Challenges in access to safe drinking water and its impact on maternal and child health in Gaza

Gazze'de güvenli içme suyuna erişim zorlukları ve bunun anne ve çocuk sağlığı üzerindeki etkisi

Iman Farajallah[1,2,3], Hanan Farajallah[4]

[1] Clinical Psychology, Hyde Street Community Services Clinic, San Francisco, California, USA

[2] Sumud Publishing Company, California, USA

[3] Iman Network, Santa Clara, California, USA

[4] High School, Gaza Strip, Palestine

Abstract

Access to safe drinking water is a critical public health issue, particularly in war-affected regions like Gaza, where political instability, infrastructure destruction, and economic blockade have led to a severe water crisis. This paper explores the challenges faced by the population of Gaza in accessing clean water and examines the impact of water scarcity on maternal and child health. The contamination of Gaza's primary water source, the coastal aquifer, combined with inadequate sanitation infrastructure, has resulted in widespread waterborne diseases, such as diarrhea, cholera, and typhoid, which disproportionately affect pregnant women and children. For pregnant women, water insecurity increases the risk of dehydration, malnutrition, and infection, contributing to poor pregnancy outcomes such as preterm labor and low birth weight. Children are similarly vulnerable, with unsafe water consumption leading to high rates of morbidity and mortality due to diarrheal diseases and malnutrition. This paper also highlights the psychosocial impacts of water insecurity on maternal and child mental health. Despite international humanitarian efforts, sustainable solutions remain elusive due to political and logistical barriers. The study underscores the urgent need for comprehensive interventions that address both the short-term water needs and long-term infrastructure challenges in Gaza to improve maternal and child health outcomes.

Keywords: Child; Gaza strip; human rights abuses; maternal; mental health; war; water

Öz

Güvenli içme suyuna erişim, özellikle savaş bölgelerinde kritik bir halk sağlığı sorunudur. Gazze'de siyasi istikrarsızlık, altyapı yıkımı ve ekonomik ambargo nedeniyle ciddi bir su krizi yaşanmaktadır. Bu makale, Gazze halkının temiz suya erişimde karşılaştığı zorlukları ve su kıtlığının anne ve çocuk sağlığı üzerindeki etkilerini incelemektedir. Gazze'nin ana su kaynağı olan kıyı akiferinin kirlenmesi ve yetersiz sanitasyon altyapısı, ishal, kolera ve tifo gibi su kaynaklı hastalıkların yayılmasına neden olmuştur. Bu hastalıklar özellikle hamile kadınları ve çocukları orantısız bir şekilde etkilemektedir. Hamile kadınlar için su güvensizliği, dehidrasyon, yetersiz beslenme ve enfeksiyon riskini artırarak erken doğum ve düşük doğum ağırlığı gibi olumsuz gebelik sonuçlarına yol açmaktadır. Çocuklar da benzer şekilde savunmasızdır; güvensiz su tüketimi, ishal hastalıkları ve yetersiz beslenme nedeniyle yüksek morbidite ve mortalite oranlarına neden olmaktadır. Bu makale ayrıca su güvensizliğinin anne ve çocukların ruh sağlığı üzerindeki psikososyal etkilerine de dikkat çekmektedir. Uluslararası insani yardım çabalarına rağmen, siyasi ve lojistik engeller nedeniyle sürdürülebilir çözümler hâlâ bulunamamıştır. Çalışma, Gazze'de hem kısa vadeli su ihtiyaçlarını hem de uzun vadeli altyapı sorunlarını ele alan kapsamlı müdahalelere acil ihtiyaç olduğunu vurgulamakta ve anne ile çocuk sağlığı sonuçlarını iyileştirmek için öneriler sunmaktadır.

Anahtar Sözcükler: Anne; çocuk; Gazze şeridi; insan hakları ihlalleri; ruh sağlığı; savaş; su

Received/*Geliş* : 30.10.2024
Accepted/*Kabul*: 28.11.2024

DOI: 10.21673/anadoluklin.1575390

Corresponding author/*Yazışma yazarı*

Iman Farajallah
Clinical Psychology, Hyde Street Community Services Clinic, San Francisco, California, USA.
E-mail: imaanfarj@gmail.com

