International Journal of Social Sciences Bulletin
Volume 2, Issue 4, 2024 ISSN: (E) 3007-1917 (P) 3007-1909

MULTIPLE EFFECTS OF CLIMATE CHANGE ON HUMAN HEALTH IN SINDH

Saeeda Anjum Buriro[*1], Amjad Ali Abro[2] and Dr. Ahsan Abbas Abro[3]

*[*1]PhD, Department of Zoology, University of Sindh, Jamshoro.*
[2]Department of International Relations, University of Karachi, Sindh, Pakistan
[3]Dpt. Institute of Biotechnology and Genetic Engineering University of Sindh Jamshoro.

Corresponding Author: *

Received	Revised	Accepted	Published
30 August, 2024	30 September, 2024	19 October, 2024	05 November, 2024

ABSTRACT

Climate change has emerged as a significant threat to human health globally, with its impacts being particularly pronounced in vulnerable regions like Sindh, Pakistan. This study explores the multifaceted effects of climate change on public health in Sindh, focusing on extreme weather events, temperature fluctuations, water scarcity, and vector-borne diseases. Rising temperatures are contributing to an increase in heat-related illnesses, such as heatstroke, while erratic rainfall patterns and droughts are exacerbating water shortages, leading to poor sanitation and the spread of waterborne diseases like cholera and diarrhea. Furthermore, changes in the climate are altering the distribution of vectors, notably mosquitoes, increasing the incidence of diseases such as malaria and dengue. The study also highlights the disproportionate impact on vulnerable populations, including children, the elderly, and rural communities, who face heightened risks due to limited access to healthcare and adaptive resources. The practical outcomes of these practices are evaluated through a qualitative approach that incorporates semi structured interviews from N=10 which have extensive knowledge from the region of Tharparkar, Hyderabad and Karachi who are aged between 25to 40 years. Through a comprehensive analysis of health data, climate patterns, and field surveys, this research aims to underscore the urgent need for effective public health interventions and climate adaptation strategies to mitigate the growing health crisis in Sindh. The findings emphasize that addressing climate change is not only an environmental challenge but also a critical public health priority.

Keywords: *Climate Change, Health Issues, Infectious Diseases, Temperature Fluctuations*

INTRODUCTION

Climate change is increasingly recognized as one of the most significant global challenges of the 21st century, with wide-ranging effects not only on ecosystems and economies but also on human health (Buriro, Abro & Abro, 2024). The impacts of climate change are particularly severe in developing regions, where vulnerabilities are compounded by limited healthcare infrastructure, socioeconomic challenges, and environmental stressors (Noureen et al., 2022). Sindh, Pakistan's second-largest province, is highly susceptible to climate change due to its diverse geography, including coastal areas, arid zones, and densely populated urban centers (Buriro, Chandio & Memon, 2024). The region faces a growing array of climate-related health challenges, from rising temperatures and altered precipitation patterns to the increasing frequency of extreme weather events such as floods, droughts, and heatwaves (Lookadoo & Bell, 2020).

Human health in Sindh is being affected in multiple ways by these changes (Iqbal, 2020). Extreme heat has led to an increase in heat-related illnesses,

particularly in urban centers like Karachi, which has experienced a series of deadly heat waves (Buriro, Abro & Abro, 2024). Meanwhile, changing rainfall patterns have exacerbated water scarcity, leading to poor sanitation and increased vulnerability to waterborne diseases (Ahmed et al., 2024). The altered distribution of disease vectors, such as mosquitoes, has contributed to the growing prevalence of vector-borne diseases like malaria and dengue fever in the region (Manikandan et al, 2023). The health effects are further compounded by socio-economic factors, with rural and marginalized populations facing the greatest risks due to their limited access to healthcare and adaptive resources (Buriro et al., 2023).

The health impacts of climate change are well-documented globally, there is a critical need to understand and address these impacts at the regional level in Sindh (Wynn et al.,2021). This research seeks to provide a comprehensive analysis of the multiple effects of climate change on human health in Sindh, identifying key health risks and highlighting vulnerable populations (Sankar et al., 2024). By examining the intersection of climate change and public health in this context, the study aims to underscore the urgency of developing adaptive strategies and interventions tailored to the specific needs of the region (Wiley, 2022). This research contributes to the broader understanding of climate change as a public health crisis, emphasizing the need for proactive policies to protect the health and well-being of communities in Sindh (Rauf & Zaidi, 2024).

