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REVIEW ARTICLE

Top Five Infectious Disease Outbreaks among Displaced Populations during the Gaza Conflict 2023-2024: A Comprehensive Review

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Abstract

On October 7, 2023, the Israeli-Gaza conflict erupted, resulting in tens of thousands of deaths and injuries. The devastation extended far beyond immediate casualties, obliterating Gaza's essential infrastructure, including buildings, universities, institutions, sewage systems, electricity and water networks, and health facilities. The conflict displaced hundreds of thousands of people in cramped coastal areas, living in makeshift nylon tents with no access to basic services. The absence of sanitation and the mounting piles of garbage between the tents, compounded by a stringent blockade, have left these communities without proper cleaning facilities. The severe overcrowding, lack of sewage systems, and absence of clean drinking water have created a perfect storm for the spread of infectious diseases, further exacerbated by disease-carrying insects and the complete lack of health services, first aid, and accurate infection statistics. The combination of overcrowding, poor sanitation, and a lack of necessities has contributed to the outbreak of numerous infectious diseases among the displaced. This study sets out to illuminate the five most critical infectious diseases affecting this population. It explores the underlying causes of their spread and provides a concise overview of each disease. By analyzing the scant studies and statistics available from trustworthy health and news sources, along with other research findings, this study seeks to bring much-needed attention to this pressing issue. In addition, the current study revealed a significant spread of infectious diseases among the displaced, including scabies, lice, chickenpox, various diarrheal diseases, chest infections, and hepatitis A, with a brief mention of polio recently detected in sewage water. The study recommends raising awareness among the displaced about the dangers of these diseases and how to prevent them. It emphasizes the significance of maintaining personal hygiene and properly disposing of garbage away from living areas. Furthermore, it calls for relief workers to ensure the sterilization of drinking water and the consistent delivery of cleaning and sterilization supplies to the displaced population.

Keywords

Infectious, Disease, Gaza, Displacements, Overcrowding, Conflict

Introduction

Infectious diseases stem from harmful organisms that invade the body, disrupting health. These organisms encompass viruses, bacteria, fungi, and parasites. Transmission routes vary, from direct contact between people to tainted food or water, even insect's bites. Examples range widely, from flu and measles to HIV, COVID-19, smallpox, cholera, typhus, dysentery, malaria, salmonella … etc. [1,2]. It's crucial to know that these diseases fall into three distinct categories: those

