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Health in the Crossfire - Analyzing and Mitigating the Multifaceted Health Risks of the 2023 War on Gaza

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Abstract Analysis of health-related risks of the war 2023 on Gaza is becoming essential as it goes beyond the physical and mental health impacts. This paper examines the multifaceted and escalating health risks associated with the ongoing war in Gaza, employing a systems thinking approach to understand and address these complex challenges. The research focuses on the holistic analysis of health-related risks stemming from the 2023 War on Gaza. The paper discusses the immediate and enduring effects of war on health services, including the direct and indirect impacts on various population groups and healthcare systems. The study delves into the accumulation of health risks in Gaza, considering environmental factors, the breakdown of healthcare infrastructure, and the spread of infectious diseases. In this paper, the authors analyse the continuation of the war on the accumulated health-related risk factors, and it could be mitigated despite the increase in the number of Gazan injuries, fatalities, and the disruption of Gaza healthcare systems. Then, the authors introduce a novel '3S Framework' for urgent action, encompassing Security and prevention, management of Supplies, and restoration of the Supportive health system. This framework aims to mitigate the immediate and long-term health-related risks in Gaza, especially under continued conflict. By prioritizing top health risks using a risk factor matrix, the study provides a structured approach to addressing war injuries, mental health issues, infectious diseases, chronic conditions, malnutrition, and maternal and child health concerns. The paper exploits the need to adopt double-loop problem-solving approaches for mitigating health-related risks in Gaza that would lead to establishing scenarios using multidisciplinary thinking. The implication of this work is that it gives clear mitigation plans for risks to mental health, long-term public health challenges, slow development in children, and infectious diseases. Finally, the authors call for action now before the world faces risks of regional crises that might spread all over the globe.

Keywords Health, Health-related Risks, Mitigation of Risk, War Risks, Gaza. Public Health Crisis, Systems Thinking in Healthcare, Multidisciplinary Approach, Resilience

1. Introduction

Wars and armed conflicts have proven to have a profound and devastating impact on public health, often leading to both immediate and long-term health risks for populations. The escalation of health risks due to wars can be multifaceted, affecting individuals and communities at various levels:

Understanding the risks of the different health-related risks through holistic system thinking and taking them into consideration for the current impact of the war on Gaza should help define the priorities and the type of interventions by the health team on the ground. Using causal loop diagrams in the context of the Gaza conflict can provide a comprehensive understanding of the interlinked effects of war on the environment and health. This holistic view is crucial for developing effective, sustainable, and resilient response strategies for the health response as the war continues to escalate and the risk factors continue to increase and shift from one zone in the Gaza Strip to the other.

In this paper, the researchers review the impact of health-related risks on the recent wars, taking the (case of Afghanistan) as an example. The accumulation of health risks probability due to war 2023 in Gaza is explored along with the effective responses to the war situation from health professionals. The literature review also exploits both the environmental health crisis of the war on Gaza 2023 and the accumulated health risks on the population of Gaza.

After the literature review, the risks of War 2023 on Gazan's health are analysed, which helps to prioritise the top

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health risks as per the (probability x severity= risk factor). Then, a framework for urgent action to mitigate Gaza's health-related risks, especially if the war continues. The paper proposed what the authors called (3S Framework), where the first S is focused on security and prevention of escalation of health-related risks, then management of supplies for the second S, and restoring the supporting health system in Gaza for the third S.

2. Literature Review

2.1. Reviewing the Impact of Recent Wars on Health Services

The immediate and long-term health effects of war have been explicated elsewhere [1-2]; armed conflict causes an enormous amount of death and disability worldwide. It destroys families, communities, and cultures. It diverts scarce resources. It disrupts the societal infrastructure that supports the health care system. The depletion of resources, access to health care and general disruption to everyday life during times of armed conflict create excess stress and burdens, which leads to direct and indirect health impacts [3].

The health services delivery system is debilitated in armed conflict setting areas due to damage to health facilities and attacks on health care providers [4]. Chronic diseases like heart disease, diabetes mellitus, cancer, stroke, hypertension, respiratory diseases, oral diseases, arthritis, and obesity can lead to a reduced quality of life. In addition, it also causes long-term disability, hospitalisation, and death [5-6]. Delays in care and treatment due to armed conflict may result in poorly managed health issues, possible consequences, and multiple comorbidities [7].

Destruction of ecosystems as a result of wars, fires, clearing of natural habitats, and chemical spills could result in additional pressure on wildlife and the natural environment, ultimately affecting immediate and long-term human health through changes in the characteristics of pathogens and antimicrobial resistance that then lead to the emergence of rare infectious diseases, the re-appearance of eradicated diseases and frequent emergence of novel zoonotic diseases and all have deep linkages to the changing global environment [8].