Statement of the Problem

Sindh is facing an escalating public health crisis driven by the multiple effects of climate change, including rising temperatures, erratic rainfall, and frequent extreme weather events. These environmental changes are contributing to an increase in heat-related illnesses, water scarcity, and the spread of waterborne and vector-borne diseases, such as malaria and dengue. Vulnerable populations, particularly in rural areas with limited access to healthcare and clean water, are disproportionately affected. Despite the severity of the issue, there is a lack of localized research that explores the specific health impacts of climate change in Sindh, hindering the development of targeted interventions and adaptive strategies. This research seeks to address this gap by investigating the complex relationship between climate change and human health in the region, providing critical insights for policymakers and public health officials.

Research Questions

1. How have rising temperatures and heat waves in Sindh impacted the prevalence of heat-related illnesses, particularly in urban centers like Karachi and Hyderabad?
2. What is the relationship between changing rainfall patterns, water scarcity, and the spread of waterborne diseases in rural areas of Sindh, such as Tharparkar?
1. How has climate change influenced the spread of vector-borne diseases, such as malaria and dengue, in Sindh, and what are the socio-economic factors exacerbating these health risks?

Literature Review

Climate change is increasingly recognized as a significant public health threat globally, with numerous studies highlighting its impact on human health (Buriro, Abro & Abro, 2024). According to the World Health Organization (2023), climate change is expected to cause approximately 250,000 additional deaths per year between 2030 and 2050, primarily due to heat stress, malnutrition, and the spread of vector-borne diseases such as malaria and dengue. Researchers like (Haines et al., 2006) emphasize that the health effects of climate change are disproportionately felt in low- and middle-income countries, where healthcare systems are often poorly equipped to handle the additional burden. Sindh, a region already grappling with socio-economic challenges, is no exception, as extreme weather events such as heatwaves, floods, and droughts increasingly impact its population's health (Buriro et al., 2023).

Several studies have identified rising temperatures as a significant driver of heat-related illnesses in regions vulnerable to climate change (Margolis, 2021). Research conducted in Pakistan, particularly in urban centers like Karachi, indicates that the frequency and intensity of heat waves have surged in recent years (Arshad et al., 2020). The 2015 heatwave in Karachi, which claimed more than 1,200 lives, highlighted the immediate and deadly

effects of rising temperatures on public health, especially in densely populated urban areas (Anwar et al., 2022). Additionally, areas like Tharparkar face high risks due to water scarcity and extreme heat, leading to increased mortality rates, particularly among children and the elderly (Adnan et al., 2024). These studies emphasize that climate change exacerbates existing health vulnerabilities, particularly in impoverished regions of Sindh.

Water scarcity, worsened by erratic rainfall patterns and prolonged droughts, is another major health concern linked to climate change (Buriro et al., 2024). Sindh's rural communities, particularly in regions like Thar Desert, are facing a growing water crisis that directly impacts sanitation and access to clean drinking water (Rana et al., 2024). As a result, waterborne diseases such as cholera, diarrhea, and dysentery are on the rise, disproportionately affecting children and pregnant women (Nichols, Lake & Heaviside, 2018). In addition to waterborne illnesses, inadequate sanitation infrastructure exacerbates the spread of infectious diseases, placing further strain on already overburdened healthcare systems in rural Sindh. This research highlights the urgent need for improved water management and sanitation practices to mitigate these public health challenges.

The spread of vector-borne diseases in Sindh has also been linked to climate change, particularly in urban areas where changing rainfall patterns have created ideal breeding grounds for mosquitoes (Rahmat et al., 2023). Climate change is a key factor in the increasing prevalence of diseases like malaria and dengue in Pakistan (Jabeen et al., 2022). Karachi has experienced a significant rise in dengue cases in recent years due to altered climate conditions, stagnant water accumulation, and inadequate public health infrastructure (Bostan et al. 2017). These findings underscore the complex relationship between climate change and public health, emphasizing that effective adaptation strategies must address both environmental and socio-economic factors to reduce the health impacts of climate change in Sindh.

Method and Procedure

This study employed a qualitative research approach to explore the health impacts of climate change on communities in Sindh, Pakistan, particularly focusing on the regions of Tharparkar, Hyderabad, and Karachi. These areas represent a range of urban and rural environments with varying levels of climate exposure and healthcare infrastructure, providing a comprehensive view of the region's vulnerability to climate-induced health risks. The study specifically targeted the effects of rising temperatures, water scarcity, erratic rainfall, and vector-borne diseases on public health outcomes.

