Burden of Infectious Diseases in War Inflicted Strip of Gaza

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ABSTRACT

Background: Infectious diseases continue to pose a major threat to global public health, affecting more than 80% of the world's population. In conflict-affected settings, the breakdown of health systems and essential infrastructure significantly exacerbates disease transmission. In the Gaza Strip, ongoing conflict, infrastructure collapse, and population displacement have led to a sharp rise in infectious and vector-borne diseases. Inadequate treatment, disrupted vaccination programs, and the growing burden of antimicrobial resistance (AMR) further heighten the risk, posing serious concerns for regional and global health security.

Objectives: This review aims to assess the prevalence of infectious and communicable diseases in the war-inflicted Gaza Strip, evaluate the extent of antimicrobial resistance in the region, and highlight the critical role of the international community in mitigating and addressing the ongoing health crisis.

Study Design: Narrative review.

Methods: A comprehensive literature search was conducted using PubMed, focusing on studies that provide empirical evidence and relevant insights into the

prevalence, patterns, and burden of infectious and communicable diseases in the conflict-affected Gaza Strip.

Results: The findings indicate a rapidly escalating burden of infectious diseases driven by severe infrastructure damage, widespread malnutrition, overcrowded refugee shelters, disrupted immunization services, poor sanitation, and increasing antimicrobial resistance.

Conclusion: The health crisis in Gaza requires immediate and coordinated international intervention. Establishing humanitarian corridors is essential to ensure uninterrupted access to medical care, facilitate life-saving patient referrals, and enable the delivery of critical humanitarian aid. Prompt action is necessary to control environmental and public health impacts and to prevent further deterioration of health outcomes with potential global repercussions.

Keywords: Infectious diseases, Vector borne diseases, Collapse of infrastructure, Overcrowding, Malnutrition, Antimicrobial resistance

1. INTRODUCTION

The Gaza Strip has been thrust into a harrowing chapter of conflict following Israel's decisive ground incursion on October 27th, marking a pivotal moment in the region's tumultuous history and underscoring the urgent need for international attention and humanitarian action. This conflict has engendered an unprecedented scale of fatalities, injuries, and displacement, with more than 36,731 deaths documented as of June 6, 2024. The shortage of medications, fuel, and infrastructure failures has severely hindered healthcare accessibility in hospitals affecting patients in war-inflicted areas. The nexus between warfare and infectious diseases has been rigorously examined in previous Middle Eastern conflicts, notably in Iraq, Syria, and Yemen. However, the ongoing conflict in Gaza is poised to exert a uniquely substantial impact on the regional burden of infectious diseases. Since October 7, 2023, the intensifying crisis in Israel and the occupied Palestinian territories has resulted in significant civilian casualties.

In the Gaza Strip, airstrikes coupled with shortages of medical supplies, food, water, and fuel have nearly exhausted an already struggling healthcare system. Food, drinking water, fuel, medical supplies, and support to health workers through rotations and additional personnel are urgently needed in healthcare facilities across from Gaza. The WHO has documented attacks on healthcare facilities, leading to the deaths and injuries of health workers and impacting

hospitals and ambulances. Hospitals are overwhelmed, operating well beyond their capacity due to the increasing number of patients and displaced civilians, severely impacting the treatment of patients. Power outages and a lack of medicines and health supplies in Gaza Strip hospitals are severely limiting the ability to provide life-saving medical care. The water and sanitation crisis poses severe health risks to the population, as most water is not safe to consume and the infectious diseases are becoming rife. The inadequate living conditions in shelters have precipitated an increase in water-borne diseases among internally displaced people, further exacerbating the public health crisis. Overcrowding within refugee camps exacerbates the transmission of infectious diseases, further intensifying public health challenges. Conflicts and wars contribute substantially to the spread of antimicrobial resistance further compounding public health challenges