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that lead to high mortality rates, those that significantly burden populations with disabilities, and those that, because of their rapid and unforeseen spread, can result in serious global repercussions [3]. Infectious diseases in adults within developing countries place a heavy burden on healthcare and public health systems. This strain is intensified by factors such as poverty, restricted access to healthcare, inadequate sanitation, and poor hygiene practices. Additionally, social determinants, environmental conditions, and occupational exposures add to the complexity of the issue. To effectively prevent and control these diseases, it is crucial to enhance healthcare systems, promote improved hygiene practices, bolster surveillance systems, and encourage collaboration across sectors [4]. Infectious diseases continue to impose a significant global burden, with high rates of morbidity persisting despite advancements in recent decades. According to annual estimates by the World Health Organization (WHO), there are between 300 and 500 million malaria cases worldwide, 333 million cases of sexually transmitted diseases (including syphilis, gonorrhea, chlamydia, and trichomoniasis), 33 million people living with HIV/AIDS, and 14 million new HIV infections annually. Additionally, tuberculosis affects 1.1 million people, and there are 3 to 5 million cases of cholera each year. These figures, along with numerous other infectious diseases, highlight the substantial and ongoing global health challenge they present [5]. It is crucial to note that on October 7, 2023, conflict erupted in Gaza, resulting in tens of thousands of casualties and injuries to date. This conflict has also led to the destruction of hundreds of thousands of homes, institutions, universities, schools, sewage systems, and water networks, devastating essential infrastructure and the health sector, including hospitals. Furthermore, more than 1.5 million people have been displaced, forced into overcrowded tent camps along a narrow strip on the Mediterranean coast, lacking even necessities of life. This severe overcrowding in displacement camps has exacerbated the already dire living conditions [6,7]. Furthermore, the ongoing conflict in Gaza has worsened the dissemination of infectious diseases by creating ideal conditions for outbreaks. Overcrowding due to mass displacement has packed shelters and refugee camps, leading to cramped living conditions. This high population density accelerates the transmission of diseases, particularly respiratory and gastrointestinal infections, as it increases human-to-human contact, which is crucial for the spread of pathogens [6,8,9]. In addition, the destruction of Gaza's infrastructure has severely impacted sanitation systems, resulting in a scarcity of clean water and proper sewage disposal. This has led to water contamination, fostering the dissemination of waterborne diseases like cholera, typhoid fever, and hepatitis A, which thrive in unsanitary conditions. Consequently, reports have indicated a significant outbreak of gastrointestinal diseases in Gaza during this conflict due to contaminated water sources and poor waste management [8,10]. The severe blockade during the Israeli-Gaza confect has undoubtedly led to food shortages and malnutrition, significantly increasing the population's vulnerability to infectious diseases. Malnutrition compromises the immune system, making individuals more prone to infections. The conflict has resulted in a critical shortage of food, heightening the risk of gastrointestinal and other infectious diseases [10,11]. Besides, the destruction of garbage trucks, the lack of fuel required for waste transport and treatment, and the severe overcrowding in displacement camps have led to the accumulation of tens of thousands of tons of garbage near or even within these camps. This situation has undoubtedly contributed to the proliferation of insects, which are key vectors in transmitting infectious diseases. These insects can spread pathogens both mechanically and through bites, posing a significant risk to the health of the displaced populations [12-14]. In general, conflicts and wars significantly contribute to the dissemination of infectious diseases due to several factors. Wars often lead to severe overcrowding, lack of access to proper healthcare, difficulties in administering vaccinations, and poor sanitation and clean drinking water. These conditions create an environment where infectious diseases can thrive [15,16]. This is evident in the current situation in Gaza, where the conflict has exacerbated these issues, leading to an increased risk of disease outbreaks. While some infectious diseases in Palestine had been documented and controlled prior to the current conflict, the situation has drastically changed. According to a 2020 report by the official Palestinian news agency, WAFA, diseases like polio, measles, tuberculosis, tetanus, mumps, and meningitis were present but kept to small, manageable numbers [17].

In stark contrast, the ongoing conflict has led to a significant surge in infectious diseases among the displaced populations, highlighting the severe impact of the current crisis. Unquestionably, due to the aforementioned logical factors, numerous infectious diseases have become prevalent in Gaza during the ongoing war. The most notable among them are diarrheal diseases, respiratory infections, scabies and lice, chickenpox, measles, meningitis, acute viral hepatitis, bloody diarrhea, and jaundice [11,18,19]. It is noteworthy to note that the following section of this review will offer an overview of the most significant diseases that have spread among the displaced during the Gaza War of 2023-2024.

Scabies

Overview

Scabies is a parasitic infection caused by tiny mites that burrow into the skin to lay their eggs, leading to intense itching and a rash. This condition can result in skin ulcers and severe complications such as septicemia (bloodstream infection), heart disease, and kidney

issues. Treatment involves the use of creams or oral medications [20]. Actually, human scabies is caused by the itch mite *Sarcoptes scabiei var. hominis*, a permanent parasite that is specific to humans. As arachnids, the nymph and adult stages of this mite have four pairs of legs, while the larvae have three pairs of legs [21]. Furthermore, scabies is highly contagious, primarily spreading through direct skin-to-skin contact with an infected person. It can also spread, to a lesser extent, through sharing contaminated personal items like clothing, bed linens and towels. Crusted scabies, in particular, is extremely contagious and can spread more easily through indirect contact [20,22]. Scabies is one of the most common and widespread skin diseases globally. As of 2015, it was estimated to affect approximately 204 million people worldwide. According to the Global Burden of Disease (GBD) study, the global prevalence of scabies was 100.6 million in 2010, rising to over 204 million by 2013. Notably, scabies accounts for 0.21% of global disability-adjusted life years (DALYs) [23-25]. Addressing scabies effectively involves using appropriate scabicide treatments alongside treating all contacts. Mass treatment with permethrin cream or ivermectin directly administered to patients is recommended. Prevention efforts include administering medical treatment and interrupting the chain of infection transmission. Crucially, eliminating the source and thoroughly disinfecting tools are essential steps. It's highly beneficial to involve non-medical personnel like educators, staff, and parents in collaboration with local healthcare providers. Utilizing checklists or mobile applications can assist non-medical staff in identifying suspected cases, aiding in the eradication of scabies. Collaborative efforts among patients, their families, healthcare professionals, and non-medical staff significantly mitigate the spread of scabies, ultimately enhancing the patient's quality of life [26].

