Bulletin of the National Research Centre

REVIEW

Open Access

Impact of El Niño on public health and its preparedness measures

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Abstract

Background El Niño events disrupt atmospheric and oceanic interactions, leading to shifts in precipitation, temperature, and extreme weather events. Such alterations have the potential to exacerbate heatwaves, increase vector-borne and waterborne diseases, and compromise air quality. Understanding the connection between El Niño and public health vulnerabilities is crucial for effective mitigation and preparedness.

Main body of the abstract This article aimed to investigate the impact of El Niño on public health and its preparedness measures. A comprehensive literature review was conducted, involving systematic searches across academic databases, scientific journals, and relevant grey literature. Inclusion criteria encompassed studies that explored the link between El Niño and public health outcomes, as well as strategies for enhancing preparedness. Thematic analysis was employed to synthesize findings and identify key themes. This article revealed that El Niño events contribute to a spectrum of public health challenges, including heat-related illnesses and compromised air quality. Vulnerable populations, such as the elderly, children, and those with pre-existing medical conditions, are particularly at risk. Early warning systems, health infrastructure readiness, communication strategies, and collaborative efforts emerged as vital preparedness measures.

Short conclusion El Niño's impact on public health and preparedness measures is a complex and multifaceted issue that requires a unified and proactive approach. By understanding the interplay between El Niño events and health vulnerabilities, communities can better prepare for and mitigate the health risks posed by these climatic fluctuations. Strengthened early warning systems, improved healthcare infrastructure, effective communication strategies, and collaborative efforts between various stakeholders are crucial in enhancing preparedness and safeguarding public health in the face of El Niño's capricious influence.

Keywords El Niño, Public health, Warm, Climate, Preparedness

Background

El Niño, a climatic phenomenon characterized by periodic warming of sea surface temperatures in the central and eastern equatorial Pacific Ocean (Zhao et al. 2023), frequently leads to significant alterations in global weather patterns. It is a component of the larger climate cycle known as the El Niño-Southern Oscillation (ENSO), which also encompasses its counterpart, La Niña, characterized by cooler-than-average sea surface temperatures (McPhaden et al. 2020). El Niño events typically occur every two to seven years, impacting weather with increased rainfall in some regions and droughts

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in others (Goddard and Gershunov 2020; Richardson et al. 2022) (Fig. 1). These changes in weather patterns can have widespread effects on ecosystems, agriculture, economies, and even public health (Anyamba et al. 2019).

At its core, El Niño represents a delicate balance disrupted—an intricate interplay of atmospheric and oceanic interactions thrown out of harmony. As warm oceanic waters converge near the western coast of South America, they trigger an atmospheric reaction that resonates globally (Jorge-Romero et al. 2021). The surging warm waters prompt shifts in wind patterns and alter atmospheric pressure gradients, resulting in a series of cascading climatic effects (Cai et al. 2021). These effects manifest as changes in precipitation, temperature, and extreme weather events worldwide. From heavy downpours and floods to arid droughts and scorching heatwaves, El Niño orchestrates a potent symphony of climatic extremes (Cai et al. 2020).

In an increasingly interconnected world, where geographical boundaries seem less constraining, the consequences of El Niño's climatic disruptions have surpassed the realm of meteorology (Wengel et al. 2021; Domeisen et al. 2019). While recent El Niño events have impacted various regions across the globe, affecting both climate and ecosystems. Regions such as Southeast Asia, Australia, and parts of southern Africa have been recently affected by El Niño (Wang et al. 2023). These areas experience altered precipitation patterns, leading to drought conditions and water scarcity (Cao et al. 2023). Conversely, central Asia, including Indonesia, Malaysia, the Philippines, and in Latin America, including Brazil, are facing increased rainfall, elevating the risk of flooding and landslides in affected regions (De Silva et al. 2023). The impacts on these regions are multifaceted. Reduced precipitation has severe consequences for agriculture, resulting in crop failures, economic hardships, and food insecurity. Water scarcity exacerbates these challenges, affecting both rural and urban communities (Dube et al. 2023). Additionally, the heightened risk of wildfires due to high temperatures in certain regions poses environmental threats, impacting ecosystems and air quality (Helo Sarmiento et al. 2023).

