https://doi.org/10.62585/sigh.v1i2.86

Volume and Issues Obtainable at Centeriir.org
Journal of Social Informatics and Global Health
ISSN (Print): 3006-9424 ISSN (Online): 3006-9432

Volume 2, No.1, 2023
Journal Homepage: https://journals.centeriir.org/index.php/sigh

Exploring Diarrheal Disease Trends in Gaza Under Global Warming

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ABSTRACT

By studying various latest reports of academics and climate monitoring institutions, the investigation assesses the influence of climatic factors on the prevalence of acute diarrheal diseases in the Gaza Strip, a region characterized by high vulnerability due to socio-economic, environmental, and political challenges. The research examines the correlation between climatic variables and the incidence of diarrheal illnesses, revealing a significant relationship between increased temperatures, altered precipitation patterns, and higher disease rates. Additionally, the paper conducts a health impact assessment to predict future disease burdens under varying climate change scenarios, emphasizing the urgency of adhering to stringent global warming limits. The findings underscore the critical need for enhanced climate action as part of public health strategy in Gaza, highlighting that achieving the 1.5°C goal of the Paris Agreement could mitigate significant health risks in this and similar communities.

Article History: Received: September 02, 2023: **Accepted**: October 02, 2023: **Published**: October 05, 2023
Keywords: disease, health, diarrheal, gaza

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https://doi.org/10.62585/sigh.v1i2.86

1. Introduction

Climate change's impact on human health is increasingly recognized, especially in low- and middle-income countries which often lack the economic resilience to adapt to these changes. The Middle East, characterized by its extreme heat and severe water scarcity, is projected to experience temperature increases surpassing the global average (Zitti et al., 2022). Among the regions affected, the Gaza Strip in the Occupied Palestinian Territories is particularly vulnerable. Classified by the Organization for Economic Co-operation and Development as a high-risk area, Gaza faces a confluence of challenges including poverty, inadequate infrastructure, high population density, and complex political conditions.

These vulnerabilities are compounded by the escalating climate crisis. Predicted temperature increases and decreases in precipitation are likely to exacerbate drought conditions, heightening existing developmental issues such as food insecurity and water scarcity. Gaza's sole natural water source, the Coastal Aquifer Basin, is already under severe stress from over-extraction, pollution, and saltwater intrusion, leading to its rapid degradation. As reported by Cook (2014), “Over 90% of water supplies in Gaza are now non-potable, with a stark decrease in children's access to clean water from 98% in 2000 to just 11% in 2014, a situation that remains unchanged in the West Bank.” The deteriorating access to clean water is critically undermining public health measures, as evidenced by the high prevalence of water, sanitation, and hygiene (WASH)-related diseases, including diarrheal disease. Diarrheal illness is a leading cause of mortality among children under five globally and ranks as a primary cause of death and disability in low- and middle-income countries (Troeger et al., 2018).

The link between increased temperatures, irregular rainfall, and the likelihood of diarrhea has been established in various regions, yet data from Gaza remain sparse despite the high incidence of the disease. Seasonal patterns in the occurrence of cryptosporidiosis among children in Gaza, with peaks during hotter and drier seasons, underscore the potential influence of climate variables. Notably, there is a lack of comprehensive studies examining the effects of climate conditions on diarrheal diseases in Gaza, nor predictions of future health impacts based on climate change scenarios, despite the unique environmental, socio-economic, and political challenges faced by the population. As Depledge (2016) emphasized, “adhering to the Paris Agreement goals, including limiting global temperature increases to below 2°C and striving for a 1.5°C cap, is crucial.” Understanding the health impacts associated with these Global Warming Levels (GWLs) is vital for effective policy-making, particularly for regions like Gaza, where such data are critically needed.

This paper seeks to fill these gaps by analyzing various relevant records to examine the impacts of climatic variables on acute diarrheal disease in Gaza. Additionally, a health impact assessment will be conducted to evaluate the prospective disease burden under various climate change scenarios.

2. Health Situation in Gaza

The "Palestinian Ministry of Health in the Gaza Strip" supplied the epidemiological data used in this study, consisting of weekly records of acute diarrhea cases reported by patients at healthcare facilities throughout Gaza from 2009 to 2020. This data was gathered from all healthcare entities within the Gaza Strip that participate in the communicable diseases

surveillance system. According to Mosleh et al. (2020), "healthcare provision in Gaza is divided into four main sectors: the Government, the United Nations Relief and Works Agency (UNRWA), non-governmental organizations (NGOs), and private commercial providers. While the government and UNRWA are responsible for delivering health services to the bulk of the population, NGOs and the private sector serve more limited portions of the community."

In terms of disease surveillance, the Gaza Strip employs a disease-specific passive surveillance approach to track the spread of infectious diseases. Of the 161 officially recognized health institutions in Gaza, 112—or 69.5%—actively participate in the surveillance, recording, and reporting of communicable diseases (Suther et al., 2020).