Scabies in Gaza-Palestine

Scabies is a significant infectious disease that frequently spreads in wartime. Several sources and estimates reveal that this skin condition is widespread among displaced populations during Gaza conflict 2023-2024 [27]. One study reported 55,400 cases of scabies and lice outbreaks among children under five who have been displaced [28]. In addition, The World Health Organization has raised concerns that severe overcrowding in displacement camps, combined with a complete lack of hygiene practice, clean water, and healthcare, as well as poor sanitation, puts residents at risk of contracting infectious diseases, including scabies. The organization reported that over the past few weeks, more than 9,000 cases of scabies and lice have been documented among the displaced [29]. Scabies is a prevalent public health issue in the West Bank and Palestinian Territories. Research indicates that scabies is present in all governorates of the West Bank, with individuals under the age of 20 being particularly vulnerable. From 2005 to 2010, the average annual incidence of scabies in the West Bank was 17 cases per 100,000 people [30]. In Addition, one study showed that there have been three outbreaks of scabies in Palestine over the past 12 years, with the most serious outbreak linked to the war in the Gaza Strip in 2014. During this time, people were forced to leave their homes for safer but crowded places [31]. On the other hand, another study revealed that the total number of parasitic infection cases in the Palestinian territories over the past ten years reached 137,106, with 92,494 (67%) in the Gaza Strip and 44,612 (33%) in the West Bank. Among these were 8,665 cases of scabies, with 4,027 in the West Bank and 4,638 in Gaza. The higher prevalence of scabies in Gaza compared to the West Bank is attributed to factors such as high levels of poverty, poor personal hygiene, limited access to clean water, crowding and overpopulation in addition to inadequate sanitation systems. All of these issues have been exacerbated by the repeated wars and the siege on Gaza [32].

In a sobering update from Al Jazeera on July 3, 2024, the World Health Organization revealed alarming health challenges among Gaza's displaced population. Amid the ongoing conflict, over 96,400 cases of scabies and lice have been recorded, equating to more than one in ten individuals suffering from it. This foreshadows a severe health and environmental disaster in the region [33].

Chickenpox

Overview

Chickenpox, a widely transmitted and highly infectious disease, is caused by the varicella-zoster virus (VZV). This virus, belonging to the Herpesviridae family, comprises DNA viruses notorious for their lifelong occurrence in the human body. VZV is remarkably efficient at spreading, typically infecting people via respiratory droplets. Once it infiltrates human cells, it causes the hallmark symptoms of chickenpox: an extensive itchy rash, fever, and fatigue [34,35]. Chickenpox is widely recognized as one of the most highly contagious diseases affecting humans. It transmits mainly through direct contact with fluid from its characteristic blisters or through airborne transmission via respiratory droplets from an infected person, classifying it as an airborne disease. The virus can also be transmitted indirectly by touching contaminated surfaces or objects. Furthermore, individuals with active chickenpox can disseminate the virus for one to two days before the rash appears and continue to do so until all the lesions have crusted over. This pre-symptomatic transmission poses a significant risk factor; as infected individuals can unknowingly spread the virus before any symptoms become evident [34,36,37]. Globally, chickenpox (varicella) continues to be a highly prevalent infectious disease, with around 140 million cases of chickenpox and shingles reported worldwide in 2013. Notwithstanding the fact

that the level of incidence remains high, there has been a notable decline in mortality rates, with 6,400 deaths recorded globally in 2015, down from 8,900 in 1990. The mortality rate stands at about 1 per 60,000 cases. Before the varicella vaccine was implemented, chickenpox cases almost mirrored the annual birth rate. However, with widespread vaccination, infections in the United States have plummeted by nearly 90% [38,39]. By adopting these prevention and control measures -such as vaccination, maintaining good hygiene, isolating infected individuals, and thorough cleaning and disinfection- the spread of chickenpox can be significantly curtailed [40,41].