Moreover, the World Health Organization (2023) has emphasized the future threats posed by El Niño, highlighting potential health implications arising from associated environmental changes. Water scarcity and food insecurity can lead to malnutrition and the spread of waterborne diseases. Additionally, it underscores the importance of preparedness and adaptive strategies to mitigate the health risks associated with changing climates during and after El Niño events (World Health Organization 2023). However, the intricate dance

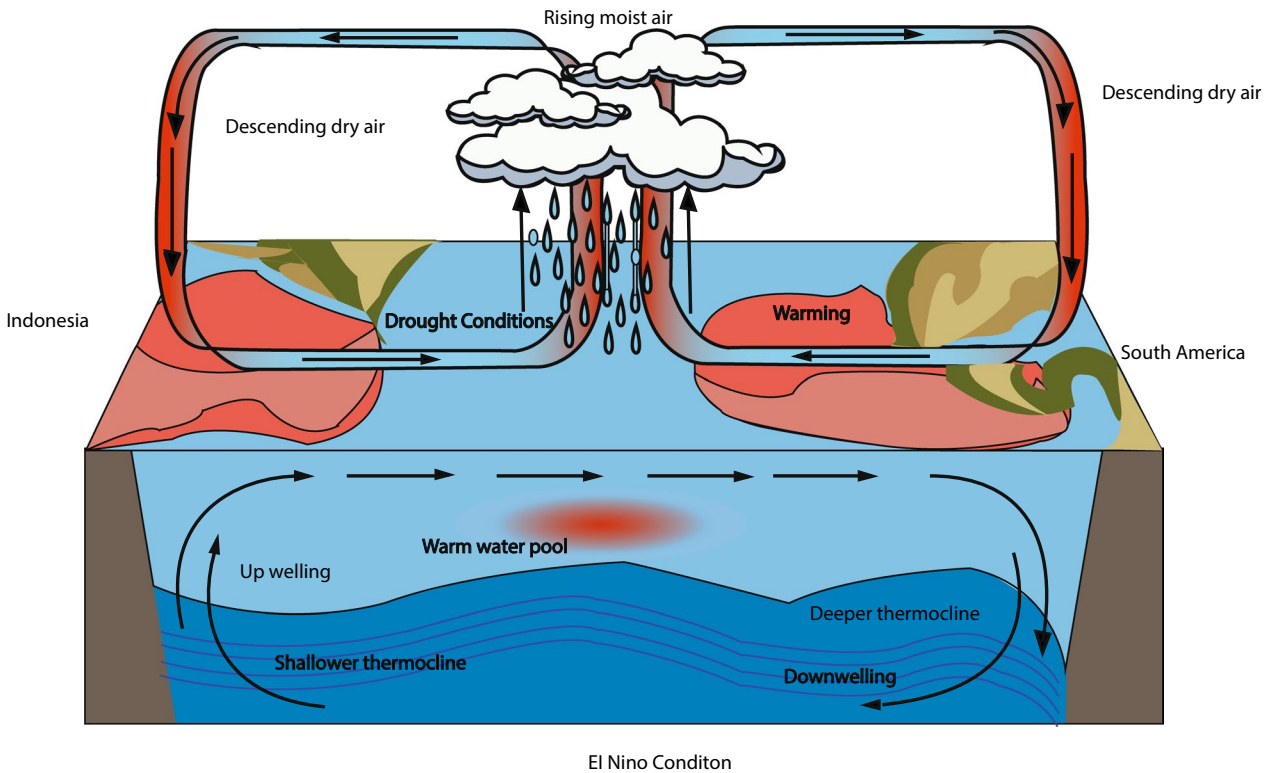

Fig. 1 El Niño condition

between El Niño and public health emerges as a growing area of concern and investigation. As El Niño sets a sequence of climatic events into motion, it simultaneously paves the way for a series of public health challenges (An et al. 2023). The rise in heatwaves poses risks to vulnerable populations, while altered precipitation patterns can lead to waterborne diseases and compromised sanitation (Arshad et al. 2020). The expansion of vector-borne diseases and shifts in air quality adds further complexity to the scenario (Chua et al. 2023). However, understanding El Niño's impact on public health and enhancing preparedness measures becomes a matter of paramount significance. By delving into the interconnection between climatic shifts and health vulnerabilities, this exploration contributes to the expanding body of knowledge devoted to safeguarding communities and fortifying global resilience. Thus, the objective of this article was to delve into El Niño's influence on public health and strategies for preparedness.