ORCID
Iman Farajallah: 0009-0008-2391-6149
Hanan Farajallah: 0009-0006-8444-0266

WATER SCARCITY IN GAZA: A HUMANITARIAN CRISIS

Water is a fundamental necessity for human life, underpinning basic survival and economic activities. As the Quran notes, "And we made from water every living thing" (1). However, since 1967, Israeli authorities have required permits for any water-related infrastructure, including rainwater collection systems, under Israeli occupation military order 158**.** Palestinians are frequently denied these permits, and structures built without them are subject to demolition, severely limiting water access, particularly in arid regions where rainwater harvesting is crucial. This has forced many Palestinian communities to rely on purchasing water from Israeli companies at high costs, negatively impacting agricultural activities and livelihoods (2). In the Gaza Strip, Israel controls the entry of essential materials needed for building and maintaining water infrastructure. Since the blockade in 2007, these restrictions have made developing effective rainwater harvesting systems nearly impossible. Gaza's water crisis is compounded by the destruction of water and sewage facilities, leaving 97% of the water undrinkable due to contamination. The blockade severely limits efforts to repair or build rainwater collection systems, further exacerbating the water shortages (2)

Access to clean water has become increasingly difficult due to the destruction of water infrastructure and the economic blockade. The burden of securing water falls disproportionately on women, particularly in families where the male breadwinner has been killed or imprisoned. Women are frequently forced to walk long distances and wait for hours in lines to collect water, often under the threat of indiscriminate airstrikes. This situation places immense physical and emotional strain on women, affecting their ability to care for themselves and their children. The scarcity of clean water further complicates their efforts to maintain personal and household hygiene, leading to increased risks of waterborne diseases (3).

The Gaza Strip, home to approximately two million people, faces one of the most severe water crises globally (4). While the water crisis in Gaza has been ongoing for decades, it has worsened significantly due to the cumulative effects of prolonged Israeli conflict, over-extraction of natural resources, and infrastructure destruction (5). Gaza relies on the coastal aquifer for 90% of its water supply, but this source is heavily contaminated due to saltwater intrusion, sewage leakage, and agricultural runoff (6). A 2018 article in Haaretz reported that 97% of the water in Gaza is unsafe for consumption, far exceeding World Health Organization (WHO) guidelines for salinity, nitrates, and chloride contamination (6,7).

The Israeli blockade, imposed in 2007, has severely restricted the entry of materials necessary to repair and maintain Gaza's water and sanitation systems (8).

Picture 1. Palestinians at one of the shelters in the Bureij refugee camp are waiting for their turn to get some drinking water from a potable truck (Photo courtesy of Hanan Farajallah).

Picture 2. A young Palestinian man (Hussain Farajallah) was using his donkey to transport drinking water in the Nuseirat refugee Camp to Palestinians in the school shelter. The Israeli Occupation Army Killed and injured his donkey back in February 2024. (Photo courtesy of Iman Farajallah).

As a result, desalination plants, wastewater treatment facilities, and distribution networks have deteriorated, and the 2023–2024 conflict has further damaged essential infrastructure (6). Consequently, many families are forced to rely on bottled or untreated water sources, posing significant health risks.

Displacement camps and shelters

The current Israeli war has displaced thousands of families in Gaza, forcing them into temporary shelters and displacement camps. The destruction of approximately 70% of Gaza's water networks during the 2023–2024 conflict has made access to basic water services in these camps extremely limited. Women, in particular, face significant challenges in maintaining personal hygiene and caring for their families. Overcrowded shelters exacerbate these difficulties, often forcing women to reduce their water intake to avoid using public toilets, which lack privacy. This creates a severe psychological and physical burden, as women must navigate the daily struggles of displacement without access to clean water (9).

Women living in shelters in Deir al-Balah reveal the immense strain placed on mothers to secure water for their families. One mother, Um Ahmed Abu-Awda, 40, described standing in line for hours to collect a few gallons of water, often insufficient for her seven children, one of whom required clean mineral water due to illness. Another mother, Hanadi Atya, 36, described her difficulty in providing clean water for her newborn daughter, Ayla, due to the lack of safe drinking water and proper nutrition. These testimonies highlight the immense strain placed on mothers as they struggle to care for their children amid an ongoing Israeli war on the Palestinians living in the Gaza Strip.

Lack of health and safety

The severe shortage of clean water in Gaza has forced many families to rely on unsafe water sources, increasing the risk of waterborne diseases such as cholera, diarrhea, and Hepatitis A.