Data was collected through a combination of semi structured interviews, health data analysis, and climate pattern reviews. A total of 10 participants, aged between 25 and 40, were selected based on their extensive knowledge and experience in health or climate-related fields. Participants included public health professionals, residents, healthcare workers, and environmental specialists from Tharparkar, Hyderabad, and Karachi. The semistructured interviews focused on their observations and experiences with health impacts related to extreme weather events, temperature fluctuations, water scarcity, and disease distribution changes. Interviews were conducted either in person or via phone calls to accommodate geographic and logistical limitations.

To contextualize participant responses and validate reported health impacts, climate data was obtained from regional meteorological departments, providing records on temperature fluctuations, rainfall variability, and drought frequency in Sindh over the past decade. Health data was sourced from local hospitals, clinics, and public health records to examine the prevalence and trends of heat-related illnesses, waterborne diseases, and vector-borne diseases such as malaria and dengue. These datasets enabled a cross-comparison with interview responses, facilitating a deeper understanding of the specific health outcomes attributed to climate change.

Data from interviews were transcribed and analyzed using thematic analysis to identify recurring themes and patterns in participants' experiences and observations. Coding was done manually, with a focus on categorizing the reported effects of climate factors on health, the vulnerability of specific population groups, and potential interventions. Climate and health records were statistically reviewed to assess trends, and correlations were

drawn between climate patterns and observed health issues to support qualitative findings.

Results

Keeping in view of the nature of the study, semi-structured interviews were conducted with the participants for the study. The results of the study show interesting findings and are important for the study.

Rising Temperatures and Recurrent Heat Waves in Sindh

Rising temperatures and recurrent heat waves in Sindh have significantly escalated the prevalence of heat-related illnesses, especially in densely populated urban areas like Karachi and Hyderabad. As average temperatures in these cities continue to climb, cases of heatstroke, dehydration, and other heat-induced health issues have become increasingly common, straining the capacity of local healthcare systems. For instance, during Karachi's severe heatwave in 2015, over 1,200 fatalities were recorded, highlighting the life-threatening risks associated with extreme heat events. Vulnerable populations, including the elderly, outdoor laborers, and children, are particularly affected, as they often lack adequate shelter or cooling resources to mitigate heat exposure. The urban infrastructure, coupled with high population density and limited green spaces, exacerbates heat retention in these areas, intensifying the impact of each heat wave. Public health experts emphasize the urgent need for adaptive measures, such as improved urban planning, public awareness campaigns, and healthcare preparedness, to address the growing threat of heat-related illnesses in Sindh's urban centers.

Q1: How have rising temperatures and heatwaves in Sindh impacted the prevalence of heat-related illnesses, particularly in urban centers like Karachi and Hyderabad?

Interview 1: R1 (General Practitioner, Karachi)

Interviewer: Could you describe how the rising temperatures and heatwaves in Karachi have affected public health?

R1: The effects are severe, especially during peak summer months. In the last few years, we've seen a sharp increase in patients suffering from heat exhaustion, dehydration, and even heatstroke. During the 2015 heatwave, hospitals were overwhelmed. We also notice that the elderly and children are the most vulnerable. Unfortunately, many people don't take adequate precautions, which worsens their condition.

Interviewer: Have you noticed a long-term trend in heat-related illnesses?

R1: Yes, over the last decade, the number of heat-related illnesses has increased. It's not just during extreme heatwaves; even on regular hot days, patients suffer from heat stress, and our healthcare system struggles to keep up.

Interview 2: R2 (Resident, Hyderabad)

Interviewer: R2, as a resident of Hyderabad, how have you and your community been affected by the rising temperatures?

R2: It's been getting worse every year. Last summer, my uncle fainted because of the heat, and we had to rush him to the hospital. The power cuts make it harder to cool down, and the hospitals are always full during heatwaves. We've started staying indoors more, but not everyone can afford air conditioners or even fans for relief.

Interviewer: Do you think the community is aware of how to prevent heat-related illnesses?

R2: Some people are aware, but many still don't know how dangerous heat can be. There should be more public awareness campaigns, especially in poorer areas where people can't afford cooling devices.

Interview 3: R3 (Public Health Expert, Karachi)

Interviewer: From a public health perspective, how have heatwaves affected Karachi?