Main text

Link between El Niño-driven weather anomalies and public health risks

El Niño, a climatic phenomenon of immense consequence, exerts a profound influence on the delicate equilibrium of Earth's weather patterns. It begins with the unusual warming of sea surface temperatures in this region, disrupting the conventional dynamics that govern atmospheric circulation (Alizadeh 2022). As warm waters accumulate in the central and eastern Pacific, they release an upwelling of energy that radiates outward, affecting weather systems across continents (Zhang and Li 2023). Furthermore, the alteration of sea surface temperatures sets in motion a series of atmospheric responses. Tradewinds, which typically blow from east to west, weaken or even reverse their course, diminishing their role in cooling oceanic surfaces (Vos et al. 2023). This change in wind patterns disrupts the balance of heat distribution, causing air masses to shift and leading to deviations from the norm in global climatic systems (Li et al. 2023).

One of the most tangible consequences of El Niño's atmospheric upheaval is the onset of scorching heatwaves. As prevailing winds weaken, the movement of cooler air masses from the ocean is restricted, resulting in elevated temperatures over land (Gan et al. 2023). Prolonged and intense heatwaves can create life-threatening conditions, causing heat stress, dehydration, and exacerbating pre-existing health conditions (Matsee et al. 2023). Moreover, El Niño's widespread effects extend to altering precipitation patterns, often leading to excessive rainfall in certain regions. Intensified by the phenomenon of warm oceanic waters, atmospheric moisture levels rise, generating an increase in torrential downpours (Alizadeh et al. 2022).

Paradoxically, as El Niño drenches certain regions, it leaves others parched in its wake. The disruption of typical weather systems can lead to prolonged droughts in areas that usually receive ample rainfall (Geng et al. 2022). Agriculture and water supply systems suffer, impacting food security and triggering a chain reaction of economic and health-related challenges. Drought-induced crop failures can contribute to malnutrition and foodborne illnesses, amplifying public health concerns (Khraishah et al. 2022). In addition, the intensification of heatwaves not only strains the limits of physiological endurance but also poses a direct threat to individuals who lack access to proper cooling and hydration (Bowen et al. 2023). Vulnerable populations, such as children, the elderly, and individuals with pre-existing health conditions, respiratory ailments, become more susceptible to heat-related illnesses and fatalities (Yadav et al. 2023).

Furthermore, the torrential downpours and subsequent flooding have cascading effects on public health. As a result, contaminated water sources, overcrowded shelters, and compromised sanitation facilities create an ideal breeding ground for waterborne diseases such as cholera and dysentery (Gavilan et al. 2023). The aftermath of floods can disrupt healthcare infrastructure, restricting access to medical services and heightening the risk of infectious disease outbreaks (Suresh et al. 2022). On the opposite end of the spectrum, El Niño-induced droughts contribute to a myriad of public health challenges (Woyessa et al. 2023). Limited access to clean water jeopardizes basic hygiene practices and can lead to the rapid spread of infections. Malnutrition and weakened immune systems render individuals more vulnerable to diseases (Stewart-Ibarra 2022). Additionally, the social and economic stressors stemming from droughts can fuel displacement, poverty, and social unrest, further aggravating public health vulnerabilities (Bowen et al. 2023).

Methodology

This article adopts a comprehensive methodology to analyze and synthesize the existing body of literature on the impact of El Niño on public health and preparedness measures. A systematic and rigorous search strategy was employed using academic databases such as PubMed, ScienceDirect, and JSTOR, with keywords like "El Niño," "public health," and "preparedness measures." The focus was narrowed by including terms like "health outcomes," "disease prevalence," and "vulnerability." Related concepts such as "climate change" and "extreme weather events" were incorporated. Additionally, government health agencies' reports and global health organizations were reviewed for pertinent information. The selected

studies were reviewed based on predefined inclusion and exclusion criteria, including articles focusing on the nexus between El Niño events and their implications for public health outcomes and preparedness strategies. Studies with diverse geographical contexts, health-related impacts, and mitigation efforts were considered to provide a comprehensive understanding. Relevant data from the included studies were systematically extracted and organized. Thematic analysis was employed to identify recurring patterns, themes, and insights across the extracted data. The data were subjected to thematic analysis to identify and categorize common themes and patterns. This process involved in-depth reading, coding, and clustering of data to discern overarching trends and recurring concepts related to El Niño's influence on public health and preparedness. The synthesized findings from the thematic analysis were structured and presented in a coherent narrative.