1. For example, the current Israeli war in Gaza has led to a severe outbreak of Hepatitis A, linked to contaminated water and deteriorating sanitation. Nearly 40,000 cases have been reported in UNRWA shelters and clinics since October 2023, compared to only 85 cases during the same period before the war. This increase in Hepatitis A cases is primarily due to the collapse of Gaza's water and sewage systems, which have accumulated waste and contaminated water supplies (10).

Efforts to deliver fuel to water facilities have been insufficient, limiting access to clean drinking water. Many residents receive just two to nine liters of water per day, far below the emergency minimum of 15 liters, making maintaining hygiene and sanitation extremely difficult. As a result, waterborne diseases, especially Hepatitis A, are spreading rapidly among the displaced population (10,11).

Pregnant and lactating women are particularly vulnerable due to their higher daily water and nutritional needs. Health workers in Gaza have reported a sharp increase in cases of waterborne diseases, particularly among children. According to UNICEF, the incidence of diarrhea among children under five has increased dramatically since the start of the Israeli war, as have cases of scabies, lice, and respiratory infections (12-14).

Catherine Russell, UNICEF's Executive Director, emphasized the situation's urgency: "Children and their families are forced to use water from unsafe sources that are too salty or contaminated. Without safe drinking water, more children will die of deprivation and disease in the days ahead" (14,15).

The lack of water, limited access to it, and the rising stress, anxiety, and depression among displaced individuals are challenges that can only be fully understood by those who have experienced life inside the displacement camps. An overwhelming sense of fear, anxiety, stress, and destruction characterizes

these camps. The conditions are so harsh that no human being should have to endure them, and as a result, the population is grappling with extreme water scarcity. By the end of October 2023, water production had decreased by 5.5% from pre-Israeli war levels, reaching only 17% of the required amount. However, by November 21, 2023, production had increased to 12.5% above pre-war levels, thanks to the resumption of fuel deliveries. Despite this improvement, water access remains far below the standard needed to sustain Palestinian households in the Gaza Strip, and severe suffering continues. Local communities in Gaza have been forced to rely on unsafe water supplies contaminated with pollutants. Women and children must fetch water from contaminated wells to meet basic needs, as all water and sanitation facilities have been closed (16).

Amidst these severe challenges, UNICEF and its partners strive to make a difference by providing fuel to enable clean water production and distributing water tanks, plastic containers, and hygiene kits to thousands of people, including children, across different parts of the Gaza Strip. For instance, UNICEF distributed 67,785 liters of bottled water in Khan Younis and Rafah, directly benefiting over 22,595 individuals, including 11,500 children. To further support water distribution and enhance household storage capacity for those residing in shelters, UNICEF, in collaboration with partners, distributed 5,901 collapsible jerrycans, each with a 10-liter capacity. Moreover, minor repairs to WASH facilities were carried out, benefiting over 35,406 individuals in non-formal shelters in Rafah.

Furthermore, UNICEF provided 3,749 hygiene kits, which included menstrual pads, benefiting 22,494 individuals, including women and adolescents, in the areas of Jabalia, Khan Younis, and Rafah. These interventions were crucial in addressing the immediate WASH needs of the affected population, ensuring access to clean water, sanitation, and hygiene supplies during a period of extreme crisis (17).

Khishawi, the water and sanitation officer for Médecins Sans Frontières (MSF), highlights the obstacles in addressing the water crisis: "Lack of fuel for pumping and transportation is the first challenge we face when distributing water. The second challenge is the lack of proper roads for our trucks to drive on, with tents set up on asphalt. The third challenge is destroying water distribution points, pipes, streets, and infrastructure, all of which have been bombed" (11).

Challenges in access to safe drinking water

Water scarcity is a critical global issue, yet it presents unique and compound challenges in conflict zones such as Gaza. As of late 2023, the total water available in Gaza has decreased to between 10% and 20% of pre-war levels, with availability largely contingent on fuel supply, according to the Palestinian Central Bureau of Statistics. This severely limited water supply imposes significant hardships on mothers, who are often responsible for obtaining and managing water for their families. This is often due to the death or arrest of male family members. Women frequently must walk long distances under dangerous conditions, including ongoing Israeli airstrikes, to access water. Fuel scarcity exacerbates these challenges, as women are forced to wait in long queues under harsh conditions, spending hours collecting water for their households. Local humanitarian organizations have documented the physical and emotional toll on women securing water (18,19). One woman, Hanan Hararah, a 37-year-old mother of five, recounted her daily struggle of standing in long lines at a local distribution point only to receive a fraction of the water her family requires. This limited supply is insufficient to maintain personal and household hygiene, a critical concern for mothers caring for infants and young children. The lack of clean water significantly increases the risk of waterborne diseases, especially for children under five, posing threats to their physical health, mental well-being, and overall quality of life.