3. Climate Reports

The ERA-5 Land reanalysis dataset, provided by the "Copernicus Climatic Change Service" (C3S), serves as the source of the most current climatic data used in this study. This dataset offers detailed gridded information on variables such as precipitation and air temperature, with a spatial resolution of 9 km. It was selected primarily due to the absence of local weather station data within the study area. Observational datasets that utilize a grid format do not have weather stations directly in the Gaza Strip; thus, they estimate local climate conditions through interpolation methods using data from neighboring countries' stations. Dun et al. (2020) state that, "the climatological data were synchronized with health data from the period 2009–2020, revealing that the average annual temperature for this period was 20.98°C and the annual precipitation was 303 mm."

4. Impacts and Consequences

As highlighted by Hajat et al., (2022), "Between 2009 and 2020, a total of 706,699 cases of diarrhoea were reported among children aged 0-3 years, while 392,499 cases were reported among children older than 3 years, at the participating health institutions." As per various weather reports, the incidence of diarrhea reaches its highest point with the beginning of summer, with the variation in occurrence being most noticeable among those aged 0-3 years. The mean weekly temperature exceeded the threshold of 19 ◦C for an average of 31.3 weeks each year, while the total weekly rainfall remained below 6 mm for an average of 32.8 weeks per year (Chaurasia et al., 2020).

Multiple publications indicate that the DLNM model has been used to analyze the association between temperature, rainfall, and the risk of diarrhea in children aged 0-3 years. The analysis takes into account the seasonal variations and considers different time delays. High temperatures at lags 0 and 1 weeks were shown to be related to a progressively rising risk of diarrhea. However, there was no observed influence on diarrhea risk at longer lags. The heat threshold was determined to be 19 ◦C using model deviance statistics. The correlation between rainfall and the risk of diarrhea showed a consistent and gradual rise in risk as rainfall decreased (Levy et al., 2020). The risk was found to be significant when rainfall dropped below 6 mm, and this impact lasted for a period of 4 weeks after the exposure. Relationships within the age category of over 3 years were comparable, albeit they were not as robust (not shown). Based on many studies, it was noted that there is no elevated risk of diarrhea related to heavy

rainfall. Nevertheless, research has shown that the impact of exposure may be explained by linear-threshold models. This leads to an estimate of the yearly number of diarrhea episodes that can be attributed to high temperatures and poor rainfall. Due to the elevated baseline rates of diarrhea, a significant proportion of cases among children aged 0-3 years may be ascribed specifically to high temperatures and little rainfall.

5. Discussion

The findings from several research studies indicate that there is now a significant prevalence of acute diarrheal sickness in Gaza. This is attributed to the combination of poor rainfall and high temperatures, and is expected to worsen as climate change progresses. According to many research, the occurrence of heat-related diarrhoeal sickness is projected to rise by over 10% if global warming exceeds 2 ◦C. Nevertheless, if we manage to achieve the 1.5 ◦C goal, the aforementioned rise would be mitigated to around 2% (Chau et al., 2021). Although reducing the affects of some activities is necessary, it is equally crucial to develop adaptation measures alongside mitigation efforts to defend against the expected repercussions in the near future. Undoubtedly, the author's findings indicate that immediate measures must be implemented to enhance the current state of affairs.

The prevalence of diarrhea in children has declined in most regions of the globe; yet, the burden in Gaza remains substantial. A study conducted in Gaza found that 14% of children under the age of 5 had suffered from an episode of diarrhea during the two weeks prior to the interview. A significant number of children below the age of 5 are hospitalized due to diarrhoea. Factors such as poor family income, living in metropolitan areas, and using municipal water for drinking and cooking all contribute to an increased risk of this condition. This highlights the severe and deteriorating problems of water shortages and food security in Gaza, which will be worsened by climate change. Most of the food in the region is imported, making it very susceptible to future climatic, economic, and political disruptions.

In comparison to other regions, the prevalence of diarrheal diseases caused by elevated temperatures was comparatively diminished in Gaza. Nevertheless, the absolute number of cases ascribed to heat remained substantial, owing to the disease's already elevated baseline rates and the observation of detrimental effects at temperatures comparatively moderate in nature (Abuzerr et al., 2019). The predominantly immediate nature of the relationship between temperature exposure and disease suggests a swift mechanism of action, such as increased food spoilage or consumption of contaminated water during periods of high temperature. This data may serve as a guide for prospective behavioral adjustments in anticipation of elevated temperatures.

Nevertheless, as highlighted by James et al., (2017), “temperature-related consequences of climate change may manifest through alternative pathways, including an extension of the transmission season, thereby bolstering the viability of viruses beyond their host. Individuals between the ages of 0 and 3 had the greatest likelihood of developing diarrhea, an occurrence that is more significantly correlated with Cryptosporidiosis than in other age cohorts.” The research investigation found that low rainfall was the climatic condition that had the most correlation with the likelihood of diarrhea. Circumstances of drought may increase the concentration of pathogens and encourage the use of water sources of inferior quality. Although water scarcity is an increasing issue in numerous Middle Eastern countries, the problem of obtaining potable water in Gaza is of the utmost importance. Irrespective of climate change, the Gaza Strip is compelled to augment its natural water resources in response to

varying water supply and population expansion scenarios (Efron et al., 2018).