Among different armed conflicts or wars in the world, the conflict in Ethiopia resulted in loss of life, destruction of infrastructure, as well as drained growth and development of the country [9]. Attacks and mistreatment of towns and villages in northern Amhara and in Afar since July 2021 have resulted in hundreds of civilian deaths from shelling or massacres, and by mid-September 2021, more than 550,000 people had been evacuated [10].

2.2. Learnings Type of Health Risks (Case of Afghanistan)

More than two decades of conflict have led to widespread human suffering and population displacement in Afghanistan; two studies from this country are significant in terms of both their scope and their findings. The first study [11] used a national multistage, cluster, population-based survey including 799 adult household members aged 15 years and above. 62% of respondents reported experiencing at least four trauma events during the previous ten years. Symptoms of depression were found in 67.7% of respondents, symptoms of anxiety in 72.2%, and post-traumatic stress disorder (PTSD) in 42%. The disabled and women had a poorer mental health status, and there was a significant relationship between the mental health status and traumatic events. Coping strategies included religious and spiritual practices.

The second study [12], using a cross-sectional multi-cluster sample, was conducted in the Nangarhar province of Afghanistan, to estimate the prevalence of psychiatric symptoms, identify resources used for emotional support and risk factors, and assess the present coverage of basic needs. About 1011 respondents aged 15 years and above formed the sample. Nearly half of the population had experienced traumatic events. Symptoms of depression were observed in 38.5% of respondents, symptoms of anxiety in 51.8% and PTSD in 20.4%. High rates of symptoms were associated with higher numbers of traumatic events experienced. Women had higher rates than men. The study shows that the main sources of emotional support were religion and family.

Over the long wars in Afghanistan, the Afghani's suffered a dramatic deterioration of a humanitarian, health, and environmental emergency that increased short and long-term risks to health and wellbeing; which include the spread of communicable diseases and deteriorated their quality of life. Besides, its deep multidimensional poverty (MPI), many outbreaks of waterborne, foodborne, and vector-borne diseases; conflict-related injuries, and mental health impacts are still prevalent in Afghanistan despite the end of the occupation of the USA and its allies a few years ago. [13]

2.3. Accumulation of Health Risks Probability Due to War on Gaza

Recent history shows that non-communicable diseases (NCDs) would be one of the main early risks that could pose a high probability of severity on the population, for example, through exposure to contaminated water, food, air, soil, and damaged building materials, such as those containing asbestos [14-15]. Exposure to outdoor and indoor air pollution caused by the unsafe burning of fuels, further compounded by often overcrowded living situations due to the war on Gaza, poses a health risk.

Understanding these probabilities is crucial for Gaza's healthcare providers, and humanitarian aid organisations, so that they can prioritise resources and interventions in different conflict zones in Gaza. It's important to note that these risks are interrelated and can exacerbate each other, making a holistic and proactive approach to healthcare and humanitarian aid essential.

2.4. Effective Responses to War Situation from Health Professionals

Motivation for public health involvement in the prevention of war derives from the professions' code of ethics, which affirms that public health focuses on "principally the fundamental causes of disease and requirements for health, aiming to prevent adverse health outcomes" [16] (p4).

The WHO has stated, "The role of physicians and other health professionals in the preservation and promotion of peace is the most significant factor for the attainment of health for all" [17]. War often infringes on international humanitarian law [18] specified in international conventions and protocols [19] and is illegal except in circumstances allowed by the United Nations Security Council.

Effective responses to the complex, interrelated, and multidimensional effects of the war on both the environment and health require methodological approaches that account for such complexities. Systems approaches, using tools such as causal loop diagrams, can provide novel insights that go beyond the multiple discrete elements of the problems that are faced to take into account the interactions and relations between these factors. An appreciation of these kinds of interactions can help to identify potential opportunities to disrupt harmful synergies, as well as support more effective prioritisation of both immediate actions and long-term recovery efforts in ways that will save lives and promote health and wellbeing [20,21,22].

2.5. The Environmental Health Crisis of War on Gaza 2023

The massive humanitarian toll of the war in Gaza, as in other conflicts, is thus compounded by an environmental health crisis, and as the conflict continues, the health of the people living in Gaza has been greatly affected. Access to medical care and basic necessities such as clean water and food have been limited, leading to an increase in diseases and malnutrition [23,24,25].

Children are especially vulnerable in these circumstances, with many suffering from trauma and psychological distress as a result of the ongoing violence. The war has devastated much of Gaza's infrastructure, disrupting essential services in many parts of the strip. This damage has affected the provision of and access to energy, water, food, sanitation and hygiene, waste management, health care, education, housing, transport, and agricultural products. The consequences of the war in Gaza have detrimentally impacted the environment as well as people's health and wellbeing beyond the direct harms of conflict. It is important for the international community to act and provide support to those affected by the conflict [26,27,28].

2.6. The Accumulated Health Risks on the Population of Gaza from War 2023

The population of Palestine has suffered from abject poverty, escalating conflict, occupation, and military incursions for more than a decade, and recently, in 2023, Gaza has been subjected to brutal and unprecedented aggression. The war causes civilians to leave their homes in search of safety. These displaced populations are at a greater risk of disease and illness. In particular, refugees are at an elevated risk of contracting infectious diseases.