2. BACKGROUND

The aftermath of Israel's ground incursion into Gaza on October 27th has left an indelible mark of devastation, underscoring the urgent need for international attention and humanitarian action. Between October 27, 2023, and June 6, 2024, reports indicate 36,731 fatalities and approximately 83,530 individuals injured during this period. The Gaza Strip, with a population of approximately 2.1 million, faces significant socioeconomic challenges due to a blockade imposed by Israel since 2007. This blockade severely limits movement, access to markets, and basic necessities, leading to widespread poverty, unemployment, and food insecurity. Clean water and electricity are scarce, and the economy is heavily impacted. Despite reconstructive efforts, repeated conflicts and the blockade continue to deeply affect the population [1]. There is a general problem of low-quality health care due to ‘restricted mobility impairing effective health-system function, management, and accountability; the presence of underqualified healthcare providers; and weak institutional capacity for monitoring and assessment’ [2].

The degree of health of the people in Gaza has also suffered a serious and excruciating price due to the ongoing crisis that has gripped the region. As the health system already finds itself on the edge of the precipice prior to the nature of the conflict, it is now plunged on the verge of collapse, which greatly impacts the health of the population. The problem of hospitals being overwhelmed,

restricted movement, and limited space and an alarmingly poor health situation develop. Women, children and neonates are particularly vulnerable groups who suffer as collateral victims and face disadvantages with regard to the provision of essential maternal, newborn and infant health services [3]. The main provider of healthcare is the Palestinian Ministry of Health that provides primary care services for children up to 5 and secondary care in hospitals in the West Bank and Gaza (the Ministry of Health operates 24 of 78 hospitals in Palestine). Others include UNRWA, non-governmental organizations, and the Palestinian Red Crescent. Due to war, there is a lack of effective coordination between these different sectors, and also a severe deficiency of services for child protection, mental health, and child disability. There is also a shortage of medical staff in sectors such as family practice, neurology, oncology, pediatric surgery and psychiatry [4].

3. METHODOLOGY

The references for this article were identified through PubMed until July 2024 with the search terms “Health status and health services in the occupied Palestinian territory", "Impact of wars and natural disasters on emerging and re-emerging infectious diseases", "Vaccine-preventable diseases in humanitarian emergencies among refugee and internally displaced populations", "Antimicrobial resistance in the ongoing Gaza war: a silent threat.", "The Urgent Call for Improved Healthcare for Children in Palestine Amidst Conflict". We selected clinical studies and review articles relevant to these topics. We selected a total of 14 papers in the review (see Bibliography). Other studies were referred to in presenting the clinical presentation of infectious diseases and their transmission in Gaza.

3.1. Surveillance System of Attacks on Healthcare

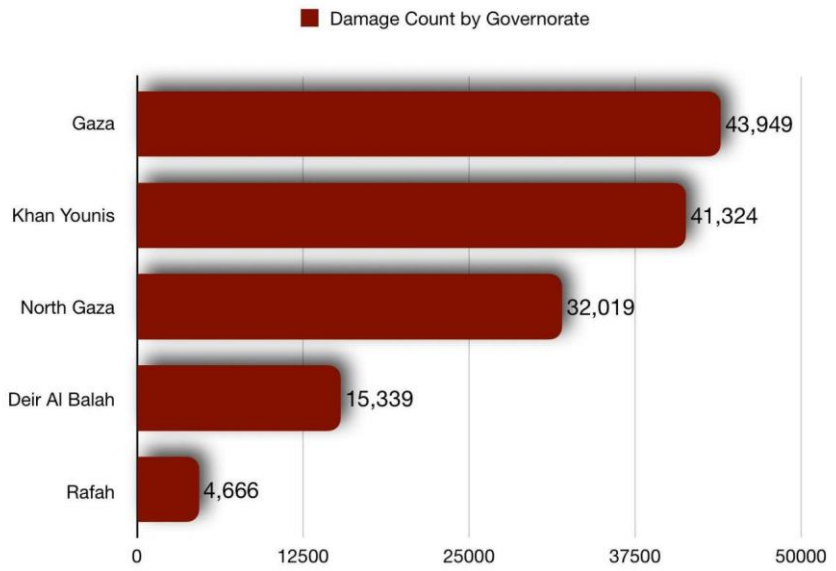
The SSA, established by the World Health Organization (WHO), collects comprehensive data on attacks, their immediate impact on healthcare delivery, and the circumstances surrounding each incident. This data, shared in a publicly accessible global database, informs advocacy efforts, programmatic priorities, and interventions at national, regional, and global levels [5]. The ongoing attacks by Israel on the Occupied Palestinian Territory (oPt) are also marked by attacks on the medical infrastructure. According to WHO, a total of 871 attacks on healthcare have been done by Israel in oPt. Out of these 871 attacks, 472 attacks

