

The Impact of Climate Change on Maternal and Child Health in the Caribbean

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Abstract: Maternal health concerns the well-being of women during pregnancy, childbirth, and the postpartum period. Climate change events often threaten maternal health because mothers and their offspring are more susceptible to environmental changes. In developing countries, 88% of children succumb to climate change-related deaths. The inherent vulnerability of mothers and their offspring to infections, illness, and malnourishment due to limited social services, healthcare, low household income, and dependency, are often to blame for the high mortality rate. Given that the literature on the impact of climate change events on maternal and child health in the Caribbean region is scarce, this chapter seeks to address this gap by using a secondary research approach. The impacts that climate change events in the Caribbean are likely to have on the maternal and child health of persons residing in flood-prone areas and coastal communities will be discussed. Like Nigeria, Ghana, and India, in the Caribbean, climate change events negatively impact the mortality of the mother and her child. The decline in the nutritional quality of food, amongst other health-related issues, also contributes to adverse pregnancy outcomes.

1. Introduction

Climate change represents one of the most significant global health threats of the 21st century, but more so for vulnerable populations, such as pregnant women and children. Extreme temperatures, airborne diseases, and the intensity of hurricanes with destructive high storm surges negatively impact some of the poorest countries in the Caribbean. Airborne diseases are caused by pathogenic microbes small enough to be discharged from an infected person via coughing, sneezing, laughing, close personal contact, or aerosolization of the microbe. The discharged microbes remain suspended in the air on dust particles, and respiratory and water droplets. Illness occurs when the microbe is inhaled or contacts mucus membranes or when secretions remaining on a surface are touched (Division of Disease Surveillance 2023). Some of these countries do not have the measures to either mitigate or adapt to these climate change events, leaving them at the mercy of climatic elements that accompany these natural disasters. Globally, approximately 1.3 billion people in low- and middle-income countries live below the poverty line, with 70% of these people being female (Sorensen et al. 2018). Climate change diminishes women's health, especially during pregnancy, where maternal health and nutrition are vital to the developing foetus and infant (Franco-Orozco and Franco-Orozco 2018; Sorensen et al. 2018).

Roos et al. (2021) assert that climate change impacts the maternal health of expectant mothers in many ways, such as pregnant women experiencing physiological changes that make it challenging to thermo-regulate. These changes include internal heat production due to foetal growth. When heat balance cannot be maintained, heat shock causes proteins are released, creating biological and physiological reactions with severe effects on maternal and perinatal health, including the neonatal period. Heat exposure can increase the risk of premature birth and rupture of membranes, low birth weight, and stillbirth (Chersich et al. 2020; Bekkar et al. 2020). Dehydration from increased sweating in pregnant women can cause the onset of early labour and prolong the duration of labour (Hnat et al. 2005).

The United Nations Children's Fund (UNICEF) (2015) posits that the dangers of climate change are more pronounced for children than for adults. Children are more vulnerable to vector-borne diseases than adults and face dangers from under-nutrition and diarrhoeal diseases. UNICEF adds that the physical dangers of extreme weather events can cause adverse effects on their young bodies and mind. Children will also experience these effects longer than adults. This chapter examines climate change's social impact and economic cost on maternal and children's health. Apart from the impacts, it calls attention to ways in which adaptation can help quell these impacts to enhance the standard of living for those affected.

The debate on the impact that climate change has on maternal health around the world has consistently focused on vulnerable populations in countries such as India, Indonesia, Nigeria, Ghana, and Uganda, as well as regions such as Sub-Saharan Africa and Asia. This focus is often the case because the populations of such countries and regions are prone to experiencing extreme forms of natural disasters. For example, in the case of the Asian Pacific region, there is a tendency for tsunamis, volcanic eruptions, earthquakes, and cyclones to occur, while in Asia, there is a frequent incidence of floods, landslides, mudflows, and extreme temperatures (UNICEF 2022; Burunciuc 2022).

Even though these countries have very little control over the prevalence of these climate change events, as they are indeed natural disasters, what countries can control is their response to these events through the timely implementation of mitigation and adaptation strategies. Unfortunately, many disastrous climate events tend to occur in low-income developing countries and small island developing states, where there are minimal resources and means of responding to such disasters.