Chickenpox in Gaza - Palestine

According to WHO reports, over 90% of Palestinian children are vaccinated against chickenpox, showcasing strong adherence to the national vaccination program. The chickenpox vaccine is a standard part of Palestine's immunization agenda, with the first dose administered at 12-15 months and a second dose at 4-6 years of age. This high vaccination rate accentuates the effectiveness of public health initiatives in Palestine in ensuring widespread immunity among children [42]. While Palestine maintains high childhood vaccination rates, including for chickenpox, the region still faces challenges in achieving universal coverage and preventing occasional outbreaks. Proximity to areas with lower vaccination rates, such as Israel, has contributed to these outbreaks. For instance, in 2017, there was a notable increase in measles cases, likely due to the spread from unvaccinated populations in Israel. Continued efforts to bolster the healthcare system and vaccination programs are essential to protect Palestinian children from vaccine-preventable diseases like chickenpox [42]. Prior to the recent conflict, the occurrence of chickenpox in Gaza was relatively low due to the routine vaccination programs implemented in 2022, despite existing health system challenges. Nevertheless, by mid-2023, the escalation of conflicts led to severe overcrowding and a breakdown in healthcare services. This resulted in a dramatic increase in infectious diseases, including over 1,000 cases of chickenpox. The situation was aggravated by the lack of access to vaccines and healthcare facilities, making it difficult to control the outbreak effectively. On another note, according to UNICEF Report No. 15, released between January 11-17, 2024, chickenpox cases have surged dramatically since mid-October of last year, climbing to nearly six thousand cases [19]. The ongoing conflict has led to a staggering rise in skin infections, with over 150,000 people affected by the squalid conditions in the enclave. According to Al Jazeera, citing the World Health Organization on July 4, 2024, more than 9,274 cases of chickenpox have been reported among the displaced since the war began. This alarming surge highlights the severe impact of the war on public health, as overcrowding and disrupted healthcare systems have worsened the spread of diseases [33]. Furthermore, according to a report by UNICEF, residents of the Gaza Strip are on the brink of a significant outbreak of infectious diseases. Among the displaced population in the current conflict, 6,000 cases of chickenpox have been documented from mid-October 2023 until the report's release on January 24, 2024 [43].

Diarrheal Diseases

Overview

Diarrheal disease presents a formidable public health challenge, particularly pronounced in developing countries where it stands as a pervasive threat. Globally, it holds the grim distinction of being the third leading cause of mortality among children under 5-years-old. This condition not only affects individual health but also imposes substantial burdens on healthcare systems, economies, and societal well-being in regions grappling with limited access to clean water, sanitation, and healthcare infrastructure [44,45]. Annually, diarrhea causes the deaths of approximately 443,832 children under 5 and an additional 50,851 children aged 5 to 9 years. Across the globe, there are roughly 1.7 billion cases of childhood diarrheal disease each year. Moreover, diarrheal disease stands as a main cause of malnutrition among children under 5-years-old, underscoring its profound impact on child health and highlighting the critical need for effective prevention and treatment strategies [46]. Diarrhea often manifests as a symptom of infections caused by a diverse range of bacterial, viral, and parasitic organisms. The most common pathogens responsible include rotavirus, norovirus, adenovirus, astrovirus, *Escherichia coli*, *Salmonella* spp., *Shigella* spp., *Campylobacter* spp., *Cryptosporidium*, *Giardia*, and *Entamoeba* spp. These infectious agents are commonly transmitted through contaminated food, water sources, and inadequate hygiene practices, highlighting the critical role of sanitation and safe food handling in combating diarrheal diseases worldwide [44,47,48]. Overall, diarrheal disease remains a substantial public health burden, particularly in developing countries, despite its relatively stable incidence in developed countries including the United States. The disease is mostly caused by exposure to various pathogens in contaminated water and food, with its transmission heavily influenced by environmental factors such as air and water temperature, precipitation patterns, extreme weather events, and seasonal changes. These factors can affect the survival and spread of the pathogens, emphasizing the need for robust public health strategies that address these environmental influences to effectively reduce the global burden of diarrheal diseases [49].