impacted facilities, 355 attacks impacted transport, 729 attacks impacted personnel, 615 attacks impacted patients, and 34 impacted supplies [6].

3.2. UNOSAT

The United Nations Satellite Centre (UNOSAT), operating under the United Nations Institute for Training and Research (UNITAR), serves a vital role in providing satellite analysis, training, and capacity development to United Nations entities, funds, programs, and specialized agencies upon request. Additionally, it offers support to Member States by conducting satellite imagery analysis of their territories. Since 2003, UNOSAT has been engaged in satellite image analysis in cases of humanitarian disasters, complex emergencies, and conflict cases during humanitarian crisis [7].

Figure 1: Damage Count by Governorate



Source: Conducted by UNOSAT

A satellite imagery-based comprehensive assessment of damage and destruction to structures in the Gaza Strip by UNOSAT is shown in Figure 1.

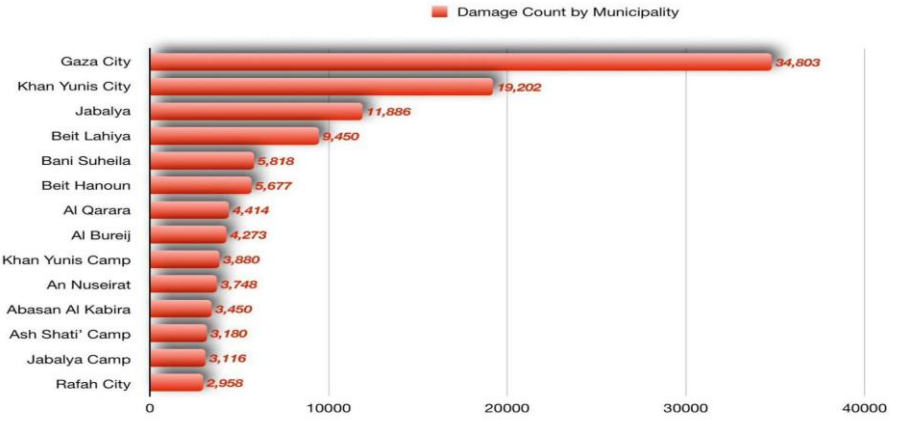
3.3. International Committee of the Red Cross (ICRC)

The ICRC serves as a critical humanitarian organization. It holds an impartial, neutral, and independent stance, dedicated to safeguarding the lives and dignity of individuals affected by armed conflict and violence while providing essential assistance. The ICRC's mission encompasses not only direct aid provision but also the promotion and reinforcement of humanitarian law and principles. This ensures that it can offer assistance without constituting interference in the internal affairs of states, thus upholding its commitment to humanitarian principles in diverse and challenging contexts [8].

3.4. The Collapse of Infrastructure

Under a timeframe between October 7 and November 7, 2023, there was an assessment of 167,292 buildings in the Gaza Strip and 106 medical complexes were determined. Of these, 9% of non-medical structures (15, 768) and 9% of the medical complexes [9] were discovered to be damaged in the IDF bombardment campaign. On 3 May 2024, UNOSAT conducted a comprehensive damage and destruction assessment of the images in the photographed structures in the Gaza Strip as part of the Occupied Palestinian Territory and conducted based on an orchestrated assessment of satellite imagery input as represented in Figure 2.