Public health implications of El Niño

As El Niño conducts a symphony of climatic anomalies, its influence reaches beyond mere meteorological fluctuations, casting a significant shadow on public health. The complex interaction between El Niño-induced weather extremes and community well-being highlights the pressing need to comprehend and tackle its multifaceted consequences.

Heat-related illnesses and mortality

Among the most palpable and immediate consequences of El Niño's climatic disruptions are the surging heatwaves that envelop regions in their stifling embrace. As temperatures soar to unprecedented heights, vulnerable populations become increasingly susceptible to heat-related illnesses, ranging from heat exhaustion to life-threatening heatstroke (Matsee et al. 2023). Senior citizens, teenagers, and individuals with underlying health conditions are particularly at risk. The intensification of heatwaves under El Niño conditions can strain healthcare systems, potentially overwhelming medical facilities, and personnel (Masselot et al. 2022). Tragically, these heatwaves can lead to a rise in mortality rates, further highlighting the imperative of early warning systems and effective public health strategies to mitigate the impact of extreme heat (Kapwata et al. 2022).

Waterborne diseases and contamination

El Niño's disruption of precipitation patterns can unleash a cascade of water-related health risks. Excessive rainfall, flooding, and compromised sanitation infrastructure can contaminate water sources, increasing the likelihood of waterborne diseases such as cholera, dysentery, and giardiasis (Rusca et al. 2022). The inundation of communities can lead to the mixing of sewage and drinking water supplies, providing fertile ground for disease transmission (Mukherjee 2023). Rapid response measures, including water quality monitoring and hygiene education, are essential to prevent and control waterborne disease outbreaks during and after El Niño events.

Vector-borne diseases

El Niño's influence extends even to the microscopic realm as changes in weather patterns can impact the distribution and prevalence of disease-carrying vectors. Warmer temperatures and altered precipitation patterns can create favorable environments for vectors such as mosquitoes and ticks to thrive and expand their habitats (Ma et al. 2022). This expansion elevates the risk of vector-borne diseases like malaria, dengue fever, and Lyme disease (Kuleshov et al. 2022). Populations in regions unaccustomed to these diseases may be particularly vulnerable due to a lack of immunity (Andhikaputra et al. 2023). Surveillance, vector control strategies, and public awareness campaigns are crucial to curbing the spread of vector-borne diseases during El Niño events. Furthermore, disruptions in healthcare infrastructure due to increased demand for treating vector-borne diseases can strain medical resources, necessitating additional preparedness measures to enhance healthcare capacity during such periods.

Respiratory and cardiovascular issues due to air quality changes

El Niño's extensive impacts stretch to the quality of the air that envelops us. Shifts in atmospheric circulation and heightened forest fires, often exacerbated by drier conditions, can lead to elevated levels of air pollutants and particulate matter (Xu et al. 2022). These alterations in air quality can have profound implications for respiratory and cardiovascular health (Khraishah et al. 2022). Individuals with pre-existing lung conditions, such as asthma and chronic obstructive pulmonary disease (COPD), are at heightened risk of exacerbations (Alahmad et al. 2023). Furthermore, the general population may experience increased respiratory symptoms and hospital admissions. El Niño-induced air quality changes underscore the importance of public health measures, including respiratory health management (Hasan et al. 2023).

Navigating the intricate implications of El Niño on public health clarifies that safeguarding communities necessitates proactive strategies, early interventions, and robust healthcare systems (Fu et al. 2023). The convergence of heatwaves, waterborne diseases, vector-borne illnesses, and air quality concerns mandates a comprehensive and interdisciplinary approach (Akasha et al. 2023). Recognizing these interconnected interdependencies and

enhancing public health preparedness empowers societies to effectively reduce the risks linked with El Niño's unpredictable climatic patterns, fostering a future that is both healthier and more resilient (Santika et al. 2023).

Vulnerable populations at risk

El Niño's dynamic and often tumultuous climatic disruptions cast a wide net of impact, affecting communities and individuals across the globe. However, within this complex network of environmental changes, certain populations emerge as particularly vulnerable, facing heightened risks and challenges in the face of El Niño's capricious dance.

