spouses, Rabai; Participant 6). Carrying heavy loads of firewood or water in the heat was specifically linked to abdominal pain and vaginal bleeding, according to some of the CHVs and male spouses we spoke to. One man in a FGD in Kaloleni recounted the story of how he had brought his wife to the district hospital as she was bleeding:

… when she arrived in Mariakani, she was told it is because of carrying heavy loads. She leaves our place and carries water from the dam, then carries it on her back. So, when she reached [the hospital], she was told 'Reduce your heavy work, it is this heavy work that is making you this way' …. That is why she is bleeding (FGD Male Spouses, Kaloleni; Participant 6).

The view among healthcare workers and most of the regional government officers we interviewed was that hard physical labour in the heat potentially affected the growing foetus. Mothers-in-law and pregnant women read some abdominal pain as a sign that *"the baby in the womb is not relaxed"* (FGD Mothers-in-law, Ndatani; Participant 6). They spoke of the foetus being *"anxious"* in the womb – expressed in the local idiom that babies in the womb do not "*play*" as much in the heat compared to when temperatures are cooler. This mother-in-law from Rabai explained:

The foetus, sometimes it does not feel like playing because of the high temperature. Up to when she delivers and finds peace, then she is peaceful (FGD Mothers-in-law, Rabai; Participant 5).

Also from Rabai, a CHV recalled how she had assisted a woman who "*used to struggle with the heat*" and had felt reduced foetal movements as her delivery date drew near. The woman had told her that "*the way I was feeling him playing [before] and right now, I feel he is not playing well*" (FGD Female CHV, Rabai 1; Participant 1). The CHV's advice was to go to the hospital even though her pregnancy was not yet full term.

When she reached the hospital, she was told:

'Your clinic days are not yet over but what will you do? You will deliver'. So now that is the heat that made the baby not to play. This one was ailing in her stomach … and the woman was sweating. She had to go to be operated, she was told the heat had increased from inside, so if she wanted to save the baby and herself, she was to sign and go for caesarean section. That baby survived by luck.

4. Discussion

From the narratives of diverse participants in this study, a picture has emerged of the lived experience of pregnancy in extreme heat involving many of the classic symptoms of heat exhaustion. These include dizziness, fatigue and lethargy, sleep disturbances, tachycardia, and irritability (Cheshire, 2016; Wexler, 2002). Participants attributed maternal hypertension to the heat, and interpreted tachycardia as the body's way of signalling the presence of hypertension. Adverse birth outcomes such as preterm birth, stillbirth, and miscarriage were believed to increase in periods of extreme heat, with several participants offering personal accounts of such losses.

Some of the above symptoms are also common in pregnancy, such as heart palpitations and tachycardia, especially in the final trimester (Adamson and Nelson-Piercy, 2007), making it difficult to know how much of a role was played by heat and how much by pregnancy in the eventual manifestation of these symptoms. But maternal health is very much a "social and economic phenomenon, not just a clinical and biological issue" (Filippi et al., 2018, 6). Any analysis of the experience of pregnancy must be underpinned by an understanding of the social determinants of health and the local contexts in which these determinants operate (Braveman and Gottlieb, 2014). Women's experiences of heat stress in pregnancy will be shaped by multiple and intersecting factors in their environment, from socio-economic status, health service access, and the built environment to local norms and interpretations of what constitutes a healthy pregnancy.

In Kilifi County, a region with a hot and humid climate and in the grip of a multi-year drought, exposure to ambient heat appears to

contribute an additional burden to pregnancy and impacts on women's wellbeing. These heat effects are felt by women not only in the form of heat stress symptoms, but also in their potential to disrupt the household and kinship relations that coalesce around domestic labour and provide the social substrate for the raising of children. These relations make child-bearing women responsible for physically demanding labour that is integral to the survival of households and the wellbeing of the family. Yet women's ability to do this work while pregnant (and meet their obligations to kin) is reduced when temperatures are high: their "maternal energy balance" (MacVicar et al., 2017) is threatened, in other words. Our findings suggest that women in this rural, subsistence economy setting – adolescents and young women in particular – have limited autonomy to negotiate a reduction in their workload during hot periods or to recruit extra support. In part, this is a product of local gender relations that favour men as household heads. But it is related also to the mechanics of poverty and scarcity. Where households have limited cash to hire additional labour and members simply cannot take on extra work, pregnant women who are struggling to complete their chores in the heat may be regarded as a 'burden'.