Palestinian people who were displaced from their homes during times of conflict in October 2023 are subject to numerous factors that contribute to putting them at a greater risk of disease and illness. These factors include increased levels of poverty, overcrowded living conditions, food shortages, and lack of medical care or other social services. The overall health status in Gaza has declined and is expected to dramatically worsen in the near future as a result of the following conditions [29,30,31] shown in Table (1).

Table (1). Factors Affecting Human Health and Provide Base for Health-related Disaster

1. Destruction of critical infrastructure, including hospitals, clinics, water and sanitation systems.
2. Deterioration of the socioeconomic infrastructure.
3. Deterioration in the psychological and social wellbeing of communities.
4. Degradation of environmental conditions.
5. Lack of clean water and safe sanitation
6. Shortages of essential medicines and medical supplies/equipment
7. Restrictions on the supply of electricity lead to a breakdown in the cold chain for vaccines and disruption of safe blood storage and operation of medical diagnostic equipment.
8. Increased poverty
9. Fuel and goods insecurity
10. Increased rates of malnutrition
11. Re-emergence of diseases previously under control.

The destruction is comprehensive—it wears away the whole Gaza's Strip economy, environment, infrastructure, and population's physical and mental health. The plight of those Palestinians who are being displaced by the 2023 war, who become refugees, is heart-breaking. It is the role of public health to communicate clearly and consistently the challenges to health imposed by war, as depicted by the events in Gaza.

3. Methodology

Based on the literature review, a basic analysis of health-related risks of the war 2023 in Gaza, as well as physical and mental health impacts, is conducted. Also, the authors analyse the continuation of the war on the risks to women's health, increasing Gazans' injuries and fatalities, disruption of Gaza healthcare systems, environmental health risks, risk of malnutrition and food insecurity, children's health impact, and infectious diseases health impact.

The researchers use the matrix of risk factors to prioritise the top health-related risks due to the war on Gaza that started in October 2023. Then, a framework is proposed for urgent action to mitigate Gaza's highest health-related risks. The researchers bring in three Tables that help the Gaza health team and their multidisciplinary collaborators to focus on what could help to effectively stop the deterioration of the

health status in Gaza after three months of the war, if actions are taken as a priority.

4. Analysis of Risks of War 2023 on Gazans' Health

4.1. Physical Health Impact

The Gaza Strip, a small enclave home to roughly 2.3 million people, has been under continued bombardment by the Israeli military since October 7th, 2023, killing more than 21.000 and injuring more than 50.000 people, triggering mass displacement of the population and causing widespread destruction of civilian property and infrastructure [25,26,27].

The physical health of Gaza's residents has been seriously impacted; the conflict has led to severe injuries, including loss of limbs, spinal cord injuries, traumatic brain injury, and other physical disabilities due to the use of explosive weapons. The violence has led to numerous injuries, many of which are life-threatening. War also results in the destruction of critical infrastructure, including hospitals, clinics, besides water and sanitation systems. This destruction makes it difficult for civilians to receive medical care and proper sanitation, which can then result in a variety of other health problems. Prior to this latest outbreak of violence and Oppression in Gaza, about 80% of Gaza's population was dependent on humanitarian aid and food subsidies provided by humanitarian organisations.

Since October 7th, the Gaza Strip has been cut off from water and electricity networks, while all crossings for import of fuel and goods have been closed, leaving Gaza's population without the most basic needs for survival. Without fuel, Gaza's health facilities cannot deliver lifesaving healthcare, tend to the relentless flow of patients with trauma injuries, or provide basic necessities to people who sought safety from bombardment. [34] In the latest provided update on December 31, 2023, by the Ministry of Health (MoH) in Gaza, the Palestinian fatality toll in Gaza stood at 21,672, 8,506 of whom were children and 7,027 women. 5,700 persons, including about 2,500 children, are reported to be missing and considered to be trapped or dead under the rubble, awaiting rescue or recovery. Another 56,165, Palestinians have reportedly been injured [35,36,37].

4.2. Mental Health Impact

The war in Gaza has also had a severe psychological impact on residents. The continuous bombardment and lack of adequate help in Gaza can have severe and lasting impacts on the mental health of its residents. Prolonged exposure to war, violence, and instability can lead to a range of psychological and emotional issues, often compounded by the absence of sufficient support and resources.

Failure to mitigate the risks of this continuous exposure to inhuman situations would lead to risks of the spread of PTSD, risks of chronic anxiety, risks of deep depression and suicidal thoughts, risks of long grief and complicated bereavement, risks of slow development of Gaza children, risks of substance abuse, risk of deterioration of social and community networks, risk of long-term mental health challenges. This also would create an impact on the mental health of healthcare workers.