Identification of communities and individuals most susceptible to El Niño's effects

In the intricate tapestry of societies, some threads are woven more delicately than others, rendering certain communities and individuals disproportionately vulnerable to the adverse effects of El Niño. Geographical location plays a pivotal role, with coastal and low-lying areas often bearing the brunt of intensified storms and flooding (Spiecker and Menge 2022). Communities in these areas, including fishing communities and informal settlements, are at the forefront of El Niño's impact. They face the challenges posed by rising sea levels and heavy rainfall, contending with the destructive forces unleashed by these phenomena (Einzmann et al. 2022). Moreover, regions prone to water scarcity face compound challenges during El Niño events. Arid and semi-arid zones, where water resources are already stretched thin, experience exacerbated drought conditions, amplifying the risk of crop failure, food insecurity, and displacement (Glantz et al. 2022). Indigenous and marginalized populations, often dependent on subsistence agriculture, grapple with the daunting task of adapting to dwindling water supplies and diminishing harvests (Irenso et al. 2022).

Socioeconomic factors amplifying health risks during El Niño events

El Niño's effects intersect with socioeconomic realities, magnifying health risks and forming a network of vulnerabilities that can have far-reaching implications. Poverty and limited access to resources intensify the impact of El Niño's disruptions, rendering disadvantaged communities ill-equipped to cope with the resulting challenges (Zhao et al. 2022). Lack of proper housing and infrastructure exposes individuals to greater risks during extreme weather events, leading to increased injuries, displacement, and loss of livelihoods (Santika et al. 2023). Furthermore, the intricate interplay between socioeconomic factors and health extends beyond the immediate aftermath of climatic disturbances. Impaired access to healthcare services and medical facilities exacerbates the strain on already overburdened health systems (Xu et al. 2022). With limited resources allocated to healthcare, the ability to respond effectively to El Niño-induced health crises is compromised, leaving vulnerable populations without essential medical care (Ramírez and Lee 2022). In addition to that, indirect effects of El Niño's impact, such as food price fluctuations and economic instability, reverberate through vulnerable communities, perpetuating cycles of hardship and health risks (Hao 2022). Disruptions to local economies can lead to decreased income opportunities, hindering access to nutritious food and adequate healthcare (Majeed et al. 2023). Vulnerable groups, including women and children, often bear the brunt of these economic shocks, facing increased malnutrition and susceptibility to diseases (Salvador et al. 2023).

Strengthening preparedness measures

In the ever-evolving orchestration of El Niño's climatic fluctuations, the imperative to enhance preparedness measures takes center stage. As communities worldwide brace themselves for the unpredictable rhythm of El Niño's phenomenon, a multi-faceted approach to readiness becomes essential to safeguarding public health and minimizing the toll of its effects.

Early warning systems for extreme weather events

Timely information is a cornerstone of effective disaster preparedness, and early warning systems could play a pivotal role in providing critical alerts before the storm. By harnessing meteorological data and cutting-edge technology, early warning systems can predict and communicate the onset of El Niño-associated extreme weather events (Ewbank et al. 2019). These alerts empower governments, local authorities, and communities to take proactive measures, such as evacuation planning, securing essential supplies, and reinforcing vulnerable infrastructure (Hao et al. 2020). The integration of meteorological insights with community engagement fosters a culture of preparedness, allowing individuals to make informed decisions and reduce the impact of El Niño-induced disasters (Iyer et al. 2021).

Health infrastructure readiness and capacity building

Preparedness on the healthcare front is essential to managing the surge in health-related challenges during El Niño events. Strengthening health infrastructure involves bolstering medical facilities, ensuring a robust supply chain of essential medications, and enhancing the capacity of healthcare professionals to respond effectively (Rafisura et al. 2022). Training healthcare workers to recognize and manage El Niño-associated health risks,

from heat-related illnesses to infectious diseases, equips them with the tools to mitigate the impact on vulnerable populations (Glantz et al. 2022). Furthermore, building the resilience of health systems through investments in equipment, personnel, and surge capacity ensures that communities are better equipped to weather the storm of El Niño's health consequences (Ramírez and Lee 2021). Moreover, implementing telemedicine initiatives can optimize healthcare delivery during El Niño events, facilitating remote consultations and monitoring. This technology can enhance accessibility and reduce the burden on physical healthcare facilities (Ferreira et al. 2023). Additionally, fostering community-based healthcare initiatives can empower local populations to actively participate in health protection. By promoting community health education programs and establishing local health networks, resilience is built from the grassroots level (Rawat et al. 2022).