Figure 2: Damage count by Municipality

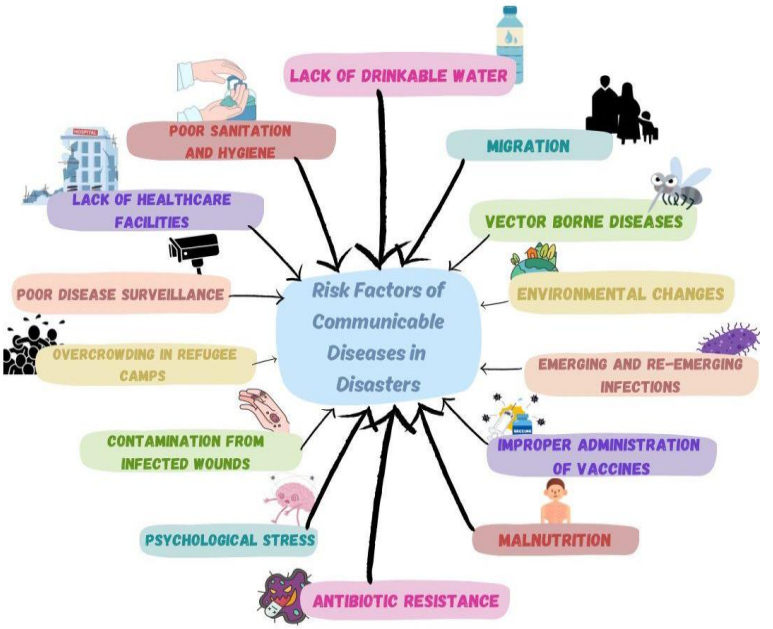


Source: UNOSAT

3.5. Water and Sanitation

In conflict zones, the disruption of water and sanitation systems exacerbates the spread of infectious diseases, posing significant threats to public health. Armed conflicts frequently damage critical infrastructure like water treatment plants and sewage lines, contaminating water sources and limiting access to clean water [10]. This compromised water quality, coupled with inadequate sanitation facilities, heightens the likelihood of waterborne diseases such as diarrhea, cholera, and parasitic infections. Additionally, contaminations from weapon residues exacerbate these risks, contributing to the spread of waterborne diseases. In war-affected populations, overcrowding, mass displacement, and inadequate WASH (water, sanitation, and hygiene) infrastructure in refugee camps and internally displaced persons (IDPs) further increase these risks [11].

Figure 3: Risk factors for Communicable Diseases in Disasters



Source:

Women and children are particularly vulnerable to the spread of diseases. Insufficient access to clean water and sanitation also contributes to food insecurity and malnutrition, exacerbating the susceptibility to infectious diseases among affected populations [12].In the Gaza Strip, essential infrastructure remains damaged due to past conflicts and blockades. For instance, the wastewater treatment plants in Gaza sustained significant damage during Israeli military operations like "Cast Lead" in 2008 and "Protective Edge" in 2014. Consequently, water scarcity and poor sanitation conditions persist, contributing to the spread of communicable diseases [13].

Thus, the intersection of armed conflict, damaged infrastructure, and compromised water and sanitation systems create fertile ground for the rapid spread of infectious diseases, amplifying the humanitarian crisis in war-affected areas. Fig.3 shows the risk factors for communicable diseases in wars and disasters.

3.6. Malnutrition

War exacerbates health crises by causing food blockades, resulting in famine, deteriorating public health services, and mass displacement. Malnutrition affects entire populations or specific groups such as children and pregnant women, making them more susceptible to infectious diseases. This analysis underscores the importance of adopting syndemic approaches in public health and clinical practice to address the complex health challenges arising from conflict [14]. Similar findings are seen in Gaza where food shortage has resulted in severe malnutrition among children making them susceptible to infectious diseases.