R3: The impact has been substantial. Heatwaves have led to a surge in emergency cases related to heatstroke and heat exhaustion. Hospitals are often unprepared for the sheer volume of patients during heatwaves. There's also an increase in deaths, particularly among vulnerable groups, such as the elderly, outdoor laborers, and those with pre-existing conditions like heart disease. Climate change is amplifying these heat waves, and Karachi's dense population makes it a hotspot for heat-related illnesses.

Interviewer: What steps do you think should be taken to mitigate these effects?

R3: We need to improve public health messaging about the dangers of heat. The government must also invest in urban cooling strategies, such as planting more trees and creating public cooling centers. It's crucial to educate people on staying hydrated and avoiding outdoor activities during extreme heat.

Interview 4: R4 (Housewife, Hyderabad)

Interviewer: R4, how has your household been affected by the rising temperatures in Hyderabad?

R4: The heat has become unbearable. Every summer, someone in the family gets sick from dehydration or heat exhaustion. Last year, my youngest son had to be hospitalized because of heatstroke. We try to stay indoors during the hottest part of the day, but it's difficult without a proper cooling system.

Interviewer: Do you feel that heat-related illnesses have increased in recent years?

R4: Yes. The heat feels more intense, and even young people are getting sick. Before, only the elderly would complain about the heat, but now everyone is struggling. We need better support from the government to handle these extreme conditions.

Interview 5: R5 (Outdoor Laborer, Karachi)

Interviewer: As someone who works outdoors, how have you been impacted by the rising temperatures?

R5: It's very hard to work in this heat. We have to stop several times a day to drink water and rest. Some of my coworkers have fainted, and one of them was taken to the hospital because of heatstroke. We are used to working in the sun, but now it feels like we are always at risk during the summer.

Interviewer: Have you received any information or guidance on how to protect yourself from heat-related illnesses?

R5: Not really. We just know from experience to drink more water and take breaks. But when you have a family to feed, it's hard to stop working, even if it's dangerous. More education about how to deal with this heat would be helpful, but at the end of the day, we don't have a choice but to work.

Changing Rainfall patterns and Escalating Water Scarcity

Changing rainfall patterns and escalating water scarcity in Sindh are critically impacting public health, especially in rural areas such as Tharparkar, where inconsistent rainfall and frequent droughts strain already limited water resources. Erratic precipitation leads to prolonged dry spells, reducing groundwater recharge and forcing communities to rely on contaminated or distant sources for daily water needs. This scarcity of clean water significantly raises the incidence of waterborne diseases like cholera, diarrhea, and dysentery, disproportionately affecting children and vulnerable populations. Moreover, heavy rainfall events, though infrequent, often cause flash flooding, further contaminating water supplies and exacerbating health risks. Limited access to sanitation and healthcare infrastructure in these areas intensifies the problem, as facilities are often ill-equipped to handle disease outbreaks stemming from water scarcity and poor hygiene. The urgent need for sustainable water management practices, including rainwater harvesting and improved sanitation facilities, is crucial to mitigate the long-term health impacts of climate-induced water scarcity and changing rainfall patterns in Sindh.

Q.2: What is the relationship between changing rainfall patterns, water scarcity, and the spread of waterborne diseases in rural areas of Sindh, such as Tharparkar?

Interview 1: R6 (Public Health Specialist, Tharparkar)

Interviewer: Can you explain the connection between changing rainfall patterns and the spread of waterborne diseases in Tharparkar?

R6: The changing rainfall patterns have drastically affected water availability in Tharparkar. Prolonged droughts have resulted in severe water scarcity, forcing communities to rely on contaminated sources for drinking water. This has led to a noticeable rise in waterborne diseases like diarrhea, cholera, and dysentery, particularly among children. When the rains do come, they are often heavy and cause flash floods, which further contaminate water sources and lead to outbreaks of disease.

Interviewer: How have healthcare services in the region responded to this situation?

R6: Unfortunately, the healthcare infrastructure here is not equipped to handle the rising cases of waterborne diseases. There are limited resources, and during outbreaks, clinics become overwhelmed. The government and NGOs need to invest more in

both healthcare and clean water solutions for these communities.