Water quality issues

In addition to scarcity, groundwater contamination in Gaza poses a serious threat to public health. Elevated nitrate levels, often due to agricultural runoff and sewage discharge, are particularly dangerous for infants, as they can lead to methemoglobinemia, commonly known as "blue baby syndrome" (10). Moreover, pathogens in untreated water increase the risk of waterborne diseases such as cholera, typhoid, and dysentery (20). This health risk is intensified by the limited availability of healthcare services in Gaza, which struggles to manage the health burden caused by contaminated water (21).

Picture 3. Palestinian Children waiting in line to get some water (Photo courtesy of Iman Farajallah).

Economic and political factors

The Israeli blockade has restricted access to essential materials needed to repair and upgrade Gaza's water infrastructure. As a result, many households rely on bottled water, which is often unaffordable for low-income families (22). An assessment by OCHA's Multi-Sectoral Needs Assessment (MSNA) in 2022 noted that while 95.1% of Gaza households have water access on their premises, a majority (82.6%) rely on unimproved water sources for drinking. Additionally, 84.9% of households employ negative coping mechanisms related to water consumption, such as receiving water on credit (23). In 2018, the report by the World Bank highlighted that despite high connection rates to piped water, service delivery in Gaza is intermittent, with only 30% of households receiving daily network water supply for limited hours. Consequently, many residents rely on unsafe water from unregulated vendors, increasing expenses (22).

An analysis of Gaza's Water Crisis in 2023 emphasized that the average Gazan receives only 3 liters of water per day for all needs, well below the United Nations recommended minimum of 50 liters per person per day. This scarcity forces many to purchase water from private vendors at high costs, further straining household finances, leading to financial strain, and limiting access to other basic needs, such as food and healthcare. This economic hardship affects hygiene and nutrition and exacerbates health risks (24).

Psychological stress

The struggle for safe water access in Gaza is also a significant source of psychological stress, particularly for families. The constant worry over the quality and availability of water contributes to heightened levels of anxiety and depression, especially among women and caregivers (23). This psychological strain can negatively impact maternal health and disrupt family dynamics, with increased stress-related complications arising during pregnancy (22). Furthermore, the psychological stress associated with water insecurity can affect children's mental health, perpetuating cycles of anxiety and developmental issues (19).

Impact on maternal and child health

Access to safe drinking water is critical for the well-being of mothers and children, affecting various aspects of health and development. In Gaza, the dire water situation has profound implications for maternal and child health, which can be categorized into several key areas:

PHYSICAL HEALTH OUTCOMES

Maternal health complications

The relationship between water scarcity and maternal health in Gaza is deeply interconnected. Access to clean water is essential for safe pregnancies, childbirth, and postpartum recovery. Inadequate access to safe drinking water can lead to several health complications for pregnant women. The risk of infection increases significantly when clean water is unavailable for hygiene practices such as washing hands and maintaining sanitation during pregnancy. Maternal infections, such as urinary tract infections and sepsis, can lead to severe complications, including premature birth and maternal mortality (23). Pregnant women in Gaza also face increased exposure to waterborne pathogens due to the consumption of contaminated water, which leads to a higher incidence of gastrointestinal infections, such as diarrhea, dysentery, and cholera (22). These infections can result in dehydration, malnutrition, and preterm labor, posing severe risks to both maternal and fetal health. Women in Gaza who have limited access to

clean water have higher rates of pregnancy complications, including gestational diabetes and hypertension, which are associated with adverse birth outcomes (17).

Moreover, the lack of clean water and adequate sanitation complicates prenatal and postnatal care. Pregnant women are at higher risk of developing urinary tract infections (UTIs) and reproductive tract infections (RTIs) due to poor hygiene and inadequate access to safe water for washing and sanitation (18). Such infections can result in pregnancy complications, including premature labor, postpartum hemorrhage, and infections that may lead to sepsis, one of the leading causes of maternal mortality in war situations (23).