3.7. Overcrowding in refugee camps & informal settlements

Various communicable diseases are increasingly becoming prevalent in Gaza due to suboptimal infection prevention control. According to the latest statistics provided by WHO about communicable diseases in Gaza as of May 26, 2024, there are 865,157 cases of acute respiratory infections, about 485,315 cases of cholera out of which approximately 113,687 cases are in children younger than 11 years of age. About 93,630 cases of Scabies and lice, 57, 887 cases of skin rashes, 8,538 cases of Chickenpox, and 81,795 cases of acute jaundice syndrome have been reported. Other diseases that are increasing in incidence recently amid the war crises in Gaza include Tuberculosis, Measles, Influenza, hepatitis A,

Louse borne diseases (i.e. Epidemic Typhus, Trench fever, and relapsing fever), HIV, and STIs [15].

Table 1 shows (oPt) Emergency Situation Update on communicable diseases by WHO on the Gaza Strip as of May 26, 2024

Table 1: oPt Emergency Situation Update on Communicable Diseases

DISEASES	NUMBER OF CASES
Acute respiratory infections	865,157
Cholera	485,315
Scabies and lice	93,630
Skin rashes	57,887
Chickenpox	8,538
Jaundice	81,795

Source: WHO

3.8. Improper administration of Vaccination

Humanitarian emergencies disrupt routine health services, including vaccination programs [16], placing displaced populations at high risk of vaccine-preventable diseases (VPDs) such as measles, polio, meningococcal meningitis, yellow fever, hepatitis A, and cholera [17]. Factors like mass movements, overcrowding, and malnutrition exacerbate disease transmission. Vaccination is crucial but faces challenges such as security issues, destroyed infrastructure, and inadequate supplies. [16,17] Displacement leads to incomplete vaccinations and mismatched schedules, while conflicts hinder vaccination campaigns, especially in internally displaced person (IDP) camps, and further exacerbate VPD outbreaks. Destruction of cold chain equipment and logistical challenges further impede vaccination during conflicts [17]. Additional significant challenges during emergencies, apart from insecurity, logistical hurdles, and access limitations, encompass inadequately trained personnel, and shortages of supplies and equipment [18]. The collapse of public health infrastructure correlates with lower immunization coverage and contributes to the rise of diseases like malaria, polio, and measles, compounded by absent or unstable governments and poor coordination among health agencies, as seen during military conflicts in Afghanistan [19] and Ukraine [20]. Diseases targeted for eradication persist in conflict areas, jeopardizing eradication efforts [21,22].

3.9. Lack of vector control measures

The diseases themed by pathogens are known as the VBDs which are transmitted by various arthropods like the mosquito, triatomine bugs, blackflies, the tsetse fly, sand flies, lice and ticks. The primary mechanisms of such diseases are the vector control, which affects more than 80% of the world population including dengue, Chagas disease, Japanese encephalitis, leishmaniosis, the lymphatic filariasis (LF), malaria, and yellow fever among others [23]. In the situation with diseases such as dengue, chikungunya, Zika, and West Nile disease, the use of vaccines due to the limited supply is not essential [23]. War spills over to the issue of social health, where there is no proper control over vectors, which leads to the spread of disease vectors and the subsequent outbreaks, in the conflict zones. The severed infrastructure, water and sanitation facilities are also a big obstacle in the way of adopting some of the strategies to control vectors, namely larval elimination and spraying of insecticides.