Women and children are two of the most vulnerable groups negatively impacted by climate change events (Adebayo 2021). According to the World Population Prospectus by the United Nations (UN) (2022), the data for 2020–2021 reveal that within one year, both the Total Fertility Rate (TFR) and global births have fallen by 0.03 births per thousand and 1,158,000 births, while both the number of infant deaths and infant mortality rate have fallen. A similar trend is echoed in the Caribbean region where for the same timeframe, the number of births has fallen by 10,000, while the TFR has also fallen by 0.03 (UN 2022).

The same cannot be said for regions like Sub-Saharan Africa, which is prone to severe natural disasters, as there was an increase of 596,000 births between 2020 and 2021 (UN 2020). Although these population statistics on a global scale and for the Caribbean reveal a somewhat positive outcome regarding the mortality of babies and population demography, it is at the regional level that pregnant women living in places like Sub-Saharan Africa and Asia experience maternal and neonatal health problems. This situation is likely to be exacerbated by climate change.

2. The Social Impact of Climate Change on Maternal and Child Health in the Caribbean

Women are affected both socially and culturally by climate change. Five aspects of climate change that impact maternal health and children will be discussed based on Sorensen et al. (2018). From a social perspective, these aspects are the increasing frequency of extreme heat events and rising seasonal temperature; poor air quality from the combustion of fossil fuels; increased frequency of climate disasters such as hurricanes and flooding; food insecurity; as well as changes in temperature, precipitation, and ecology which are altering the presence of vector-borne diseases.

2.1. Increased Frequency of Extreme Heat Events and Rising Seasonal Temperatures

Van Zutphen et al. (2012) was one of the first studies to address elevated temperature and its association with congenital disabilities. Rylander et al. (2013) also examined elevated temperatures and maternal health and found that the physical exchange of heat to maintain a stable core body temperature is approximately 37.8 degrees Celsius. Heat will be added to the body if the air is hotter than the body. An individual's capacity to reduce excessive heat by sweat evaporation to regulate core body temperature is influenced by the surrounding temperature, humidity, wind, and clothing. If the core body temperature continues to rise, heat exhaustion can occur. Persons can adjust by seeking shade, drinking more water, and swimming. However, with the increasing temperatures caused by climate change, the heat shock risk increases. Pregnant women are at risk of 'over-heating' because of their hormonal situation at all stages of pregnancy (Cunningham et al. 2010). This 'overheating' increases health risks for both the mother and foetus. Kuehn and McCormick (2017) add that dehydration in pregnancy results in decreased uterine blood flow and could lead to pre-term labour. Newborns can experience a too high or too low temperature as they possess limited temperature regulation capacity (Poursafa and Kelishadi 2011). Strand et al. (2011) reviewed the literature and suggested that the impact of seasonal patterns of prenatal exposure to extreme ambient temperature may be a factor for pre-term birth and stillbirth. Sheffield and Landrigan (2011) stated that heat-related effects may affect school performance and increase pregnancy challenges and renal effects. The influence of these outcomes would vary by region and socioeconomic status, fuelling health inequalities (Sheffield and Landrigan 2011).

According to Sorensen et al. (2018), extreme heat events and their consequences for maternal health and children are exacerbated by poor access to healthcare services and cooling facilities, and lack of transportation to access these healthcare services. Lack of communication and awareness by the populace, those in authority, decision makers, and healthcare professionals to the effects of extreme heat adds to the list. There is also a paucity of gender-disaggregated heat-related health data to assist in decision making. Religious and culturally heavy clothing add to the consequences of extreme heat events (Sorensen et al. 2018)

2.2. Poor Air Quality

Poor air quality from the combustion of fossil fuels and air pollutants can cross the placenta and impact foetal growth. It can also impair maternal respiratory and cardiovascular health leading to reduced efficacy of placental function and consequently foetal development (Sorensen et al. 2018). Indoor Air Pollution (IAP) can also affect pregnant mothers. Pope et al. (2010) stated that the consistency of findings across settings and exposure to second-hand smoke and ambient air pollution point towards a causal relationship between low birth weight and IAP and begged for further studies in developing countries. It must be noted that traditional indoor stoves are used for cooking in many developing countries. This cooking method produces carbon monoxide and hydrocarbons and accounts for nearly 24% of ambient air pollution (Health Effects Institute (HEI) 2020).