Diarrheal diseases in Gaza - Palestine

The Gaza Strip, one of the world's most densely populated and vulnerable areas, grapples with significant

public health and developmental challenges. Climate change is worsening existing environmental issues, such as water scarcity. Consequently, diarrhea has long been an entrenched health problem in Gaza, even before the conflict of 2023-2024. Estimates indicate that over one million cases of acute diarrhea were reported to health facilities between 2009 and 2020 [50]. In another study implemented in Gaza, 421 out of 1,857 heads of household (22.7%) reported experiencing diarrhea within 48 hours prior to the interview, resulting in an overall prevalence rate of 3.8%. The prevalence was significantly higher in males (5.4/100) compared to females (1.3/100) across all age groups ($P < 0.05$). Additionally, factors such as socio-demographics, economic status, water quality, sanitation, and hygiene were identified as risk factors of diarrheal disease [51]. The Gaza Strip is highly conducive to diarrheal diseases due to various factors such as the healthcare system, water quality, sanitation facilities, and hygiene practices. The severe overcrowding exacerbates these issues, making diarrheal diseases the leading cause for children visiting primary health care centers and hospitals. Furthermore, the United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA) reported that the prevalence of diarrhea was 4,017.1 cases per 100,000 populations in 2009, rising to 6,448.2 cases per 100,000 populations in 2013 [51]. Since January 2009, the ongoing Israel-Palestine conflict has drastically impacted water and sanitation access in the Gaza Strip. A study investigated the link between water access and diarrhea cases at a primary health care center in Gaza. Researchers employed a matched case-control design, comparing 133 diarrhea patients to 133 non-diarrhea patients based on age, sex, and date of inclusion, with data collected in January/February 2010. A striking outcome was that 62% of patients depended on private water suppliers. The most important risk factors for diarrhea included restricted access to public water, the occurrence of poultry or rabbits at home. Stool analyses revealed bacterial infections in 5.5% of cases and Giardia duodenalis in 20% [52]. In Gaza, the most common causes of diarrhea among children under 5 years are intestinal pathogens, including rotavirus, *Entamoeba histolytica/dispar*, *Shigella* spp., *Campylobacter coli/jejuni, Escherichia coli*, *Salmonell*a spp., *Giardia intestinalis*, and *Strongyloides stercoralis* [53].

All of this happened prior to the conflict, and the situation has undoubtedly deteriorated as the number of danger elements has increased dramatically. A report by Al Jazeera News on its English page highlighted that over 33,551 cases of diarrhea have been reported, with at least half among children under five, according to the World Health Organization in 10 November 2023. For comparison, 2021 and 2022 saw an average of 2,000 cases per month in children under five. Drinking contaminated water remains a primary cause of diarrhea [54]. Furthermore, starting from mid-October 2023, Gaza has witnessed over 152,000 reported cases of diarrhea, with over half (81,000 cases) affecting children under five-years-old. This marks a staggering 23-fold increase in diarrhea cases among young children compared to the previous year in 2022 [42,55]. The catastrophic conflict has created numerous circumstances that have significantly increased the spread of diarrheal diseases among displaced people in camps. The war has disrupted health and water systems, severely damaging sewage and drinking water networks, leading to an extremely serious shortage of clean drinking and domestic water. Moreover, severe overcrowding in displacement camps has exacerbated the prevalence of diarrheal diseases, with limited access to sanitary facilities fostering an environment ripe for the rapid transmission of infectious diseases with symptoms such as diarrhea. Malnutrition and food insecurity, with 90% of children under the age of two in Gaza experiencing "severe food poverty," have further diminished the population's immunity [42,46,55,56].