Communication strategies to disseminate health advisories and guidelines

Effective communication is the linchpin of successful preparedness efforts, and clear, accessible health advisories and guidelines are crucial in ensuring that individuals can take protective actions. Public health agencies must employ diverse communication channels, including traditional media, social platforms, and community networks, to convey accurate information on health risks and recommended precautions (Elsaid and Ahmed 2021). Culturally sensitive and linguistically appropriate messaging bridges the gap between expert knowledge and public understanding, empowering individuals to make informed decisions about their health and safety (Kotcher et al. 2021). Regular updates and real-time communication during El Niño events enable swift adjustments to strategies and interventions, enhancing the overall effectiveness of preparedness measures (Bhardwaj et al. 2021).

Collaborative efforts between public health agencies, disaster management, and meteorological institutions

The complex tapestry of El Niño's effects necessitates a unified response, and collaborative partnerships between public health agencies, disaster management authorities, and meteorological institutions are instrumental in mounting an effective defense (Ahmed and Basnayake 2022). Interdisciplinary coordination enables the pooling of expertise, resources, and data, resulting in a holistic approach to preparedness (Baudoin et al. 2022). Public health professionals, disaster responders, and meteorologists working in tandem can anticipate and address emerging health risks, formulate targeted interventions, and allocate resources strategically (Hove and Kambanje 2019). The synergy between these entities enhances the adaptive capacity of communities, paving the way for a more cohesive and resilient response to El Niño's climatic disruptions (Briones 2022).

Community engagement and education

In the intricate fabric of climate and health interactions, community engagement and education emerge as crucial threads, binding together efforts to mitigate the impacts of El Niño's capricious climatic fluctuations. By elevating public awareness, empowering communities, and providing education to healthcare providers, societies can weave a tapestry of resilience that helps weather the storms brought about by El Niño.

Importance of raising public awareness about El Niño's health risks

Empowering individuals with knowledge are a cornerstone of effective disaster response. Raising public awareness about El Niño's potential health risks equips communities with the information needed to make informed decisions, take preventive actions, and respond swiftly when faced with emergent challenges (Iyer et al. 2021). Broadcasting accurate and accessible information through various channels, including mass media, social platforms, and community outreach, bridges the gap between scientific understanding and everyday lives (Ebi and Hess 2020). By highlighting the links between El Niño's climatic anomalies and health consequences, societies can cultivate a heightened sense of vigilance and preparedness, turning individuals into active participants in their own safety (Zhao et al. 2022).

Empowering communities to take preventive actions

Empowerment lies at the heart of resilient communities. Equipping individuals with the tools and knowledge to take preventive actions during El Niño events is an investment in community well-being. Educational campaigns can provide step-by-step guidance on measures such as heatwave preparedness, safe water storage, and vector control (Nurhayati et al. 2021). Community-based organizations, local leaders, and grassroots initiatives play a pivotal role in tailoring these campaigns to address specific needs and cultural nuances (Terzano et al. 2022). By fostering a sense of ownership and responsibility, communities can collectively reduce vulnerabilities, fortify their defenses, and respond effectively to El Niño-induced health challenges (French et al. 2020).

Education initiatives for healthcare providers

The frontlines of public health demand a well-prepared and educated healthcare workforce. Educational initiatives targeting healthcare providers are essential to

ensuring that those responsible for safeguarding community health possess the necessary knowledge and skills (Irenso et al. 2022). Training programs can focus on recognizing El Niño-related health risks, understanding the intricacies of climate-health interactions, and implementing evidence-based interventions (Suresh et al. 2022). Equipped with this specialized knowledge, healthcare providers can deliver timely and appropriate care to those affected by heat-related illnesses, waterborne diseases, and other El Niño-driven health concerns. Strengthening the capabilities of healthcare providers reinforces the resilience of healthcare systems and enhances the quality of care during El Niño events (Ahmed and Basnayake 2022).

Future challenges and adaptation

As the world grapples with the complex interplay between climate dynamics and public health, the path forward is illuminated by the pressing need to anticipate and adapt to future challenges posed by El Niño's capricious dance. The evolving landscape of climate change brings to the forefront a series of critical considerations, including the potential intensification of El Niño events and the imperatives of fostering adaptive strategies and continuous enhancement of preparedness measures.