2.3. The Frequency of Climate Change Disasters

There is an increasing frequency of climate disasters, such as hurricanes and flooding, in Small Island Developing States (SIDS). Mycoo et al. (2022) posited that among the 29 Caribbean Small Island Developing States (SIDS), at least 22 were affected by at least one Category 4 or 5 tropical cyclone in 2017. These climatic events highlighted these islands' high exposure and vulnerability, which can add to community vulnerability for long periods of time. Added to this, the exposure of the surface of these islands over their entire area, the high concentration of people, infrastructure, utilities, lack of services in flood-prone coastal areas, inadequate housing, limited access to food and transportation, and unpreparedness explains the widespread total devastation. This devastation affects island supply chains which depend on ports, roads, power, and communications and contributes to the complexity of rescue operations and the delay in returning to a sense of normalcy on the affected islands. Fresh water, food supplies, medications, and fuel are in short supply for several weeks or months after the climatic event. The vulnerability of healthcare systems is triggered and can become a burden to many (Shultz et al. 2018). Morbidity and physical injuries escalate. Imagine this scenario for maternal health and children. There are 29 Small Island Developing States (SIDS) in the Caribbean.

Women suffer disproportionate mortality during natural disasters. Women that are particularly vulnerable during disasters are mostly homebound, caring for

children and the elderly while waiting for relatives to return from disaster-related evacuation. Underlying inadequate literacy and education can add another layer to vulnerability as women may not have access to information. This inadequacy can affect women's ability to take steps to safeguard their lives (United Nations Division for the Advancement of Women (UNDAW) 2001). Women seem to be more calorie-deficient than men, leading to poor physical health and vulnerability to resource shortages, as suggested by studies from Bangladesh (Rahman 2013; Del Ninno et al. 2001). Pregnant women and those giving birth post-disaster have been found to have increased risks of complications such as preeclampsia, uterine bleeding, and low birth weight (Tong et al. 2011). Notably, women and girls in the aftermath of a disaster, particularly those in lower-economic situations, are at higher risk for physical, sexual, and domestic violence (International Federation of the Red Cross and Red Crescent 2007). Women suffer undesirable job loss, stagnant personal economic recovery, and poor access to obstetric care following and during disasters (Sorensen et al. 2018).

UNICEF (2015) states that floods threaten children's survival and development. The direct impact includes injuries and death by drowning. Many children lack the strength to stay on their feet against raging waters with debris. Floods compromise safe water supplies. Contaminated water can lead to diarrhoeal outbreaks. Worldwide, diarrhoea ranks among the top five causes of death for children under 5 years of age. Diarrhoea is a significant cause of death during natural disasters and other complex emergencies (UNICEF and WHO 2009). In these situations, people are further displaced, and they move into temporary, overcrowded shelters where the drinking water may be tainted and space is limited. Additionally, damage to housing and lack of sufficient shelters expose children to danger and lack of food availability. Coastal flooding salinates, i.e., the reintroduction of soluble salts into arable land, destroy crops and reducing food availability and income. In such instances, breastfeeding becomes vital as preparing breastmilk alternatives can become nearly impossible.

2.4. Food Security

The vacillation of rainfall and temperature patterns negatively impacts crops, livestock, and fishery yields, adding to food insecurity. According to Sorensen et al. (2018; Jáuregui-Lobera 2014), women suffer higher rates of macro- and micronutrient deficiencies, and higher rates of anaemia which can impair cognitive functioning such as poor attention span, diminished capacity to remember things, emotional highs and lows, and impaired sensory perception. Malnutrition can cause negative impacts on neonatal outcomes, including intrauterine growth retardation and perinatal mortality (FAO 2002). Taking all these aspects into consideration, women are inherently sensitive to food insecurity and the resulting deficiencies due to increased needs during pregnancy and post-pregnancy, for example, in the feeding of the newborn. Often, culturally, women may prioritise food provision for children and adult males,

neglecting to ensure that they obtain a balanced or available meal. In low-income countries, women produce 60–80% of all food. As such, livelihoods, as well as nutrition, are negatively impacted during times of disaster (GDI 2017). Further, less than 10% of female farmers are landowners and barely 2% have proper paperwork for their land, exacerbating control over farmland and food security (GDI 2017).