The mental health impact of the 2023 war in Gaza extends beyond the risks of PTSD and anxiety, profoundly affecting the psychological well-being of the population. There's a high prevalence of depression among the population due to the ongoing conflict, economic hardships, and loss of loved ones. The constant state of uncertainty and insecurity exacerbates feelings of hopelessness and despair. The continuous exposure to warfare and its aftermath causes trauma beyond the immediate physical injuries. This includes the trauma of loss (losing family members or homes) and the trauma of living in a constant state of fear and uncertainty.

The high casualty rates and destruction have resulted in widespread grief. People are not only mourning the loss of loved ones but also their homes, communities, and a sense of normalcy. Children, in particular, are vulnerable to the psychological impacts of war. Their exposure to violence and instability can lead to developmental issues, emotional disturbances, and behavioral problems. The impact on their education and normal development can have long-term consequences.

In some cases, individuals may turn to substance abuse as a coping mechanism to deal with the stress, trauma, and loss experienced during the conflict. The conflict disrupts community and social networks, which are crucial for mental well-being. The loss of these support systems can lead to feelings of isolation and difficulty in coping with the stresses of the situation.

4.3. Risk on Women's Health

Pregnant women may lack access to essential prenatal and postnatal care. Wars often see an increase in sexual violence, leading to physical and psychological trauma, and an increased risk of sexually transmitted infections.

The war in Gaza in 2023 has had a devastating impact on women's health and well-being. A major concern is the situation of pregnant women and new mothers, who are facing extreme hardships. According to the World Health Organization (WHO), there are around 50,000 pregnant women in Gaza struggling to receive basic health services, and many are expected to give birth in increasingly dire conditions. The conflict has led to the displacement of nearly 1 million women and girls, and more than 12,000 women and children have been killed. The situation is exacerbated by the lack of access to essential provisions in overcrowded shelters, heightening the risk of gender-based violence and other health issues.

The healthcare infrastructure in Gaza has been severely impacted. The WHO has reported that only 38 percent of pre-conflict hospital beds are available, and only 30 percent of the original health staff are still working. This has left hospitals and healthcare facilities struggling to cope with the influx of patients and the increased healthcare needs.

Furthermore, the blockade has limited access to clean water and electricity, exacerbating the crisis for women and girls, particularly in terms of managing menstrual hygiene and the increased health risks associated with it.

International organizations, including UN Women and Human Rights Watch, have highlighted the urgent need for humanitarian aid, including food, water, fuel, and health supplies, which are critical for the survival of women and girls in Gaza. Despite these efforts, the delivery of aid has been hampered, leaving many in desperate need of assistance.

The conflict has also had a profound psychological impact. High levels of depression and anxiety have been reported among both men and women, with the situation in Gaza being described as one of the most dangerous places for children. UNICEF has reported that the violence and upheaval have induced toxic stress in children, interfering with their physical and cognitive development.

4.4. Risk of Increasing Injuries and Fatalities

Bombings, gunfire, and other forms of violence lead to traumatic injuries, including life-threatening ones. High mortality rates are a direct consequence of warfare, with both combatants and civilians often losing their lives.

The 2023 war in Gaza have a significant risk due to wide range of injury types reported. Due to bombings and explosions, blast injuries are common. These include traumatic amputations, penetrating injuries from shrapnel, and injuries from the blast wave itself affecting the ears, lungs, and brain.

Gunfire results in penetrating injuries, often leading to severe blood loss, damage to organs, and complex bone fractures. Incendiary devices and explosions can cause severe burns, which are complicated to treat and have a high risk of infection, especially in a setting with limited medical resources. The destruction of buildings and infrastructure can lead to crush injuries, often resulting in complex fractures, internal organ damage, and the risk of crush syndrome, a life-threatening condition.

One of the increasing traumatic injuries are head injuries from blasts, falls, or debris can lead to traumatic brain injuries, ranging from concussions to severe brain trauma. Children are suffering deep injuries that affect their development and growth. Their smaller bodies is making them more susceptible to severe injury from blasts and shrapnel.

These injuries are compounded by secondary health issues such as infection, especially in a war-torn area where healthcare infrastructure is compromised and access to clean water and sanitation is limited.

4.5. Disruption of Gaza Healthcare Systems

Bombing and military operations often damage hospitals, clinics, and other healthcare facilities. The continuation of the War on Gaza often leads to shortages in medical supplies, equipment, and qualified healthcare personnel. Many of Gaza can be considered as conflict zones, which means becoming inaccessible, preventing people from receiving necessary medical care.

4.6. Environmental Health Risks

The use of certain weapons can release toxic substances into the environment, posing long-term health risks. Destruction of infrastructure and ecosystems can have secondary health effects.

4.7. Risk of Malnutrition and Food Insecurity

Wars often lead to food shortages due to disrupted supply chains and agricultural activities. Lack of access to nutritious food can lead to widespread malnutrition, especially among children. Chronic malnutrition can result in long-term developmental issues in children.