Child health risks

Children are particularly vulnerable to the health impacts of water scarcity in Gaza. Consumption of unsafe water in Gaza is a significant contributor to the prevalence of diarrheal diseases, which remain a leading cause of morbidity among children under the age of five. A community-based study reported that over 46% of children in this age group experienced diarrheal diseases. The situation in Gaza is further aggravated by inadequate water, sanitation, and hygiene (WASH) facilities. A cross-sectional household-based study specifically evaluated the influence of these factors on the incidence of acute diarrhea among children under five in the region (25).

Recent data reveal a dramatic increase in diarrheal cases among children in Gaza. Since mid-October 2023, more than 33,551 cases have been reported, with over half occurring in children under five. This represents a significant surge compared to the average of 2,000 monthly cases recorded in this age group during 2021 and 2022 (26). Repeated episodes of diarrhea contribute to chronic malnutrition, as infections prevent children from absorbing essential nutrients. This leads to stunting and wasting, which impair cognitive and physical development (27). Doctors Without Borders reported a sharp increase in cases of acute watery diarrhea, which disproportionately affected infants and young children, leading to increased hospitalizations and healthcare costs (28). These health issues can result in significant long-term developmental delays and cognitive impairments (29). These findings highlight the urgent necessity for enhanced water quality and sanitation infrastructure to mitigate the incidence of diarrheal diseases and reduce child mortality rates in Gaza.

Furthermore, malnutrition caused by food insecurity, exacerbated by the economic burden of purchasing water from private vendors, compounds the health challenges faced by children. Households that spend a significant portion of their income on water often have less money to buy nutritious food, increasing the risk of malnutrition and poor health outcomes in children (30). Chronic malnutrition in early childhood has long-term consequences, including impaired immunity, reduced educational attainment, and increased susceptibility to infections later in life (31).

Malnutrition and stunting

Unsafe drinking water contributes to malnutrition in both mothers and children. Poor water quality can lead to foodborne illnesses, limiting the nutritional intake for healthy pregnancies and child development (32). Malnutrition during pregnancy increases the risk of low birth weight, which is linked to stunted growth and developmental challenges in children (33). A longitudinal study indicated that children in Gaza with a history of waterborne diseases were 1.5 times more likely to experience stunted growth compared to their peers who had consistent access to safe drinking water (30).

MENTAL HEALTH CONSEQUENCES

Maternal mental health

In addition to physical health challenges, water insecurity contributes to significant psychological stress for pregnant women. The daily burden of securing safe water for their families adds to the anxiety and emotional strain already present in war-affected areas. Studies indicate that maternal stress related to water insecurity correlates with adverse pregnancy outcomes, including low birth weight and stillbirths (34). Research has shown that pregnant women in Gaza experience higher levels of anxiety and depression due to water insecurity (19). This psychological stress can adversely affect pregnancy outcomes, including increased rates of preterm births and lower birth weights. Additionally, maternal mental health issues can hinder maternal-infant bonding, affecting breastfeeding practices and early childhood development (19,30).

The ongoing water crisis in Gaza has profound implications for the mental health of its residents, particularly in the context of the 2023-2024 conflict. The destruction of over two-thirds of Gaza's water systems has drastically reduced access to clean drinking water, forcing families to rely on contaminated sources. These conditions have escalated the prevalence of waterborne diseases, including skin infections and gastrointestinal illnesses, further straining an already vulnerable population (29).

Children are disproportionately affected, with many experiencing physical ailments such as rashes and infections, which lead to social stigmatization and isolation. These challenges compound existing psychological stressors, including displacement, loss of security, and exposure to conflict-related trauma. Parents report heightened anxiety over their inability to provide basic necessities, amplifying the overall psychological burden (35-38).

From a systemic perspective, the blockade and extensive infrastructure damage in Gaza have severely hindered the operation of its water utilities. Limited access to resources, along with the destruction of desalination plants and municipal wells, has exacerbated the water crisis, leaving millions of residents with less than the World Health Organization's recommended minimum daily water allowance. Furthermore, approximately three-quarters of Gaza's population face food insecurity, lack clean water, and have unreliable access to electricity. Ongoing power shortages have disrupted essential services, including health care, water, and sanitation, further weakening Gaza's fragile economy, particularly the manufacturing and agricultural sectors. Additionally, the lack of adequate medical care has led to increased malnutrition, anemia, and vitamin A deficiencies among Palestinian refugee children (39).