According to FAO (1996), food insecurity is defined as inadequate access to healthy, affordable, and culturally appropriate food and this impacts more women than men, especially those of reproductive age. Food insecurity during pregnancy has great implications for the health of the mother and her baby, as this can lead to negative maternal and child health situations (Augusto et al. 2020). Pregnant women who do not have access to proper nutrition are at a higher risk for gestational diabetes and excess maternal weight gain (Laraia et al. 2010), low birth rate (Sahlu et al. 2020), maternal stress (Augusto et al. 2020), birth defects (Carmichael et al. 2007), and premature births and can struggle to breastfeed (Orr et al. 2018). Challenges with food insecurity during pregnancy can have detrimental effects on child growth and development (Augusto et al. 2020). Moafi et al. (2018) posited that food insecurity is linked to poor quality of life for pregnant women and Maynard et al. (2018) added that it is also linked to prenatal and postpartum depression. McKay et al. (2022) supported this by stating that the burdens imposed by food insecurity worsen the mental health of pregnant woman. McKay et al. added that it is important to screen very early for food insecurity in pregnancy and to identify ‘at risk’ women. This would benefit the provision of mental health support. Most often, food insecurity initiatives, with respect to pregnant women, do not consider income and poverty, employment status, education level, location, ethnicity, and access to food and nutrition programmes (Costa et al. 2017).

2.5. Changes in Temperature, Precipitation, and Ecology Are Altering the Presence of Vector-Borne Diseases

Exposure to mosquito-borne illnesses poses health issues to pregnant women. Dengue virus, present in the Caribbean, leads to an increased risk of caesarean delivery, eclampsia, and growth restriction (Pouliot et al. 2010). It is the most rapidly spreading mosquito-borne viral disease in the world. Sorensen et al. (2018) found that pregnant women are susceptible to mosquito-borne diseases due to their higher CO₂ production and increased peripheral blood flow. Mosquitoes are attracted to CO₂. Consequently, this helps them to locate their hosts quickly. Sorensen et al. explains that women spend more time around the home performing domestic tasks, which places them close to standing water with mosquito breeding sites. They add that lack of access to proper prenatal care and supported deliveries puts women at risk for postpartum haemorrhage and poor maternal outcomes.

The issues highlighted in Sections 2.1–2.5 look at the situation where pregnant women and children are affected by the social conditions that increase their vulnerability to climatic events. Pregnant women, babies, and children deserve

to live and exist in a world free of the debilitating effects of climate change. As such, issues impacting these populations must be put on the agenda of Caribbean governments to safeguard maternal and children's health. Some interventions can include:

- Reducing greenhouse gas emissions to limit temperature rise. The focus should be on sustainable development.
- Prioritizing the needs of pregnant women and children and making them central to climate change adaptation. While we acknowledge that all people deserve protection from the vagaries of climate change, the effects will rebound more to those with the least say on climate change.
- Provisioning the most substantial protection from the government and civil organisations to pregnant women and children to reduce the inequity.
- Enhancing healthcare systems. Robust and reliable healthcare systems are critical for healthy children and mothers.
- Listening to women's and children's voices on climate change. Their participation is integral for effective interventions in their lives.
- Educating and building awareness training in climate change are critical ingredients of support. This training can help foster women's and children's capacity to adapt to change. It can also promote community resilience by imparting knowledge, skills, and engagement. People will feel a part of and be stakeholders in their own lives. Inclusion and stakeholder commitment are two tools that provide a buffer against climate change. Environmental sustainability should be put on the curriculum of primary and secondary schools to enhance the understanding of the mitigation and adaptation strategies for climate change.

Apart from the social issues, the economic costs of climate change events on maternal and child health of low-income and single-parent households were alluded to in addition to the social perspective; these socioeconomic aspects are highlighted below.

3. The Socioeconomic Aspects of Climate Change Impacts on Maternal and Child Health in Low-Income and Single-Parent Households in the Caribbean

The emphasis will be placed on briefly discussing the possible economic implications that climate change events are likely to have on the health of pregnant women and their babies residing in low-income and single-parent households in the Caribbean. This discussion is from the perspective of changes in temperature, air pollution, drought, flooding, structural racism, and eco/climate anxiety.

Such a meaningful discussion is essential, as the climate change events discussed below will likely hurt both the mother and baby's pre- and post-natal healthcare. Moreover, such a dialogue is indeed crucial at this stage in the climate change discussion as all the issues highlighted below may prevent the Caribbean from achieving goal 3 of the Sustainable Development Goals (SDGs) which focuses on

ensuring healthy lives and promotes well-being for all ages with particular reference to maternal health. This dialogue is necessary because climate change tends to impact maternal and childhood health in a myriad of ways, as discussed below, and the low-income status of many pregnant mothers in the Caribbean. This situation may prevent them from coping with the problems of food insecurity and accessing proper healthcare services and housing infrastructure (Homer et al. 2009).