Hepatitis A Virus

Overview

Hepatitis A, coined in 1967, refers to a liver infection caused by the hepatitis A virus (HAV), which primarily replicates in liver cells. HAV is a positive-sense RNA virus, part of the Picornaviridae family and the sole member of the Hepatovirus genus. Unlike its relatives, HAV takes a prolonged time to adapt in cell culture, replicates at a slow pace, and infrequently causes a cytopathic effect [57]. This virus made its debut in 1973 under the lens of immunoelectron microscopy, a groundbreaking global discovery. It stands out as the most prevalent among hepatitis viruses, spreading mainly through the fecal-oral route-ingestion of contaminated food or drink. Close personal contact also plays a significant role, making it a leading cause of acute liver disease both in the United States and worldwide. Fortunately, advances in detection, prevention, and treatment have led to a decline in HAV infections. The advent of accurate serological tests has paved the way for in-depth research into the virus's epidemiology, clinical manifestations, natural history, and swift diagnosis [58]. Sources indicate that symptoms of hepatitis A virus infection typically appear 14-28 days after the initial exposure. Furthermore, most cases resolve within a few weeks, some individuals may experience symptoms for up to 6 months. Younger children, particularly those under 6 years old, often remain asymptomatic even though they can still transmit the virus. The severity of symptoms generally increases with age, with the elderly and individuals with pre-existing liver conditions at a higher risk of severe complications. Common symptoms include loss of appetite, weight loss, general weakness, nausea, vomiting, high fever, jaundice, upper right abdominal pain, and occasionally diarrhea [59-61]. The

global prevalence of hepatitis A has diminished over time, mainly due to better sanitation, improved hygiene, and increased access to clean water in plenty of areas. Nonetheless, hepatitis A continues to be endemic in regions with inadequate sanitary conditions and limited access to safe water. The Global Burden of Disease Study reported approximately 158.94 million cases of hepatitis A worldwide in 2019, up from 139.54 million in 1990. Despite this rise in total cases, the age-specific incidence rate (ASIR) of hepatitis A remained fairly stable globally from 1990 to 2019, with an estimated annual percentage change (EAPC) of 0.00% [62,63]. Vaccination remains the most effective method for preventing hepatitis A, with several inactivated vaccines available globally. Enhancing access to clean water, sanitation, and hygiene (WASH) is crucial for reducing hepatitis A transmission, particularly in regions where the disease is highly prevalent. Despite this, hepatitis A outbreak can still occur even in countries with good sanitary conditions, often linked to imported food or transmission among at-risk groups [61,63].

Hepatitis A in Gaza-Palestine

Compared to many developing countries, there has been a lack of epidemiological research on hepatitis A in Gaza prior to the war. However, a rare study including 396 school children in Gaza revealed a significantly high prevalence of antibodies to the virus, with over 93% of the study sample testing positive [63,64]. During the ongoing conflict, the situation presents a stark contrast. Recent accounts reveal a significant surge of hepatitis A cases in Gaza since October 2023. The Palestinian Ministry of Health has documented over 8,000 confirmed cases, largely attributed to overcrowded conditions in shelters and displacement camps. The World Health Organization has also underscored the gravity of the issue, reporting 24 confirmed cases and noting a substantial number of individuals exhibiting jaundice, likely stemming from hepatitis A [65-67]. The ongoing conflict has severely disrupted Gaza's water, sanitation, and hygiene (WASH) infrastructure, resulting in shortages of clean water, non-functioning sewage systems, and poor hygiene conditions. Overcrowded displacement camps and shelters, with limited access to toilets and handwashing facilities, have created an environment conducive to the rapid spread of hepatitis A. Additionally, the collapse of the healthcare system, with many hospitals and clinics damaged or overwhelmed, has hindered the effective detection, diagnosis, and response to the hepatitis A outbreak [68,69]. In summary, the ongoing conflict in Gaza has created a perfect storm for a hepatitis A outbreak. The collapse of WASH infrastructure, overcrowded displacement camps, and a severely strained healthcare system have all contributed to the rapid spread of the virus. Addressing this public health crisis requires urgent action to restore essential services and provide humanitarian assistance to the people of Gaza.