Child mental health

The psychosocial effects of water insecurity on children should also be considered. Living in an environment where access to basic necessities such as water is precarious can have a detrimental effect on a child's mental health. Children in Gaza, already experiencing the trauma of living in a continuous war, are further affected by the stress and uncertainty of their daily struggle to secure clean water. This stress can manifest as anxiety, depression, and behavioral issues, which can have long-term effects on their emotional and psychological development (31)

The stress and anxiety experienced by mothers can lead to adverse developmental outcomes in children. Children who grow up in environments with high levels of stress and insecurity may exhibit behavioral issues, including increased aggression and anxiety (31). A study conducted in Gaza found that children exposed to the stress of water scarcity showed a 30% increase in behavioral problems compared to those with reliable access to safe drinking water (32).

SOCIOECONOMIC IMPACTS

Economic strain on families

The financial burden of accessing safe drinking water can exacerbate socioeconomic challenges for families in Gaza. Many households spend a significant portion of their income on bottled water or water purification methods, limiting their capacity to meet other essential needs, such as food, healthcare, and education (32). This economic strain can lead to food insecurity and increased family stress, negatively impacting mothers' and children's overall health and well-being (21).

Education and future opportunities

Water insecurity can also hinder children's educational opportunities. The ongoing conflict has severely damaged water and sanitation infrastructure, leading to a scarcity of safe drinking water. This crisis forces children to spend considerable time fetching water, detracting from their studies. For instance, children must walk long distances to water collection points, leaving them physically exhausted and with less time for education. Health issues from unsafe water can increase school absenteeism, impacting educational attainment (28). Moreover, economic hardship may force children, especially girls, to drop out of school to help support their families (18). The cycle of poverty and lack of education can perpetuate health inequities, making it difficult for future generations to break free from these constraints.

Long-term consequences

Water insecurity in Gaza severely impacts children's educational opportunities through various channels, including health, school infrastructure, and psychosocial

well-being. The contamination of water sources, with only 10% of Gaza's water deemed safe for consumption, leads to a high prevalence of waterborne diseases, particularly among children, resulting in frequent absenteeism (28). These health issues cause frequent school absenteeism, disrupting education and reducing academic achievement (26). Studies have documented significant absenteeism rates in Gaza's schools, with some reporting that absentee rates can reach 20-30%, exacerbating learning disruptions. For instance, a 2022 UNICEF report highlighted that out-of-school rates among young people were 17% in the Gaza Strip (40). Moreover, the burden of fetching water, which often falls on children—especially girls—limits their time for study and exposes them to physical and emotional stress, with families spending an average of 2-4 hours per day collecting water (41). Schools in Gaza, many of which have been converted into shelters for displaced families, are experiencing severe shortages of water and sanitation facilities. Overcrowding in these shelters exacerbates the issue, with some shelters having only one toilet for every 150 individuals, resulting in long wait times and unsanitary conditions. Poor hygiene facilities pose significant health risks, particularly for children. Additionally, the infrastructure of schools is compromised, as many lack reliable water supplies and sanitation, rendering them unsafe (42,43). The ongoing water crisis exacerbates psychosocial stress, further hindering children's ability to focus and perform academically, with many children facing anxiety and depression as a result of water scarcity (44). Furthermore, the economic strain of water insecurity, with over 80% of Gaza's population living below the poverty line, forces families to prioritize survival over education, contributing to higher dropout rates (45,46). Thus, addressing water insecurity is crucial not only for improving public health but also for ensuring that children in Gaza have the opportunity to succeed in their education.

PUBLIC HEALTH INFRASTRUCTURE CHALLENGES

Healthcare system strain

The public health system in Gaza is already under significant strain due to limited resources and ongoing Israeli wars. The burden of waterborne diseases places additional pressure on healthcare facilities, which struggle to provide adequate care to all patients. The high rates of hospitalization for water-related illnesses, combined with the existing healthcare challenges, can lead to overcrowding and limited access to essential maternal and child health services (47,48).

Lack of preventive services

The healthcare system is under severe strain in the Gaza Strip due to ongoing conflicts and resource shortages. This situation has led to a focus on immediate healthcare needs, particularly those related to waterborne diseases, which has inadvertently diverted attention from preventive health services for mothers and children.