4.8. Children's Health Impact

The youngest members of Gaza society are particularly vulnerable to the health impacts of conflict. Children are often the most affected by food insecurity and malnutrition. They are also at a greater risk of developing mental health problems due to exposure to violence and trauma.

4.9. Infectious Diseases Health Impact

Generally, war and conflict can have a significant impact on public health, including the spread of infectious diseases. Some of the potential effects result from the displacement of populations, which creates crowded and unsanitary living conditions in refugee camps or temporary shelters. War also can disrupt healthcare infrastructure, making it difficult for people to access medical care and for healthcare providers to deliver services. Individuals will be more susceptible to infectious diseases, and the severity of illnesses will be further exacerbated by food shortages and malnutrition, in addition to the disruption of disease surveillance and control programs, making it challenging to monitor and respond to infectious disease outbreaks effectively.

The indirect impact of any war on the healthcare sector includes a significant rise in infectious disease cases mainly due to limited access to safe water, such as gastroenteritis outbreaks like cholera, shigella or other gram-negative bacterial pathogens. Due to the migration of thousands of people to a small geographical area, there have been reports of cases of contagious respiratory disorders such as tuberculosis, influenza and COVID-19, mainly due to the crowded living conditions.

Non-cholera bacterial agents, such as bacillary aetiologies of enteric disease, would be expected, but in the vast majority of diarrheal cases, the etiologic agents might not be established. The development of such diseases could be more catastrophic than the number of casualties from airstrikes or ground invasions.

According to the United Nations (UN) and the Palestinian Health Authority, Gaza is not getting enough aid to match their basic emergency needs. The UN has warned that due to a lack of clean water, the deaths from infectious diseases

could outstrip those from war itself. A UN report stated that only a dripping of aid reached Gaza, even during the fighting pause, and this is not nearly enough to serve the affected population. Infectious maladies such as the emergence of chickenpox are soaring in Gaza, with more than 1000 cases documented, the WHO reported [29].

According to the most recent report from inside Gaza, approximately 55,000 cases of upper respiratory tract infection have been recorded so far. This could progress to more severe respiratory infections and would affect the overall health of the individual. Respiratory diseases were already labelled as the sixth-most common cause of death in the Gaza Strip prior to the outbreak of the war before the October 7th conflict. Over 12,000 cases of skin rash have been reported, including scabies from inadequate water supply for proper hygiene; the cases of scabies and lice have exceeded 8000 so far [29]. Various infections are developing due to unsafe drinking water as a result of severely restricted water supplies across Gaza, leading to people resorting to seawater use.

Going back to the history of wars in different parts of the world, such as the Afghan war during the US invasion, several outbreaks of infectious diseases among both foreigners and local populations were reported. Available data suggest that the Afghan population was greatly affected by many infectious diseases, with excess mortality from diarrheal disease (including cholera), respiratory tract infections, and measles, mainly due to population displacement and destruction of infrastructure. It appears likely that the infectious disease situation in Gaza will worsen before improving. Control of communicable infectious diseases will have to be a top priority of local and relief officials.

The risk of emerging infectious diseases is very high indeed, and can include viral haemorrhagic fevers, COVID-19, malaria and trypanosomiasis, as previously highlighted by Gayer et al. in 2007 while analysing the geographic distribution of such infections as documented by the WHO [31].

Besides, long wars like Afghanistan, recent history shows a correlation between cases of emerging infectious diseases that lead to high mortality in war-torn zones over the last century can be summarised as follows:

- *Ukraine (2021)* - The appearance of paralytic polio diagnosed in 2021 resulted in a vaccination campaign, which was unfortunately also limited by the war [30],
- *Syria (2018)* - A measles outbreak developed in 2017/2018 after the disease had been almost non-existent since 1999.
- *Kosovo (2000)* (post-war)- The occurrence of the Tularaemia outbreak amongst displaced people from 1999-2000.
- *Tajikistan (1994)* - The occurrence of the Plasmodium falciparum Malaria outbreak in 1994 after 35 years of virtual elimination of malaria [32]
- *World War II (1939-1945)*- The occurrence of Typhus and malaria became prevalent.
- *World War I (1918-1919)*- The occurrence of Spanish flu spread and became a pandemic with a very high mortality rate.

Table (2) summarises the different types of recent infections that have been reported in war/conflict zones since the 1990s [31,34].

Table (2). Emerging or Re-Emerging Infectious Diseases Previously Reported in War or Conflict Zones

Bacterial	Viral	Viral Haemorrhagic Fevers	Parasitic
Shigella Dysenteriae	Influenza (H5N1)	Ebola	Trypanosomiasis
Cholera	SARS-CoV	Marburg	
Malaria	Monkeypox	Crimean-Congo Haemorrhagic Fever (CCHF)	
Tularaemia	Nipah	Lassa fever	
Plague	Hendra	Rift Valley fever	
	Polio	Yellow fever	
	Hepatitis E virus		
	Measles		

War-torn environments also promote the development of antimicrobial resistance (AMR). In Ukraine, the interruption of HIV and TB treatment placed the displaced people at risk of developing AMR. [30]. Hence, it is key that the urgent re-establishment of health care services is facilitated, to avoid the severe consequences that will likely result otherwise.