3.1. Temperature-Related Impacts

According to Molina and Saldarriaga (2016), there are five ways in which temperature can influence the growth and development of an unborn foetus in pregnant women. These are discussed briefly below and include the accessibility of food, maternal mental health, biological infectious diseases, extreme temperatures, and temperature-related diseases.

3.1.1. Inadequate Access to Food Supplies at the Household Level

In the first case, severe malnutrition in pregnant women can occur because of climate change events such as droughts, flooding, and landslides. This malnutrition is because, under such severe weather conditions, the quantity and quality of food produced become constrained. The limited availability of nutritious food due to changes in agricultural production and low household income often creates an unpredictable environment for the foetus to grow and develop.

To cope with extreme cases of hunger, pregnant women in the Caribbean who are part of low-income households may change their consumption of foods to one which may be high in calories, but low in nutrients, also known as nutrient-poor foods because of their cheaper cost (Bloem et al. 2010; Darnton-Hill and Cogill 2010). Such an unexpected change in the quality of pregnant women's diet can lead to micronutrient deficiencies, which are associated with higher birthweight/large gestational age, maternal obesity, and gestational diabetes (Zhu et al. 2019).

The unpredictable nature of changes in the weather was also noted to affect pregnant women in rural Uganda, for example, who are part of indigenous communities. Even though there was a marked improvement in their access to antenatal healthcare, the overall maternal and child health amongst their people declined and worsened as food insecurity persisted when compared to non-indigenous women (Bryson et al. 2021). Nevertheless, regardless of the origin, such food insecurity will likely result in less diet diversity in the long run and a rise in maternal health disorders in the Caribbean, which are associated with poor diet and nutrition (Niles et al. 2021).

3.1.2. Maternal Mental Health (MMH) Costs

In the second case, according to Engle (2009, p. 963S), maternal mental health is "a state of well-being in which a mother realises her abilities, can cope with the normal stresses of life, can work productively and fruitfully, and can

make a contribution to her community.” Often conditions associated with extreme temperatures, such as heat stroke and dehydration, can exacerbate pre-existing mental health conditions experienced by some pregnant women, such as postpartum depression, maternal dysthymia, pregnancy, and postpartum anxiety and obsessive compulsive disorder (OCD), as well as birth-related Post-Traumatic Stress Disorder (PTSD) (Waqas et al. 2022).

In cases where such conditions exist, they can affect the developmental outcomes of the foetus in many direct ways, such as interrupting the bonding process between mother and baby, breastfeeding, and changes in the cognitive ability of the baby (Smith et al. 2022; Juvrud et al. 2021). Notwithstanding these factors, pregnant women and single parents from low-income households in the Caribbean may suffer from higher rates of MMH disorders. Pregnant women and single parents in the Caribbean reside in low-income households with more than one dependent relative and children. Household resources may be diverted from accessing additional forms of care, such as counselling and social services, to satisfy primary needs, such as paying utility bills and buying groceries.

In addition, pregnant women who suffer from MMH conditions may access less treatment because the topic of mental health in the Caribbean carries a great deal of stigma. Consequently, even though healthcare institutions in the Caribbean provide such services, and while it may be essential to maintaining the health of some pregnant women, these services may not be used due to fears of discrimination by family, peers, and community members. The internalisation of shame by pregnant women brought on by MMH disorders and the associated stigma can worsen these conditions, making the condition more prevalent in the Caribbean.

3.1.3. Biological Infectious Diseases

In the third case, there is a class of diseases transmitted by biological vectors, which can also be transmitted from mother to baby. The World Health Organization (WHO) (2020) has listed nine vectors, that is, mosquitoes, aquatic snails, fleas, ticks, lice, blackflies, sandflies, tsetse flies, and triatomine bugs, as being the primary cause of 27 diseases which can be manifested as either viral, bacterial, parasitic, or ectoparasitic diseases. According to Brand and Keeling (2017), temperature changes influence the life cycle of biting insects, including those listed above, which may cause these insects to bite more on warm days, leading to greater transmission of diseases.