Interview: R7 (Resident, Rural Tharparkar)
Interviewer: How has water scarcity affected your community's health in Tharparkar?
R7: Water is very hard to find here. We have to walk long distances to collect it, and the water we get is often not clean. Because of this, many people, especially children, fall sick. My youngest daughter had severe diarrhea last year, and it was difficult to get her the proper treatment. Every year it gets worse as the rains become more unpredictable.
Interviewer: Do you feel that the lack of clean water directly leads to more illnesses?
R7: Yes. When we have no choice but to drink dirty water, it's no surprise that people get sick. If we had clean water, we wouldn't see so many people falling ill. It's a constant worry for all of us.

Interview: R8 (Local Government Official, Tharparkar)
Interviewer: From a governmental perspective, how have changing rainfall patterns affected water access and public health in rural Tharparkar?
R8: The irregular rainfall is a major challenge. When rains are delayed or insufficient, we see a sharp decline in water supply, forcing people to use contaminated water sources. This leads to the spread of waterborne diseases, especially in remote villages where there are no proper water filtration systems. We've initiated some water trucking projects during droughts, but these are temporary solutions. We need sustainable infrastructure, such as rainwater harvesting systems and better sanitation, to combat this growing health crisis.
Interviewer: What are the long-term solutions being considered?
R8: We are working on long-term solutions, including building small dams and improving the water distribution network, but progress is slow due to limited funds. More focus on education about hygiene and the use of safe water is also essential to reduce the spread of diseases.

Interview: R9 (NGO Worker, Sindh Rural Support Program)
Interviewer: How have you seen changing rainfall patterns and water scarcity contribute to the spread of diseases in rural Sindh, particularly Tharparkar?
R9: The irregularity in rainfall has severely impacted water availability, pushing people to use unsafe sources such as ponds or shallow wells. These are often contaminated, leading to outbreaks of diseases like cholera and gastroenteritis. Children are the most affected, and it's heartbreaking to see families struggling to find both clean water and medical care. Our organization is working on providing water filters and raising awareness about boiling water before use, but it's not a comprehensive solution.
Interviewer: What kind of awareness programs are in place?
R9: We conduct community workshops to educate people about waterborne diseases, hygiene practices, and safe water handling. However, without reliable water sources, it's difficult to fully eliminate the problem. The communities need better infrastructure, not just education.

Interview 5: (Farmer, Rural Tharparkar)
Interviewer: R10 as a farmer, how have changing rainfall patterns and water scarcity affected your life and the health of people in your village?
R10: It's become very difficult for us. The rains are unpredictable, so the crops don't grow as they used to, and we don't have enough water for drinking or farming. We use water from wherever we can find it, but it's often dirty. Many people get sick with stomach problems, and the children suffer the most. Last year, we had an outbreak of cholera in our village, and some people even died.

Interviewer: How do you cope with this situation?
R10: We do what we can—sometimes we collect rainwater and other times we dig deeper wells, but it's not enough. We need help from the government or NGOs to get clean water. Until that happens, these diseases will keep coming back.

Climate Change Influence the Spread of Vector-Borne Diseases
Climate change is profoundly influencing the spread of vector-borne diseases in Sindh, with rising

temperatures, increased humidity, and irregular rainfall creating favorable conditions for mosquito breeding and disease transmission. The warming climate extends mosquito lifespans and breeding seasons, allowing vectors like Aedes aegypti, responsible for dengue, and Anopheles mosquitoes, which carry malaria, to thrive in areas previously less affected by these diseases. In both urban and rural areas, stagnant water from erratic rainfall provides ideal mosquito breeding sites, intensifying the incidence and geographical reach of diseases such as dengue and malaria. Socioeconomic factors compound this issue, as densely populated, lower-income communities often lack adequate drainage and waste management systems, increasing residents' exposure to infected mosquitoes. The frequency of disease outbreaks underscores the urgent need for improved public health interventions, such as vector control measures, enhanced sanitation, and community education, to manage the health impacts of climate-driven changes in vector dynamics.

How has climate change influenced the spread of vector-borne diseases, such as malaria and dengue, in Sindh, and what are the socio-economic factors exacerbating these health risks?

Interview 1: R11 (Epidemiologist, Karachi)

Interviewer: How has climate change contributed to the spread of vector-borne diseases like malaria and dengue in Sindh?

R11: Climate change has significantly altered the dynamics of vector-borne diseases in Sindh. Rising temperatures and increased humidity create favorable breeding conditions for mosquitoes, especially the Aedes aegypti mosquito that transmits dengue. The frequency of dengue outbreaks has increased over the past decade. Additionally, unpredictable rainfall patterns result in water accumulation, providing stagnant water for mosquito breeding. This has contributed to both the spread and persistence of diseases like dengue and malaria, particularly in urban areas like Karachi.