Lack of immunisation or any interruption in the immunisation program and services would have both a short-term and long-term impact on the prevention of many preventable viral illnesses such as hepatitis viruses, which is well known to be a significant health risk for the local people, humanitarian workers and neighbouring countries. Historically, hepatitis A and B have been major infectious diseases, and more recently, there has been concern about hepatitis C because a high prevalence of hepatitis C virus (HCV) infection has been found in some populations of different countries in the region.

5. Prioritising the Top Health Risks Due to the War on Gaza 2023

The types of health risks during the war that started in December 2023 in Gaza can be categorised and prioritised based on the probabilities and total risk factors, which are the result of

(Probability x Severity= Risk Factor).

Table (3) shows the high, moderate and low probabilities compared to the type of risks. The total risk factor, for example, as a result of multiplying the probability by the

severity, would define the priority of talking about the type of accumulated risk. i.e. War Injuries and mental health, along with infectious diseases, should be the top priorities for the health team in Gaza due to their total risk factors.

Then, the next set of health-related risks that need to be tackled by the health team in Gaza, even if the war continues, are addressing people with chronic diseases, the increase of malnutrition and maternal and child health issues.

Table (3). Type of Probability and Severity that Resulted from War on Gaza 2023

Type of Risk Probability *(Total Risk Factor)*	**Probability 1**	**Probability 2**	**Probability 3**
1. High Probability Risks *especially in areas of active conflict.* *(3 x 3= 9)*	**1-Warfare Injuries:** Includes injuries from explosives, shrapnel, and gunshots.	**2-Mental Health Issues:** Stress, trauma, and loss associated with war significantly increase the likelihood of mental health issues such as PTSD, anxiety, and depression.	**3-Infectious Diseases** Overcrowding, poor sanitation, and limited access to clean water can lead to the spread of infectious diseases like cholera, typhoid, and hepatitis.
2. Moderate Probability Risks *(2 x 3 = 6)*	**1-Chronic Disease Complications:** People with chronic conditions like diabetes, heart disease, or respiratory issues may face complications due to disrupted access to medications and healthcare services.	**2-Malnutrition:** Food scarcity or limited access to balanced nutrition can lead to malnutrition, especially in children and vulnerable populations.	**3-Maternal and Child Health Issues**: Pregnant women and children are at risk of health complications due to limited access to healthcare services, including prenatal and postnatal care.
4. Long-Term Health Risks *(2 x 3= 6)*	**1-Cancer and other Long-Term Illnesses:** Long-term exposure to certain war-related environmental factors, like depleted uranium or other toxic substances, can increase the risk of cancers and other chronic illnesses over time.	**2-Psychological Trauma:** The long-term psychological impact of war, including trauma and chronic stress, can have profound effects on mental health.	
5. Indirect Health Risks: *(2 x 2 = 4)*	**1-Healthcare Infrastructure Damage:** Destruction of healthcare facilities reduces access to medical care, indirectly affecting overall health.	**2-Economic and Social Disruption:** Long-term economic and social disruptions can lead to poverty, which is strongly correlated with various health issues.	
3. Lower Probability but High Impact Risks *(1 x 3= 3)*	**1-Chemical Exposure:** Depending on the nature of the conflict, there might be a risk of exposure to hazardous chemicals, although this is less common.	**2=Radiation Exposure:** Similar to chemical exposure, this is a less likely but highly impactful risk, especially if there's damage to facilities housing radioactive materials.	

6. Framework for an Urgent Action to Mitigate Gaza's Health-related Risks

6.1. Introduction to the Purpose of the Proposed Framework

As the conflict and War on Gaza escalates, the healthcare system faces unprecedented challenges. The attacks have put healthcare workers in an untenable position, with many dealing with an overwhelming number of injured patients while facing severe shortages of essential supplies. Thousands of internally displaced people who have sought refuge in hospitals are now at risk due to shortages of food and medicine. Gaza's hospitals are running with inadequate medical staff, as some have been killed or injured outside of their work. The situation in Gaza has reached a critical juncture as Human Rights Watch (HRW) presents evidence of repeated, apparently unlawful attacks on medical facilities, personnel, and transport by the Israeli military. These actions have severely compromised Gaza's healthcare system, resulting in a grave healthcare crisis that demands swift international intervention.

This paper calls upon more organised action to address the urgency of the health risks on the Gazans and even the rest of the world. The international community need to take immediate action to address the crisis in Gaza's healthcare system. Building on the capacities and partnerships developed during the COVID-19 response that helped overcome the pandemic, the international community can provide support to maintain the healthcare system in Gaza.