The expectation that women continue their household chores even while pregnant may be linked to the local conceptualization of pregnancy as a 'normal' state of being. But this idea of normality begins to break down in the face of epidemiological evidence on the adverse maternal health outcomes of heat exposure in pregnancy (Chersich et al., 2020; Li et al., 2018), and also in light of our findings that illustrate the interplay between heat, pregnancy, and patterns of social vulnerability.

Given the current and projected disease burden caused by heatwaves and extreme heat events (Vicedo-Cabrera et al., 2021), developing risk reduction strategies for women in these settings is critical. A good starting point would be to work with communities to raise awareness of the heat-health nexus in pregnancy, within a framework that is cognisant of local gender dynamics yet does not feed into the development discourse of "virtuous women and negligent men" (Rao et al., 2019). Wherever possible, interventions should be co-designed with community members, harmonising scientific knowledge and local knowledge to foster shared decision-making (Ataöv and Peker, 2021). Interventions could take the form of a participatory behaviour change approach, for example, to harness greater support for pregnant women in hot seasons and heatwaves while strengthening women's agency to protect their own and their baby's health. This approach aligns with a framework of climate justice, in which community alliances and self-sufficiency are cultivated to empower the most disadvantaged populations while building resilience (Ebi, 2009). Within this framework, developing targeted approaches for married adolescents would be especially important given the high numbers of child marriage in the region (UNICEF, 2022).

There were limitations to our study. Interviews with pregnant and postpartum women yielded less detail than we were hoping for. It may be that young women in these remote study communities were not used to outsiders asking about their experiences and seeking their opinions, as the social organisation of power means that they lack the authoritative voice of male household heads. Women were also reluctant to discuss their pregnancies in much detail, possibly because culturally, talking about the unborn child is thought to invite bad luck. Upon reflection, we might have obtained richer data from young women by using serial interviews or FGDs to build rapport more effectively, and women may have drawn confidence from hearing their peers express opinions in a group setting. In future studies on this topic, the addition of ethnographic participant observation would gather emic perspectives, generate more granular data on the impact of heat on women's day-to-day activities, and allow for triangulation with interview data.

5. Conclusion

As the global climate continues to warm, heat will become an increasingly hazardous exposure with serious human health consequences. Maternal health outcomes associated with heat – which, at present, go largely unreported – may have major implications for populations in sub-Saharan Africa (SSA), where pregnancy is already a high-risk event (Graham et al., 2016). In low-resource communities like these in Kilifi County, warming will interact with existing material and social constraints to increase vulnerability and risk for pregnant women. Additional research is urgently needed to develop culturally appropriate adaptation strategies for reducing heat risks in pregnancy that are acceptable to local populations in low-resource settings.

Ethical approval

This paper uses data from a qualitative study approved by the Ethics Review Boards at the Aga Khan University, Kenya (Ref.2020/IERC-94 (V2), the National Commission for Science, Technology and Innovation (NACOSTI), Kenya (Ref. BAHAMASABS/P/20/7568), and the Research Ethics Committee of the London School of Hygiene and Tropical Medicine (LSHTM), United Kingdom (Ref. 22685). At the county level, permission to conduct the study was received from the county government of Kilifi and its relevant ministries and local authorities (Ref. DOM/KLF/RESCH/Vol.1/66).

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Author contribution statement

Fiona Scorgie: Conceptualization, Methodology, Supervision, Data curation, Formal analysis, Visualization, Writing - Original draft preparation. Adelaide Lusambili: Conceptualization, Methodology, Project administration, Investigation, Data curation, Formal analysis, Writing - Review & Editing. Stanley Luchters: Conceptualization, Funding acquisition, Supervision, Writing - Review & Editing. Peter Khaemba: Investigation, Formal analysis, Writing - Review & Editing. Veronique Filippi: Conceptualization, Writing - Review & Editing. Britt Nakstad: Conceptualization, Funding acquisition, Writing - Review & Editing. Jeremy Hess: Conceptualization, Writing - Review & Editing. Catherine Birch: Conceptualization, Writing - Review & Editing. Sari Kovats: Conceptualization, Funding acquisition, Supervision, Writing - Review & Editing. Matthew Chersich: Conceptualization, Funding acquisition, Methodology, Supervision, Writing - Review & Editing.

Data availability

Data will be made available on request.

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