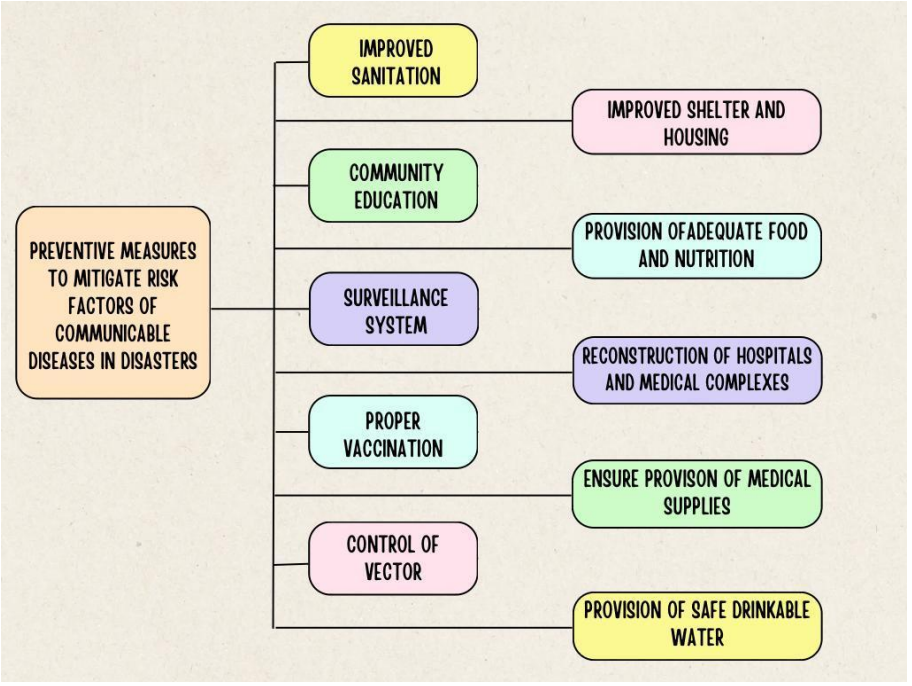
Moreover, the displaced populations often bring in the vectors to new territories in the process of moving and they cause the disease further. Moreover, continued warfare and insecurity will frustrate access to the affected regions, restraining the process of delivering necessary interventions and surveillance operations [24]. Overcrowded conditions and temporary shelters in conflict zones elevate the frequency of mosquito bites and disrupt sanitary services, fostering ideal environments for disease transmission. In response, community-based programs promote vector control interventions tailored to local contexts, such as insecticide-treated mosquito nets for malaria and improved water storage practices for dengue prevention. Despite these challenges, effective vector control remains crucial for mitigating the public health impact of conflict on vulnerable populations [25].

3.10. Environmental Health Risks

Armed conflict results in significant morbidity and mortality among both military personnel and civilians, with long-lasting effects on physical and mental health. The damage to infrastructure disrupts access to essential services like healthcare, sanitation, and food, exacerbating health problems [13]. The health effects of radiation exposure vary based on the dose received. Lower doses primarily lead to cancer, while higher doses can result in complications affecting the heart, digestive system, and other systemic functions [14]. The increased

incidences of cancer and renal failure in the war-torn regions is a complicated circumstance of environmental pollution, lifestyle and socioeconomic status. The special geopolitical setting in the regions where war took place intensifies the environmental problem particularly air, water and soil contamination caused by poor waste disposal and industrial and industrial emissions. The water crisis further compounds health risks, with contaminated water leading to kidney failure and cancer. The blockade limits access to medical supplies and advanced equipment for disease diagnosis and treatment. Additionally, ongoing military actions contribute to stress, trauma, and exposure to hazardous materials, increasing the risk of both communicable and non-communicable diseases [26].

Figure 4: Preventive Measures to Control the Spread of Communicable Diseases in Disasters



Source:

3.11. Antimicrobial resistance in the ongoing Gaza war, a silent threat

Conflicts and wars contribute significantly to the development and spread of antimicrobial resistance. In Gaza, antibiotic resistance is increasing, with a 300% increase in resistance to specific antibiotics seen in isolates from injured patients [27]. The factors responsible for antimicrobial resistance include limited resources, high casualties, suboptimal prevention control of infection, environmental pollution from infrastructure destruction, and heavy metals which are released from ammunition and explosives. Before the start of the war on Oct 7, 2023, inadequate wastewater management in Gaza led to bacterial contamination in 34% of hospitals' water and surface samples leading to high resistance to antibiotics, particularly to carbapenems and cephalosporin's. Due to limited access to essential antibiotics, antimicrobial resistance has further increased [28]. From May 2018 to December 2022, at Al-Awda Hospital, approximately 70% of positive cultures were multidrug resistant. In 2022, around 65% of Staphylococcus aureus isolates were resistant to methicillin, and around 35% of Pseudomonas aeruginosa isolates showed resistance to ceftazidime and imipenem. About 30% of cultures of Gram-negative isolates were resistant to extended-spectrum beta-lactamases, and approximately 25% of Enterobacteriaceae showed resistance to carbapenem [27]. In the pilot study, all water samples showed resistance to the widely used antibiotics Vancomycin, Gentamicin, and Linezolid, and all water and wastewater samples were resistant to Penicillin [29]. Gaza faces a constant influx of injured people with heavily contaminated wounds, mass casualties with restricted resources to manage the deceased, overcrowded hospitals with wounded patients lying on floors, and an absence of transmission-based precautions, exacerbating hospital-acquired infection transmission and community. A severe shortage of medical professionals puts further strain on already exhausted staff who prioritize limb-saving and life-saving procedures over infection and antimicrobial resistance prevention. Moreover, critical shortages in essential antibiotics, along with chaos, destruction, and dysfunctional micro-biological laboratories, make implementing antimicrobial stewardship an unattainable luxury [27].

4. DISCUSSION

According to research conducted, most of the illnesses among the residents of Gaza were because of intermittent water supply, and sewage flooding. This

finding is consistent with our research according to which the destruction of water and sanitation leads to the rapid spread of infections and significantly increases mortality and morbidity [30].

Another study in North Wollo during the Civil War revealed that 60% of children were either inadequately vaccinated or not vaccinated at all, which contributed to the swift spread of infectious diseases among them. This parallels our findings, which indicate that the ongoing conflict in Gaza has severely impacted healthcare infrastructure, resulting in similarly low vaccination rates and inefficient vaccine distribution [31].

Research conducted by Eran Bendavid revealed that food security is severely threatened during conflicts, leading to widely documented increases in the number of children affected by acute malnutrition. Modern-day famines are largely confined to conflict-ridden countries. Chronic malnutrition in children is also more prevalent, especially among those living near intense conflict zones. This is aligned with our research, which shows that Gaza is experiencing comparable issues, with severe damage to its healthcare infrastructure causing widespread malnutrition and heightened vulnerability to infectious diseases among its population (32).

5. CONCLUSION

The conclusions drawn from this research underscore the imperative of an immediate ceasefire in Gaza, a pivotal measure to mitigate escalating humanitarian crises and curb civilian casualties. Effectively addressing the acute humanitarian situation necessitates the robust expansion and sustained facilitation of humanitarian access, encompassing the uninterrupted provision of fuel, water, sustenance, pharmaceuticals, and essential commodities. Concurrently, the establishment of humanitarian corridors and the ensuring of secure passage for aid distribution within Gaza are indispensable to expedite and safeguard the efficacious delivery of assistance to vulnerable populations. Moreover, the proactive safeguarding of civilians and healthcare facilities assumes paramount importance in safeguarding lives and preserving the functionality of critical medical infrastructure amidst the conflict's tumultuous landscape.

Equally crucial is the implementation and fortification of systematic protocols for medical evacuation, guaranteeing timely referral and evacuation of critically ill patients, without distinction, to secure requisite medical care beyond Gaza's borders. These imperatives not only underscore humanitarian exigencies but also underscore the pivotal role in stabilizing Gaza's beleaguered healthcare infrastructure and alleviating the protracted suffering of its populace. Immediate and sustained international support and commitment are imperative to operationalize and maintain these measures effectively, thus addressing the pressing humanitarian exigencies exacerbated by the enduring conflict. This situation also highlights the urgent need for improved infection control measures in the region. Moreover, authorities and international peacekeeping organizations must take prompt action to prevent the spread of infection in Gaza, thereby averting a potentially catastrophic situation that could have far-reaching global consequences. They must fulfill their responsibilities to mitigate this crisis and prevent its escalation into a global health emergency.

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