In this article, the authors proposed an action plan that may provide a framework for understanding the relationship

between the impacts of wars in Gaza on human health and communities, which may enable a successful response, with the aim of creating potential pathways to improve the health care system. We have identified the factors that led to the collapse of the Gaza health system, and which may lead further to a potentially high-risk environmental disaster, which is illustrated in Tables (1), (2), and (3) based on those factors the proposed action plan takes three pathways.

6.2. The 3S Framework

The proposed framework is very simple, and we call it 3S's (Security, Supplies, Support), which can be explained by the following:

6.2.1. Security and Prevention of Escalation (S1)

It is undisputed that security is essential to ensure the provision of sustainable health services, so the international community must pressurise towards establishing safe areas inside the Gaza Strip, north and south, with safe corridors.

Several countries, including the United States, United Kingdom, Canada, Germany, and others, should suspend military assistance and arms sales to Israel as long as such actions continue. The Israeli government should be scrutinised for their unlawful attacks on hospitals, ambulances, and other civilian objects by different means. The blockade of Gaza, which amounts to collective punishment, should also end.

6.2.2. Management of Supplies (S2)

All governments should demand that Israel restores the flow of essential resources, including electricity, water, fuel, and humanitarian aid, to Gaza, ensuring that these vital supplies reach the civilian population.

The international community should work to secure the Gaza Strip's needs for goods and energy. All the efforts should work to restart clean water stations and provide safe and healthy camps.

6.2.3. Restoring the Supporting Health System (S3)

An urgent call for volunteering, especially for medical personnel, in order to fill the deficit in the number of health service providers. Emphasis on establishing field hospitals with the aim of accommodating the wounded and injured and providing treatment for patients with chronic diseases should continue till Gaza stands up again on its feet.

Working to transfer patients most in need of intensive care, rehabilitation, and major surgery, to neighbouring countries should be more organised from both priorities and speed. Besides, assisting in renovating existing hospitals and providing them with medical personnel should be part of these 3S parallel efforts.

In the meanwhile, the WHO, along with its partners, including the local public health authorities in Gaza, should be adopting a strategy to combat infectious diseases even if the war doesn't stop. This strategy should extend to eliminating and/or treating the complications of malnutrition.

7. Discussion and Conclusions

7.1. Need for Adopting Double Loop Problem-Solving Approaches for Mitigating Health-Related Risks in Gaza

The war that started in October 2023 in Gaza has impacted the health and the environment in a complex and multidimensional way that was never experienced before and since the occupation of Palestine.

Understanding how various components of the health system during the war on Gaza interact with each other is very important since it would help to take into consideration all the human needs, the environmental factors, the targeted health risk mitigation outcomes, and the social structures, while taking into consideration also the economic conditions, and the political landscapes. Applying systems thinking to health-related risks would help identify how changes taken by the Gazan health team in one aspect can ripple through and affect others.

Causal Loop Diagrams (CLDs) could be used to visualise the relationships between different elements within the war-impacted health system in Gaza. The war on Gaza would need to be observed from the perspective of the level of Gaza's environmental degradation (like pollution or destruction of infrastructure) and how all of this accumulated risks to public health (through waterborne diseases, respiratory issues, etc.). Then, one could see how all of these health issues can further affect social and economic stability.

CLDs often include feedback loops, which are pathways that either amplify (positive feedback) or stabilise (negative feedback) changes in the war-impacted Gaza health system. For instance, poor health outcomes might lead to greater healthcare demands, straining resources, and potentially leading to further health declines (a positive feedback loop). Understanding these loops is crucial for identifying leverage points where interventions could be most effective.

7.2. Need for Establishing Scenarios for Mitigating Health-Related Risks in Gaza Using Multidisciplinary Thinking

In order for the health team in Gaza to have the capacity to address the complex war effects on Gaza's health and the environment, they need to apply holistic thinking and work with multidisciplinary teams. Professional expertise is needed from various fields such as education, environmental science, public health, psychology, sociology, economics, engineering and political science. To ensure the best collaboration between the different professionals, comprehensive views that transcend traditional disciplinary boundaries need to be done using systems thinking approaches. For example, by mapping out different causal pathways and feedback loops, the different team members can use CLDs to test various scenarios and interventions, assessing potential outcomes before implementing any mitigation program or actions, so that they ensure their best effects on the health and the environment.

7.3. Mitigating Risks of Mental Health Challenges

The mental health consequences for Gazans in the face of continuous bombardment and lack of aid are profound and multifaceted, affecting individuals of all ages and permeating the fabric of society. Addressing these mental health needs requires not only immediate psychological support but also long-term strategies to rebuild and strengthen community resilience and provide ongoing mental health care. The international community's role becomes crucial in providing aid, support, and resources to address these escalating mental health crises in conflict zones like Gaza.