Respiratory Infections

Overview

A respiratory tract infection (RTI) refers to any infectious disease impacting the upper or lower parts of the respiratory system. Infections in the upper respiratory tract (URTIs) encompass ailments like the common cold, laryngitis, pharyngitis/tonsillitis, acute rhinitis, acute sinusitis, and acute otitis media. Meanwhile, lower respiratory tract infections (LRTIs) cover conditions such as acute bronchitis, bronchiolitis, pneumonia, and tracheobronchitis. RTIs, caused by various viruses, bacteria, or fungi [70,71]. It's important to note that upper respiratory infections (URIs) impact the airway above the vocal cords, including the nose, sinuses, pharynx, and larynx. Typical symptoms of a URI include cough, sore throat, runny nose, headache, and fever. Common URIs encompass the common cold, tonsillitis, and sinusitis [72]. Conversely, lower respiratory infections (LRIs) affect the trachea, bronchial tubes, bronchioles, and lungs. LRIs tend to be more serious than URIs and are the leading cause of death among infectious diseases [73]. Moreover, numerous diseases involve systemic infections, often caused by bacteria such as *Streptococcus*., *Bordetella* (rheumatic fever), *Burkholderia pseudomallei*, *Mydophila*, *Corynebacterium diphtheriae*, *Haemophilus influenzae*, *Mycoplasma*, and various Cocci. *Coxiella burnetii* and *Legionella pneumophila* can lead to both acute and chronic systemic diseases. Viral pathogens, including SARS-CoV-2 (the cause of COVID-19) and common coronaviruses like 229E, NL63, OC43, and HKU1, are the most frequent culprits. Other significant viruses include the Middle East Respiratory Syndrome (MERS) coronavirus, human metapneumovirus, influenza virus, parainfluenza virus, respiratory syncytial virus, and human rhinovirus. Fungi associated with travel-related infections include *Blastomyces dermatitidis*, *Coccidioides* spp., *Cryptococcus gattii*, *Histoplasma capsulatum*, *Paracoccidioides* spp., and *Talaromyces marneffei* [71]. Additionally, Respiratory infections frequently follow seasonal trends, hitting temperate regions hardest during the winter months. Factors such as humidity and temperature influence how viruses spread. Infections from influenza, respiratory syncytial virus (RSV), and human coronaviruses are notably more common during this chilly season [74]. Acute respiratory infections claim the lives of 4.5 million children each year, mostly in developing nations. Pneumonia is responsible for 70% of these deaths, followed by measles-related pneumonia (15%), pertussis (10%), and bronchiolitis/croup (5%). The primary bacterial offenders are *Streptococcus pneumonia*, *Haemophilus influenzae*, and *Staphylococcus aureus*, with limited data on infections in infants. Respiratory syncytial virus (RSV) accounts for 15%-20% of viral cases, parainfluenza for 7%-10%, and influenza/adenovirus for 2%-4%. Mixed infections are common. Risk factors include large family size, late

birth order, crowding, low birth weight, malnutrition, vitamin A deficiency, lack of breastfeeding, pollution, and young age. Effective interventions are crucial to prevent these deaths and manage cases medically [75]. To mitigate respiratory infections, maintain good hygiene through regular handwashing, stay up-to-date with recommended vaccines, and lead a healthy lifestyle. While most RTIs clear up on their own with rest and plenty of fluids, individuals experiencing severe symptoms or those with underlying health conditions should seek medical attention [76,77].

Respiratory infections in Gaza - Palestine

Prior to the recent conflict escalation, respiratory diseases were already major health issues in Gaza, ranking as the 6th leading cause of death. In 2022, the region experienced nearly 82,000 COVID-19 cases, leading to over 400 deaths. This situation has put a tremendous strain on the health system, and the ongoing conflict has only worsened the conditions, underscoring the population's heightened vulnerability to respiratory diseases and other health emergencies [78,79]. Furthermore, a study conducted before the war, covering the years 2011 to 2016, revealed that 15,413 patients with acute respiratory tract infections (RTIs) were hospitalized during this period. The causative agent was identified in only 28.7% of these cases. Influenza viruses were found to be the most common cause of upper respiratory tract infections among Palestinian patients treated in West Bank hospitals. Children and the elderly were the most affected by these respiratory infections [80]. Since the war began, the World Health Organization has noted a significant increase in diseases among displaced individuals in the conflict zone. From mid-October 2023 to November 8, 2023, the WHO reported 54,866 cases of upper respiratory tract infections [19]. The relentless conflict and blockade in Gaza have significantly contributed to the surge of respiratory and other infectious diseases. The disruption of vital infrastructure, such as water and sanitation systems, has worsened the public health situation. Overcrowded shelters and living conditions have facilitated the rapid spread of infections. Moreover, the severe lack of access to healthcare services has left many without the necessary treatment, further escalating the spread of diseases. These combined factors have set the stage for a public health disaster in Gaza [68,81]. The surge in respiratory diseases during the conflict can be traced to several key factors. Inadequate access to clean water, proper sanitation, and waste management has fostered environments where disease vectors can flourish. Crowded conditions in shelters and displacement camps have made it easy for respiratory viruses and bacteria to spread quickly. Furthermore, interruptions to regular vaccination programs and a shortage of medicines have heightened vulnerability to infectious diseases [68,81]. Due to fuel shortages, many residents have had to turn to burning wood, charcoal, and other materials for cooking, leading to heightened exposure to toxic fumes and respiratory irritants. The smoke from these alternative fuels contains harmful pollutants like carbon monoxide and particulate matter, which can cause serious respiratory problems. Extended exposure to these pollutants can result in chronic respiratory diseases, worsening the overall health crisis in the region. This situation is especially dangerous for vulnerable groups, such as children, the elderly, and individuals with pre-existing conditions, who are more prone to the harmful effects of these toxic fumes [78,79,82,83].