The destruction of water and sanitation infrastructure has resulted in a significant increase in waterborne illnesses. Residents are compelled to use contaminated water sources, leading to diseases such as cholera and typhoid. The International Rescue Committee (IRC) warns of an imminent outbreak of these diseases, noting that 95% of the population lacks access to safe water, and 64% of primary health facilities have shut down (27). Routine maternal health check-ups, vaccinations, and nutritional support programs may be deprioritized, further exacerbating health disparities. This lack of preventive care can result in higher morbidity rates for mothers and children, reinforcing the need for integrated public health strategies that address water access and health services (49,50).

The implications of these challenges

Mothers and their children are most vulnerable to unsafe health conditions, likely leading to a serious public health crisis. UNICEF has warned that water and sanitation services are on the verge of collapse while widespread disease outbreaks are imminent.

Women and children, mainly those displaced, are the most affected by the health crisis in Gaza. Diarrheal diseases are the leading cause of child death, dehydration, and malnutrition. As of April 29, 2024, 87,800 cases of scabies and lice were reported, exacerbated by overcrowded conditions and limited access to clean water and sanitation. Additionally, the region has seen a sharp rise in acute respiratory infections (ARI), with over 1 million cases since the war began, alongside more than

half a million cases of acute diarrhea and over 100,000 cases of jaundice. This severe situation poses a growing threat to the survival of children. Concerns about waterborne diseases, such as cholera and chronic diarrhea, are escalating due to the lack of potable water, especially following recent rains and flooding (25,51).

Mohamed Abou Zayed, MSF's health outreach manager, stated, "Due to the lack of clean water for drinking and other needs, patients are suffering from intestinal disorders and the flu virus, which is circulating widely. Lately, we've also witnessed children suffering from skin rashes due to the lack of clean water for bathing or washing" (52). The lack of water also increases the incidence of infectious diseases, including reproductive and urinary tract infections (16).

1. It increases stress, anxiety, and depression among women and children, exacerbating the severity of issues among internally displaced persons (IDPs).
2. It is estimated that individuals in the Gaza Strip get less than 3 liters of water per day for drinking, cooking, and washing, far below the emergency minimum of 15 liters per person per day. Those living in displacement camps face fear, anxiety, stress, and destruction—conditions that no human being should endure (53).

RECOMMENDATIONS

1. Long-term solutions require ending the Israeli occupation and its continuous wars and Systematic killing and destruction, along with finding peaceful and sustainable solutions to ensure fundamental human rights, including access to water and essential services. Ending the blockade and allowing the import of materials necessary to reconstruct Gaza's water infrastructure is crucial. There is also a need for investment in large-scale desalination plants and wastewater treatment facilities to increase the supply of potable water. Community-based water management systems (CBWMS) and rainwater harvesting initiatives should also be promoted to increase local water availability.

   CBWMS has effectively addressed water scarcity in regions worldwide, offering valuable insights for application in Gaza. Rainwater harvesting, practiced in countries like India, Kenya, and Brazil, involves collecting and storing seasonal rainfall in tanks or ponds for domestic and agricultural use, reducing dependency on overexploited groundwater (54,55,56). In Brazil, cisterns have been deployed in semi-arid regions, benefiting over a million households (57). This approach could be implemented in Gaza at community centers, schools, and mosques, incorporating filtration and purification systems to address potential contamination (58,59). Similarly, community-managed desalination, using solar-powered plants in areas like Chile's Atacama Desert and Somaliland, provides potable water while empowering local communities through self-management (60,61). In Gaza, small-scale solar desalination units could supplement municipal water supplies, reduce stress on aquifers, and enhance sustainability through community involvement (62).

   Participatory groundwater management in India offers another model, where village committees regulate extraction and oversee recharge projects, improving aquifer sustainability and promoting conservation awareness (63). In Gaza, water management councils could address over-extraction and implement recharge methods like stormwater harvesting, supported by international aid (64). Greywater recycling, successful in Jordan and California, involves treating wastewater from sinks and showers for irrigation, reducing freshwater demand (65). Introducing such systems in Gaza could support agriculture and greenery while engaging residents through training on system operation and maintenance. Finally, integrated water resource management (IWRM), exemplified in South Africa, emphasizes collaboration between communities, government bodies, and international stakeholders to ensure equitable water distribution and sustainable practices. Adopting IWRM principles in Gaza could optimize resource allocation, enhance efficiency, and address the multifaceted challenges of water scarcity (66). Despite these potential solutions, several challenges exist in Gaza, including high contamination levels, restrictions on importing materials for infrastructure development, and political instability undermining long-term planning (67). Addressing these challenges requires a combination of community training on water-saving

techniques, partnerships with international organizations for funding and technical support, and low-cost solutions such as rooftop rainwater harvesting and solar pumps. Studies have demonstrated that community-led initiatives can significantly enhance resilience in water-scarce regions by leveraging local knowledge and fostering stakeholder participation (68,69). By adapting such proven approaches to local needs, CBWMS can play a critical role in mitigating Gaza's water crisis and fostering sustainable water management practices.