Destruction and displacement can lead to poor sanitation, increasing the risk of waterborne and infectious diseases like cholera and typhoid. Displacement camps can become overcrowded, facilitating the spread of diseases like tuberculosis and respiratory infections. War disrupts vaccination campaigns, increasing the risk of outbreaks of diseases like measles, polio, and diphtheria.

The prolonged nature of the conflict and repeated exposure to traumatic events can lead to chronic mental health conditions that may persist even after the conflict ends. There is often a stigma attached to mental health issues, and in the context of Gaza, there is also a significant lack of access to mental health services, making it difficult for those suffering from mental health issues to seek and receive appropriate help.

The mental health impact of the conflict is complex and multifaceted, requiring a comprehensive and sustained response from the international community, including access to mental health services, psychosocial support, and efforts to rebuild the social fabric of the affected communities.

7.4. Mitigating Long-term Public Health Challenges

The aftermath of war often leaves populations struggling with increased rates of chronic diseases due to prolonged stress, poor lifestyle, and lack of medical care. There is often a high need for physical and psychological rehabilitation services post-conflict.

The escalation of health risks due to wars is extensive and complex, affecting individuals and societies on multiple levels. The consequences are not only immediate but can also persist long after the conflict has ended, requiring comprehensive and sustained public health responses to address these challenges effectively.

7.5. Mitigating Risks of Slow Children's Development

The risks of slow developmental progress in children due to the war in Gaza are substantial and multifaceted. Addressing these issues requires a concerted effort from local and international bodies to provide necessary support, including psychological counselling, educational resources, healthcare, and stable environments. Ensuring the wellbeing and development of children in conflict zones like Gaza is crucial, not only for their immediate welfare but also for the future stability and health of the society.

Mitigating the risks of slow development in children during the war in Gaza is a complex challenge that requires a multifaceted approach. Efforts must be directed toward ensuring the safety, health, and emotional wellbeing of children, even in the midst of conflict.

7.6. Mitigating Risks on Women Health

The situation in Gaza poses serious risks to the health and safety of women, and there is a pressing need for a humanitarian ceasefire and unimpeded access for aid to address these critical issue regarding specific physical and mental needs.

Pregnant women and newborns face particular risks, including injuries leading to premature birth, miscarriage, or complications during childbirth due to lack of medical care.

7.7. Mitigating Risks of Infectious Diseases

Addressing the impact of wars and natural disasters on infectious diseases is a complex challenge that necessitates a comprehensive and coordinated approach, which can be achieved via a multifaceted strategy including proper humanitarian assistance, repair, and reconstruction of damaged healthcare facilities, besides strengthening disease surveillance systems to monitor and detect infectious diseases promptly. The mitigation of infection spread should be done by practical measures that improve water and sanitation conditions as much as possible.

7.8. 'Call for Action Now' Before Facing Regional Crisis

This article focuses on the mitigation of health-related risks as a means to help Gaza to be resilient to the oppression of the Israeli uncontrolled violence on civilians. However, if the Gazan health team is not supported to at least mitigate these risks, the international community will see that these health crises will spread all over the region and the world beyond anyone's imagination.

The third month of the war is carrying increasing threats to health. A total siege on Gaza, blocking food, water, electricity, and fuel for all residents, is still ongoing. The collective punishment of Palestinians living in Gaza by heavy aerial bombardment and indiscriminate attacks has been escalating severe health consequences in all categories, including women and children.

During war times, hospitals are usually known to avoid targeting. Despite this fact, all healthcare facilities and healthcare professions are deliberately targeted. The threat of health crises has to be immediately addressed and dealt with within a humane framework similar to the one addressed in this study. Otherwise, we need to think about the legitimacy of all the international agencies working in this field and whether they could be dependent upon in any future crisis.

7.9. Final Words

The war in Gaza in 2023 has led to a multifaceted health crisis with far-reaching implications, both immediate and long-term, for the population. This study has highlighted the complexities and severity of health-related risks arising from

the conflict, emphasizing the necessity of a comprehensive, systems-oriented approach to address these challenges effectively. The impacts are particularly severe on vulnerable populations, including children, women, and the elderly. The 2023 war on Gaza has also led to significant environmental degradation, which further threatens public health, highlighting the interconnection between environmental and health issues. Collaboration across disciplines is essential for developing and implementing the effective response strategy framework suggested in this study. Without immediate and coordinated action, the health crisis in Gaza risks escalating into a regional crisis, underscoring the need for a global response to this devastating conflict.

In conclusion, the war on Gaza presents a complex health emergency that demands immediate, coordinated, and multifaceted responses. The '3S Framework' proposed in this study provides a strategic approach to addressing the most pressing health risks. However, the success of any intervention depends on the commitment and collaboration of the international community, along with the implementation of systems approaches to ensure holistic and sustainable solutions. The situation in Gaza is a stark reminder of the profound and lasting impact of the war on the strip public health and the urgent need for peace and stability to restore whatever is left of the health and the wellbeing of the population there.

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