Other Infectious Diseases

The spread of infectious diseases in Gaza during this war has not been limited to the five previously mentioned diseases. The absence of healthcare, vaccinations, and accurate statistics has allowed these diseases to expand their reach. Recently, a new alarm was raised when the polio virus was detected in sewage water samples. This discovery indicates the rapid spread of another infectious disease among the displaced populations, highlighting the urgent need for improved healthcare and preventive measures [84,85]. Furthermore, the World Health Organization reported 12,635 cases of skin rash by November 8, 2023, just one month into the war [19]. This alarming figure is especially concerning considering that the number of displaced individuals was significantly lower at that time, resulting in less overcrowding. Additionally, the infrastructure for sewage, drinking water, and other vital facilities had not yet sustained the severe damage it has now, which further exacerbates the health crisis. Furthermore, numerous infectious diseases have been speculated to spread among the displaced during the war, including cholera, amoebic dysentery, typhoid fever, and acute intestinal infections [86]. However, no definitive figures are available due to the severe scarcity of medical services following the near-total destruction of health infrastructure, including hospitals and other facilities. The lack of health oversight, documentation, and accurate statistics further complicates the situation. Obviously, the severe overcrowding, oppressive siege, lack of sanitation supplies, and poor personal hygiene have all contributed to the spread of lice among the displaced. These harsh conditions are not only responsible for lice outbreaks but also play a significant role in the spread of various other diseases within the population [87,88]. Lastly, it's significant to note that these factors have significantly contributed to the spread of lice and scabies among the displaced. According to the World Health Organization, since the onset of the war in Gaza, there have been 96,417 reported cases of scabies and lice, 9,274 cases of chickenpox, 60,130 cases of skin rash, and 10,038 cases of impetigo [19,33,89,90].

Recommendations

To curb the transmission of infectious diseases

among displaced individuals in Gaza's camps, this study advocates several crucial measures: Firstly, despite challenging conditions, displaced persons are urged to employ rigorous sanitation practices and hygiene protocols, while ensuring waste disposal far from camp areas. Additionally, relief organizations must rigorously sterilize water provisions to prevent waterborne diseases. Swift vaccination deployment, particularly against polio, is strongly advised to contain disease outbreaks. Enhanced cultural dissemination and awareness campaigns among displaced communities are recommended to promote disease prevention. Lastly, amidst Gaza's harsh wartime realities, the study underscores the importance of prompt treatment protocols for infectious diseases, advocating for the isolation of infected individuals to minimize contagion risks.

Conclusion

The current study concluded, through reviewing numerous studies, websites, and statistics, that the health situation among the displaced during the Gaza War (2023-2024) is dire. The lack of essential living necessities and hygiene facilities, coupled with severe overcrowding and the absence of healthcare and vaccinations, has led to the rampant spread of many infectious diseases. The study underscores the urgent need to provide necessary vaccinations to the displaced, especially against polio, which has reemerged during this research. It also highlights the catastrophic impact of the war on the environmental and health conditions in displacement areas, emphasizing the need for urgent attention to prevent further outbreaks and an even graver environmental and health crisis.

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