Potential intensification of El Niño events due to climate change

The impact of climate change manifests in shifts across Earth's atmospheric and oceanic systems. Growing scientific evidence indicates a rise in the intensity of El Niño events due to global climate change (Tripathy et al. 2023). Warming oceans, altered atmospheric circulation, and changing precipitation patterns contribute to the orchestration of more potent and prolonged El Niño occurrences (Guo and Tan 2021). As the Earth's climate system undergoes rapid transformations, the once-predictable rhythms of El Niño may become more erratic, introducing an element of unpredictability into the climatic symphony (Shi et al. 2020).

The ramifications of intensified El Niño events are far-reaching. With greater frequency and intensity, these phenomena can amplify the risks posed to vulnerable populations, exacerbate health-related challenges, and strain already burdened healthcare systems (Odériz et al. 2020). Heatwaves may become more scorching, heavy rainfall more relentless, and droughts more unyielding, subjecting communities to a heightened barrage of health hazards. As the world braces for a future shaped by climate change, the imperative to adapt and fortify preparedness measures looms ever larger (Wengel et al. 2021).

Need for adaptive strategies and continuous improvement of preparedness measures

In the face of a changing climate, the orchestration of a harmonious response requires the crafting of adaptive strategies and an unwavering commitment to continuous improvement. As El Niño's rhythm becomes more complex, societies must enhance their capacity to anticipate, respond, and recover from its cascading impacts (Hund et al. 2021). This necessitates a dynamic approach that fosters flexibility and innovation in preparedness measures.

Adaptive strategies encompass a spectrum of interventions, from early warning systems fortified with cutting-edge technology to community-driven initiatives that prioritize local knowledge and resilience (Nguyen et al. 2021). These strategies evolve with the changing climate and health landscape, recalibrating responses based on evolving data and insights (Zhang and Li 2023). Engaging with vulnerable communities to co-create solutions, enhancing the role of traditional knowledge, and integrating climate forecasts into public health planning are some avenues through which adaptive strategies can flourish (Gao et al. 2020).

Continuous improvement forms the backbone of preparedness. As El Niño's dance evolves, so must our responses. Regular evaluations, post-event analyses, and comprehensive lessons learned contribute to a cycle of refinement, ensuring that preparedness measures remain relevant and effective (Nguyen et al. 2021). Collaborative efforts between governments, international organizations, research institutions, and communities are paramount in this journey of continuous improvement (Salvador et al. 2023). By pooling resources, sharing expertise, and learning from experiences, societies can strengthen their capacity to confront the challenges presented by intensifying El Niño events (Giamalaki et al. 2021).

Conclusions

El Niño's impact on public health and the need for preparedness measures cannot be underestimated. El Niño can exacerbate existing health vulnerabilities and create new challenges for communities worldwide. El Niño contributes to the spread of waterborne diseases due to contamination of water sources and inadequate sanitation during flooding. Additionally, prolonged droughts can lead to food and water shortages, malnutrition, and increased risk of vector-borne diseases. El Niño-induced heatwaves can result in heat-related illnesses and fatalities, especially in urban areas with vulnerable populations. Furthermore, preparedness measures are crucial to mitigate the adverse effects of El Niño on public health.

Governments, healthcare systems, and communities need to enhance their capacity to anticipate, respond to, and recover from the impacts of this climatic phenomenon. This involves developing early warning systems for extreme weather events, improving water and sanitation infrastructure, implementing effective disease surveillance and control strategies, and educating the public about health risks and preventive measures.

Acknowledgements
The authors would like to thank Tamanna Akter, BGMEA University of Fashion & Technology (BUFT).

Author contributions
Conceptualization: MKKR, MW. Data curation: MKKR, MW. Formal analysis: MKKR, MMR. Investigation: MKKR, SDB. Methodology: MKKR, MMR. Project administration: MKKR, MW. Resources: MKKR, SDB. Supervision: MKKR, SDB. Validation: MKKR, MMR. Visualization: MKKR, MW. Writing—original draft: MKKR, MW. Writing—review & editing: MKKR, MMR, SDB. All authors have read and approved the manuscript.

Funding
Not applicable.

Availability of data and materials
Data sharing is not applicable to this article as no new data were created or analyzed in this study.

Declarations

Ethics approval and consent to participate
No ethical approval was required for this manuscript.

Consent for publication
All the research studies have been duly cited and we have all the open access rights to access these studies.

Competing interests
No, the authors declare that they have no competing interests.

Received: 23 October 2023 Accepted: 21 December 2023
Published online: 02 January 2024

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