Vector-borne diseases are known to cause distress amongst pregnant women, as the timing of such infections can be in utero like congenital Zika syndrome, leishmaniasis, and Chagas disease. These diseases can have adverse outcomes during pregnancy, such as low foetal birth weight, congenital deformities, and even pre-term labour, as they can be passed on congenitally (O’Kelly and Lambert 2020). In terms of child health, vector-borne diseases, along with water- and airborne diseases, some of which are caused by climate change events, are known to negatively affect

young children's health outcomes, causing conditions such as asthma and pneumonia (Akachi et al. 2009).

The emergence of vector-borne diseases such as the Zika syndrome in the Caribbean can pose a significant risk to pregnant women, even though the WHO (2022) indicates that the region had the lowest report of such diseases in 2020. This is because there has been a lack of reporting and sensitisation of the public by the health institutions of Caribbean countries. As a result, the extent to which this vector-borne disease impacts the foetuses of pregnant women in the Caribbean may not be known. Although it is not known, it is possible that women from low-income households may not be able to access the necessary medical attention or take precautions to safeguard the foetus's life, which makes them particularly vulnerable.

3.1.4. Extreme Temperatures and Temperature-Related Diseases

In extreme temperatures such as heat waves, pregnant women in the Caribbean may become vulnerable to heat exhaustion, heat cramps, heat stroke, and dehydration, which can lead to premature labour. Extreme temperatures also make it more likely that wildfires in the Caribbean will occur more frequently and last longer. As a result, it is expected that the contents of the smoke, which may also include harmful chemicals from plastics and toxic fumes from waste materials, can also contribute to pre-term labour. This is an important problem, as low-income households in the Caribbean may not be able to manage periods of hot weather in a resilient manner because their houses may not be designed with cooling measures such as air conditioning units, thermostats, ceiling fans, and attic and garage insulation (Flores-Larsen and Filippin 2021).

The smoke contents can reduce the blood volume, which causes the level of oxytocin to become more concentrated, thus leading to Braxton Hicks contractions, better known as false labour pains (Raines and Cooper 2022). Such contractions, while expected, can potentially cause distress to the foetus. Furthermore, extreme heat waves, which are known to cause pre-term deaths, neonatal deaths, and miscarriages, were also found to be associated with seasonal variations in the use of caesarean delivery for high-risk pregnancies. One example of such an occurrence is in Ghana, where high ambient heat and extreme temperatures led to a higher incidence of both caesarean deliveries and spontaneous abortions.

Under such circumstances, as the maternal heat exposure level rises, so too does pregnant women's likelihood of experiencing an abortion (Asamoah et al. 2018). In cases where a caesarean delivery and spontaneous abortions may become a reality for some pregnant women in low-income situations, this may become a financial and legal burden. These procedures are expensive but having an abortion in many Caribbean countries like Trinidad and Tobago in its Offences against the Person Act is currently illegal (Trinidad and Tobago 2016). Therefore, while some of these procedures may not be accessible through public health institutions, in instances where such procedures are necessary to preserve the mother's life, they can be

inaccessible to pregnant women and single parents from low-income households, which may lead to a rise in illegal abortions and maternal deaths amongst this population segment.

Apart from foetuses, young children under five years old are also vulnerable to high temperatures associated with extreme heat as they have little ability to thermoregulate, i.e., to regulate their body temperature. Studies such as Hu et al. (2019) have found that short-term changes in the outdoor temperature were strongly linked with high blood pressure in children, especially if the patient is female and has a low body mass index. In countries like the Caribbean, with a distinct dry weather season, the exponential growth in heat-related child mortality is likely to outweigh any improvements made to reduce child death from these conditions. This can be due to changes in population growth and the continued rise in global emissions (Chapman et al. 2022).

3.2. Ambient Air Pollution

During the different stages of pregnancy, the immune system of pregnant women tends to change to ensure that the foetus which grows within the maternal uterus is not rejected by the mother's immune system (Förger and Villiger 2020). During this period, the mother's immune system becomes more sensitive to toxins and chemicals deposited in the environment through exhaust discharges, air congestion, and factory emissions. Inhaled toxins can influence the outcome of her current pregnancy via pre-term birth, low birth weight, and neurological disorders, and also future pregnancies due to adverse effects on her fertility.

Notwithstanding these experiences of pregnant women in the Caribbean, the reproductive health of all women, regardless of if she is pregnant or not, can be adversely affected by several climate change variables such as humidity, precipitation, and temperature of the environment, as well as changes in gonadal function and neuroendocrine regulation due to changes in health and socioeconomic status (Choudhari 2022; Jegasothy et al. 2020).