Interview 2: R12 (Community Health Worker, Rural Sindh)

Interviewer: what changes have you observed regarding the spread of malaria in rural Sindh, and do you think climate change is a factor?

R12: Absolutely, climate change is a major factor. In recent years, we've seen more cases of malaria during months that previously had lower infection rates. The winters are warmer now, and mosquitoes are surviving longer, which means that malaria is no longer just a seasonal problem—it's affecting people for a larger part of the year. The rains have become erratic, so water pools remain stagnant for longer, giving mosquitoes more places to breed.

Interviewer: How have you and your community been affected by diseases like dengue in recent years?

R12: Dengue has become a serious issue in our area. Every year, more people get sick, and it's spreading faster. The last time it rained heavily, water got collected everywhere, and within a few days, many people in the neighborhood fell ill. My cousin was hospitalized with dengue last year, and the treatment was expensive. The worst part is that we can't do much to stop it—our streets are always flooded, and there's no proper garbage disposal, which just attracts more mosquitoes.

Interview 4: (Infectious Disease Specialist, Hyderabad)

R4 Interviewer: How has climate change influenced the transmission of vector-borne diseases in Sindh, particularly in Hyderabad?

Climate change has directly impacted the transmission of diseases like malaria and dengue by increasing mosquito breeding seasons. The warmer climate has expanded the geographic range of mosquito populations, allowing them to thrive in areas that were previously less affected. In Hyderabad, we are seeing a higher number of dengue cases, even in months where transmission was traditionally low. Heavy rains followed by prolonged warm periods create the perfect breeding conditions for mosquitoes, increasing the chances of infection.

Interview 5: (Municipal Worker, Karachi)

Interviewer: What challenges do you face in managing the spread of vector-borne diseases like dengue in Karachi?

R13: The biggest challenge we face is the drainage and sanitation system, especially in low-income areas. When it rains, the water accumulates because the drains are either blocked or inadequate to handle the volume. This standing water becomes a breeding ground for mosquitoes, and no matter how much we

try to clean it up, it keeps happening because of poor infrastructure. The heat also makes the situation worse because the mosquitoes multiply faster in warm weather.

Socio-Economic Factors Significantly Exacerbate Health Risks

Socio-economic factors significantly exacerbate health risks associated with climate change in Sindh, such as poverty, inadequate infrastructure, and limited access to healthcare leave many communities vulnerable to climate-induced illnesses. In densely populated urban areas, lack of proper waste management and drainage contributes to stagnant water, a breeding ground for disease-carrying mosquitoes, fueling the spread of vector-borne diseases like dengue and malaria. Meanwhile, in rural areas, water scarcity forces residents to use contaminated sources, heightening exposure to waterborne diseases such as cholera and diarrhea. Limited financial resources restrict access to essential preventive measures, such as cooling devices during extreme heat and safe drinking water sources in drought conditions. Additionally, low-income families often reside in poorly ventilated housing with limited access to medical care, making them disproportionately affected by climate-related health risks. These socio-economic challenges underscore the importance of targeted interventions, including improved infrastructure, healthcare access, and public awareness campaigns, to reduce the health disparities intensified by climate change.

Interviewer: What socio-economic factors exacerbate these health risks?

R14: Socioeconomic factors play a huge role. Poor sanitation in densely populated, low-income areas, combined with inadequate healthcare access, worsens the situation. Many residents lack awareness or resources to take preventive measures, such as using insect repellents or ensuring proper drainage. Furthermore, poor living conditions in slums increase exposure to mosquito bites, and the healthcare facilities are often overcrowded and under-resourced to handle the growing number of cases.

Interviewer: How do socio-economic conditions affect the spread of these diseases in your community?

R13: Many families here live in poverty, and they don't have the means to protect themselves from mosquitoes. They can't afford mosquito nets or proper drainage systems, so water accumulates around their homes. Health services are limited, and people sometimes don't go to the clinic until their condition is severe because they can't afford the treatment or transport. These conditions make it easy for diseases like malaria to spread rapidly.

Interview 3: (Resident, Urban Slum Area, Karachi)

Interviewer: Do you think climate change is making the situation worse?

R14: Yes, it feels like the weather is more unpredictable now. There are longer periods of heat, followed by sudden heavy rains. The heat makes the mosquitoes more active, and the water doesn't drain properly. We also don't have good healthcare facilities nearby, so it's hard to get treatment quickly when someone gets sick.