Desalination is recognized as the only viable solution, but it requires a significant amount of energy. The construction of a desalination plant in Gaza is heavily reliant on the cooperation of neighboring nations and the easing of Israel's border restrictions. As mentioned by Abuzar et al., (2021), "The significance of the private sector in providing water during crises may also increase. In response to the COVID issues. The need for increased regional and intersectoral cooperation to enhance resilience against climate change and public health concerns in the Middle East." Presenting climate change and water challenges as a security concern in the area might hinder efforts to implement significant adaptation strategies.
The author's research has many strengths and drawbacks. The author study is one of the first research projects to quantify the effects of climate on health outcomes in Gaza. It is also the first to predict the health costs that may arise in this very sensitive region due to climate change scenarios. The author collected long-term health data, which allowed us to identify more than a million instances of diarrheal sickness that we could connect to climatic data. Nevertheless, the lack of climatic data, especially for factors like precipitation that vary greatly, continues to be a concern in the research region. Moreover, climate models are susceptible to biases, particularly when it comes to regional size and precipitation. Although the use of bias-adjusted models has mitigated this constraint for present climatic circumstances, restrictions persist for future estimates. However, as mentioned by Zittis et al., (2022), "there is a consensus that there is a noticeable decline in rainfall in the Middle East area due to the effects of global warming. Furthermore, several climate models indicate that global warming will reach a level of 1.5 ◦C in the coming years." This would lead to some overlap with the baseline period of 2009-2020 that is being evaluated. Thus, these models show a decrease in the expected disparities in precipitation and temperature, since they overestimate the present global warming of around 1.0◦. Thus, this analysis may have understated the potential future costs. Nevertheless, this impacts all scenarios equally and the finding of increased costs under 2.0◦ persists.

The author thinks that the link between weather conditions and the chance of getting diarrhea will stay the same in the future. Because the author was only interested in figuring out how big the effects of climate change are, they didn't try to model other things that are likely to add to future problems. The number of people living in the Gaza Strip is already very high, and any more people would make diarrhea even worse in the future. As discussed by Calow et al., (2011), "Integrating WASH factors and other socio-economic and ecological indicators into projections can enhance our understanding of the connections between climatic factors and diarrheal disease, as well as guide adaptation strategies." However, due to the political instability and fragility of Gaza, it is not feasible to accurately predict the potential impacts of these development factors on public health in the region. The findings of this study report just provide minimum estimates of the overall burden of diarrhea for the population of Gaza, since we have not measured the effect on death. Furthermore, although health statistics obtained from the Government, UNRWA, NGO, and commercial providers are highly representative, they do not include all healthcare institutions in the State (Jamal et al., 2022). Additionally, we were unable to categorize instances of diarrhea based on the specific kind of infection, which might potentially affect the sensitivity to climatic conditions.

6. Future Health Challenges

Several studies have been examining the predicted average number of weeks per year in Gaza characterized by intense heat (temperatures exceeding 19°C) and minimal rainfall (less than 6 mm) under both current and future climate conditions. Climate models suggest an increase in the occurrence of such weeks under scenarios of further global warming. Specifically, in a scenario where global temperatures rise by 2°C, there is a notable increase in the frequency of weeks surpassing this temperature threshold. According to Sedlar et al., (2020), "the Regional Climate Models (RCMs) used during the baseline period of 2009-2020—which coincides with a period reflecting a 1.5°C Global Warming Level (GWL) for some models—show a slight tendency to overestimate the number of hot and dry weeks compared to ERA-5 data." However, these models already indicate higher temperatures than the actual temperature increase of about 1°C. Consequently, the difference in frequency of hot and dry weeks compared to ERA-5 data is minor. This observation does not suggest any inherent bias in the modeling approach, nor does it affect the future projections presented in this research.

In terms of health impacts, under a 2°C global warming scenario, the anticipated average annual cases of heat-related illnesses in children aged 0-3 is projected to be 2446. This marks a 10.7% increase from baseline figures recorded during the 2009-2020 reference period. However, if global warming is limited to a 1.5°C increase, the rise in cases would be significantly less, at about 1.8%. For children older than 3 years, the projected increases are 1.8% under a 1.5°C warming scenario and 10.9% under a 2°C scenario, starting from a comparatively lower baseline.

7. Conclusions

The findings of this study underscore the significant role that climate variables play in influencing the prevalence of diarrheal diseases in Gaza. Historically subjected to both involuntary migration and confinement, the community's vulnerability to climate-induced health issues is notably high. The analysis reveals a direct correlation between the predicted degrees of global warming and an increase in diarrheal disease cases in the region. This serves as a compelling argument for the global community to adopt more stringent climate mitigation strategies. While climate change may not currently be the foremost concern for the Gaza Strip, it is poised to exacerbate the existing public health and developmental challenges faced by its residents in the future. Therefore, we must recognize and address the potential health impacts of global warming on vulnerable populations such as those in Gaza, ensuring that climate considerations are integral to public health planning and intervention strategies.

Funding
This article was not supported by any funding from public, commercial, or not-for-profit sectors.

Conflict of Interest/ Disclosures
The authors have disclosed that there are no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

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