In addition to the health of pregnant women, ambient air pollution in the form of exhaust fumes, forest fires, and agricultural production exacerbates climate change. It is also widely hazardous to children's health (Brumberg and Karr 2021). These fumes worsen respiratory diseases in children and babies sensitive to changes in air quality. In the case of the Caribbean, the major contributors to air pollution in the region are produced by the areas of manufacturing, oil refinery, electrical power generators, transportation, and lead production.

In the Caribbean, the average exposure to ambient air pollution remains high, about $18.3 \mu\text{g}/\text{m}^3$ with a household air pollution exposure of $0.413 \mu\text{g}/\text{m}^3$ in 2019 (Health Effects Institute (HEI) 2020). In both cases, the concentration of air pollution poses a threat to pregnant women, young children, and Caribbean economies. If sources of pollution are left unchecked, this can lead to not only public health crises in terms of a surge in the maternal problems mentioned earlier and respiratory illnesses,

but it can put a significant strain on all sectors. Financial resources would be diverted away from health, education, and infrastructure to the environmental sector to treat the problems of air pollution.

3.3. Droughts

In the Caribbean, with a defined wet and dry season, droughts can be caused by a failed rainy season with a dwindling of freshwater resources. Climate change events such as droughts tend to significantly impact pregnant women's health because the threat of famine implies that the risk of hunger and malnutrition is great.

In the Asia-Pacific and Caribbean regions, such a threat impacts not only the dietary needs of women but also their overall health and sanitary needs because droughts often cause the price of food, water, and basic amenities to increase at an alarming rate (Algur et al. 2021). As a result, during periods of drought, inadequate access to water is further complicated by poor sanitation, which in turn, can contaminate water sources, leading to a recurrence of childhood respiratory, fever, and gastroenterological illnesses in pregnant women and children (Singh et al. 2006).

The lack of a frequent, accessible, and clean supply of water poses a great risk to the foetus, as pregnant women from low-income households may not have easy access to bathroom facilities (i.e., toilet, shower, bathtub, or sink for washing) with running water, as well as clean cooking facilities (Patel et al. 2019). As a result, economically poor pregnant women may experience adverse pregnancy outcomes under drought conditions, increasing the maternal mortality ratio of women in the Caribbean. As economic resources become constrained in developing countries and regions like the Caribbean, it is also possible that fewer pregnant women may access antenatal care, and more will become malnourished. This malnourishment leads to medical conditions such as anaemia, premature birth, obstructed labour, postpartum haemorrhages, and underdeveloped organs (Parrotte 2015).

3.4. Flooding

At the other extreme of weather conditions, like drought, are the temperature changes, which create excess rainfall and a high probability of flooding. In the Caribbean, flooding has become an annual problem because the number of intense rainfall occurrences has increased due to climate change events such as extreme temperatures and meteorological events such as hurricanes and tropical storms (Fontes de Meira and Phillips 2019). These events, as expected, can cause significant socioeconomic disruption to the lives of many, as some households may be ill-prepared to deal with such events due to the rising cost of resources such as personal protective equipment.

From the perspective of maternal and child health, during these events, pregnant women, small children, and several other vulnerable groups like the elderly are likely to become victims of flooding, landslides, and high winds accompanying extreme rainfall (Bartlett 2008). In the Caribbean and other low-income developing countries

like Nepal where most citizens from low-income households have an uncertain and sometimes precarious source of income, the probability of experiencing adverse outcomes such as the loss of life is shockingly high for women and young children, especially girls, during flood events. For example, in Nepal, preschool girls are five times more likely to die from a flood-related death (Pradhan et al. 2007).

Oddly enough, during heavy periods of rainfall, the flooding of outdoor toilets can also increase the spread of water-borne diseases such as cholera and enteric viruses. With little access to piped water and rotavirus vaccines, these viruses can also impact the mortality of babies and young children in the Caribbean (Delahoy et al. 2021). As the risk of such water-borne diseases rises, this can become a burden to pregnant women living in low-income households as they may not have sufficient funds to access healthcare as needed. In this instance, public health facilities will need to be outfitted with the necessary resources and made available to pregnant women who may not be able to access private healthcare.

3.5. Structural Racism

Apart from the climate change events highlighted above, it has also been noted in the literature that pregnant women who are women of colour and those living in overpopulated rural and urban or less affluent communities are more vulnerable to climate change events. This is primarily the case because members of these communities in the Caribbean may experience discrimination during the distribution of resources needed to mitigate the effects climate change events. Thus, it forces many persons, including pregnant women, living in low-income households with less access to heat reducing resources such as air-conditioning, indoor fans, and proper housing infrastructure to address extreme temperatures.