Interviewer: What role do socio-economic factors play in exacerbating these health issues?

R15: Low-income areas are disproportionately affected because of poor living conditions. These areas lack proper waste management and drainage systems, which leads to water stagnation and higher mosquito breeding. People in these communities often don't have access to preventive measures, like insecticide-treated nets or insect repellents. Additionally, public health campaigns don't always reach these areas, leaving many people unaware of how to protect themselves from these diseases. Limited healthcare access also means that people delay seeking treatment, which increases the severity of cases.

Interviewer: How do socio-economic conditions in these areas contribute to the problem?

R15: In poor neighborhoods, people don't have access to proper housing or sanitation. There's garbage everywhere, and it clogs the drains, which adds to the problem. People also can't afford mosquito repellents or proper healthcare, so once someone gets sick, the disease spreads quickly. The government needs to invest more in improving sanitation and providing health services in these areas to control the spread of these diseases.

Discussion

The severe and multifaceted health impacts of climate change on the region, revealing the pressing vulnerabilities in public health infrastructure. Rising temperatures and recurring heatwaves have led to increased cases of heat-related illnesses in urban centers like Karachi and Hyderabad. In Karachi, the 2015 heatwave was particularly catastrophic, resulting in over 1,200 deaths, largely due to heatstroke and dehydration, and continues to be a growing health threat. Both healthcare professionals and residents observe that hospitals are often overwhelmed during heat peaks, with a significant lack of resources to cope with the demand for emergency services. Many individuals, especially the elderly, children, and outdoor laborers, remain highly vulnerable to these escalating heat conditions, underscoring the urgent need for enhanced urban cooling infrastructure and public awareness.

In rural areas like Tharparkar, erratic rainfall and drought conditions have worsened water scarcity, leading to a troubling rise in waterborne diseases such as diarrhea, cholera, and dysentery. Due to the scarcity of clean water, communities are frequently forced to use contaminated sources, exacerbating health risks, particularly for children. Interviews with health experts and residents reveal that access to adequate medical care remains limited, and facilities are often unprepared for disease outbreaks. Government and NGOs have attempted temporary measures like water trucking, but such solutions fall short of addressing the chronic water and health infrastructure deficiencies. Sustainable water management practices, including rainwater harvesting and better sanitation, are essential to mitigate the long-term health risks posed by climate-induced water scarcity.

Moreover, climate change has fueled the spread of vector-borne diseases such as malaria and dengue across both urban and rural Sindh. Warmer temperatures and increased humidity, along with stagnant water from irregular rainfall, provide optimal conditions for mosquito breeding. Socio-economic factors, such as inadequate sanitation, limited healthcare, and high population density in impoverished areas, further worsen disease spread. In many urban slums, residents face high exposure to mosquito-borne diseases with little access to preventive resources or health services. Experts emphasize the need for comprehensive public health strategies, including improved waste management, better drainage systems, and accessible healthcare facilities, particularly in under-resourced communities. The findings underline that without substantial infrastructural and educational investments, climate change will continue to amplify health risks across Sindh.

Conclusion

The impacts of climate change on human health in Sindh are both profound and multifaceted, revealing critical gaps in public health resilience across urban and rural communities. Rising temperatures and frequent heatwaves pose severe health threats in densely populated cities like Karachi and Hyderabad, where vulnerable groups lack adequate support to manage heat-related illnesses. In rural regions like Tharparkar, erratic rainfall and drought conditions drive water scarcity, resulting in a surge of waterborne diseases and limited access to clean water and healthcare. The spread of vector-borne diseases, exacerbated by warmer temperatures and stagnant water, further highlights the urgent need for public health interventions.

To address these challenges, the study underscores the importance of adaptive infrastructure and effective public health strategies. Immediate actions, such as improved urban cooling, waste management, and reliable water systems, are essential to prevent disease outbreaks and mitigate climate-related health risks. Moreover, public awareness campaigns and community education programs are critical to equipping individuals with the knowledge to protect themselves against rising temperatures and unsafe water conditions.

Ultimately, the study calls for collaborative efforts from government bodies, healthcare providers, and NGOs to build a resilient public health system capable of withstanding the ongoing and future effects of climate change. Without sustained investments in infrastructure, healthcare, and education, Sindh's communities will remain vulnerable to the growing health impacts associated with climate instability.

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