2. The lack of water in Gaza affects families and communities comprehensively, causing health, social, and economic issues that require practical and sustainable responses. The water crisis in Gaza, exacerbated by political, environmental, and infrastructural challenges, requires sustainable solutions for immediate relief and long-term resilience. Expanding desalination plants powered by solar energy is one such solution, addressing the region's electricity shortages while providing clean water to thousands (69, 70). Additionally, rainwater harvesting systems, especially rooftop installations, can collect significant amounts of water, reducing reliance on contaminated groundwater (71). Decentralized wastewater treatment systems, like those used in Khan Younis for agricultural irrigation, offer a sustainable alternative to traditional water sources (72). Education on water conservation and the integration of solar energy in water infrastructure can further enhance the sustainability of these efforts (73). Furthermore, emergency water trucking and the distribution of purification tools provide critical relief during crises (74). Advocacy to lift restrictions on water infrastructure materials remains crucial for long-term solutions (75).
3. Protecting the rights of women and children and providing safe, sustainable water must be prioritized at all times, whether in stable conditions or during conflicts, especially in fragile and under-resourced societies like Gaza, which suffers from continuous wars and displacement.
4. Educational programs should be provided for displaced women on safely accessing water and raising awareness about women's rights in displacement areas and camps.
5. International and local organizations must be called upon to provide clean water to displaced areas and strengthen efforts to deliver it to all groups.
6. Policymakers must prioritize the needs of vulnerable populations, particularly women and children, in water management strategies. Efforts to improve maternal and child health outcomes should include ensuring access to clean water, promoting hygiene education, and strengthening healthcare services for pregnant women and children. Addressing the psychological and social impacts of water insecurity is also crucial, with mental health support services being integrated into public health programs in Gaza.

CONCLUSION

The water crisis in Gaza presents a significant public health emergency with profound and disproportionate consequences for maternal and child health. Inadequate access to safe drinking water has led to widespread waterborne diseases, malnutrition, and hygiene-related infections, severely impacting pregnant women and children. Pregnant women are at heightened risk of dehydration, infections, and adverse pregnancy outcomes, while children face life-threatening conditions like diarrhea and stunted growth due to chronic malnutrition. The psychosocial stress of water insecurity further exacerbates mental health challenges for these vulnerable populations.

While international humanitarian efforts have provided some relief, long-term solutions depend on addressing the root causes of the crisis. Central to this multi-faceted crisis is the Israeli occupation, which has restricted the flow of essential materials needed for rebuilding Gaza's water and sanitation infrastructure and impeded the region's ability to manage and develop sustainable water resources. The ongoing blockade, destruction of infrastructure during Israeli military actions, and limitations on access to natural resources have perpetuated water insecurity and health disparities.

The international community's role in Gaza extends beyond humanitarian aid, encompassing advocacy for a political resolution is essential. Humanitarian assistance addresses immediate needs, but without a political solution, the underlying causes of instability persist. Advocacy for a political solution is crucial for creating sus-

tainable peace and long-term stability in Gaza and the broader region. International pressure to uphold human rights and international law, including accountability for human rights violations. Advocacy for empowering Palestinian voices is crucial for an inclusive political resolution. The international community must also push for policies addressing the conflict's root causes, such as occupation and resource distribution, ensuring a more sustainable and peaceful future (76,77). While humanitarian aid is vital, political advocacy is critical to achieving long-term stability in Gaza.

Ending the Israeli occupation and lifting the blockade are crucial steps toward resolving the water crisis in Gaza. A lasting peace and political resolution would restore essential infrastructure, including desalination plants and wastewater treatment facilities, and allow for international cooperation in rebuilding Gaza's health and water management systems. Only by addressing the political, economic, and environmental factors driving water scarcity can Gaza's maternal and child health outcomes improve, ensuring a healthier and more stable future for the region's most vulnerable populations.

Conflict-of-interest and financial disclosure

The authors declare that they have no conflict of interest to disclose. The authors also declare that they did not receive any financial support for the study.

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