Further to this, the problems experienced by pregnant women, people of colour, and impoverished communities may not be included in the discussion of climate change concerning climate justice, social and environmental justice for women of colour, social and economic equality, gender equality, and the inequitable distribution of resources to mitigate the effects of such events in the Caribbean. These issues contribute to the higher rates of pre-term labour in women of colour, and as a result, they are more likely to be hospitalised during their pregnancy.

Furthermore, apart from pregnant women, women of colour, and impoverished communities, structural racism and discrimination often exacerbate these community members' trauma and mental health needs in response to climate change events such as flooding and heat risks. They are frequently neglected by healthcare providers and governmental institutions responsible for dealing with these problems within these communities (Gutschow et al. 2021).

3.6. Eco-Anxiety and Climate Anxiety in Children

Exposure to such vector-borne and infectious diseases and climate change events often has more far-reaching effects than just the physical health of pregnant women

and children in the Caribbean. One of the most under-studied areas in which climate change events have impacted maternal and child health is that which deals with their mental health.

Climate change is likely to have a significant impact on the psychological health of children in that they may develop anxiety, phobias, PTSD, and attachment disorders, which leads to abnormal development in their emotional responses, cognition, and language skills (Burke et al. 2018). Consequently, as these children become young adults, they will continue to show signs of mental health distress in response to climate change events in complex ways, such as eco-anxiety and climate anxiety (Gislason et al. 2021).

In countries like India and the Philippines, the continued exposure to extreme weather events such as cyclonic storms, monsoons, and typhoons, have led to significant behavioural changes in children and young adults. Feelings of extreme worry, powerlessness, helplessness, anxiousness, guilt, and betrayal can ensue due to their perceptions/beliefs that their respective government's policy response to climate change is inadequate (Hickman et al. 2021). Young children in the Caribbean from low-income households who exhibit signs of eco-anxiety and climate anxiety may not have access to the resources needed to help them cope with these problems. This anxiety can be due to the high cost of mental health resources and the stigma attached to conditions such as anxiety. In this case, the relevant authorities must help parents and children through free counselling and therapy at health institutions to ensure that the children experiencing anxiety have a safe space to speak and treat their concerns.

4. Conclusions

Climate change and the social and economic challenges to maternal and children's health have been discussed. One aspect almost always impacts the other. Socially, pregnant women and children are affected by extreme heat events, increasing frequency of climate-related disasters including hurricanes and flooding, food insecurity, and risks of waterborne diseases. These stated aspects impact and exacerbate gender inequality in vulnerable groups, especially in developing countries. Climate change and the occurrence of hurricanes, flooding and storm surges create havoc on SIDS, rendering destruction to infrastructure and disrupting water supplies, transportation, and electricity. Consequently, financial burdens are incurred by the government. The economic fallout can cause limited access to necessary resources and services for pregnant women and children. Governments must put the needs of this population high on their agenda to ensure that better living conditions are available.

Notwithstanding the importance of the discussion on maternal and child health in the Caribbean in terms of climate change, it must be noted that there are several specific challenges faced in collecting health data in the Caribbean, which, if available, would have added a greater depth to the argument put forward in this

manuscript. In particular, the inability of health and data collection institutions in the Caribbean to collect health data is often the result of such institutions lacking the basic infrastructure to collect such data, which ranges from limited physical and human resources to underdeveloped institutional frameworks to guide its collection. The inability to put effective structures in place often results in the inaccurate collection of health data, which in the Caribbean, can be either incorrect or faulty. The use of such faulty data can lead to a poor representation of national health statistics. Further to this, apart from data collection issues, there is also limited access to public health data from institutions for researchers in the Caribbean due to a lack of funding, high costs, and privacy concerns. As a result of this, there is very little empirical and applied research being undertaken in the Caribbean concerning maternal and child health. To address this issue, first there should be data collection measures in place to capture the impact that climatic events are likely to have on women and children in the Caribbean through ministerial bodies in the areas of health, education, and housing. Second, there should be greater inclusion of the views of women and children in regard to the design of climate change mitigation measures at the household, community, and institutional level. Finally, there should be greater institutional investment in terms of the provisions of grants and funding for researchers to conduct research in this specific area of study.

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