

# Climate Change as a Sociomedical Crisis: Heat, Vulnerability, and Health Inequity in the MENA Region

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**Abstract:** The MENA region is now recognized as being in a socio-medical crisis. For instance, extreme heat is occurring at the same time as water shortages. Moreover, air pollution and dust storms are on the rise. And, cities are urbanizing fast. As a result, already existing health inequalities across the region are aggravated. This article reviews climate change as a public health and social justice issue whereby exposure to heat largely affects older people, children, outdoor workers, low-income households, migrants, refugees and populations living in fragile or conflict-affected settings. The increase in temperature and urban heat islands increases the risk of heat-related illness, cardiovascular and respiratory morbidity, occupational injury, lost productivity and mental distress. Due to poor housing, limited cooling, weak infrastructure, insufficient surveillance, and unequal access to health care, the risk is exacerbated. The paper also outlines the indirect health impacts of climate change, stemming from water insecurity, food system disruption and the influence of infectious diseases and poverty. To take on this crisis, countries will need equity-oriented climate-health governance, early warning systems, heat action plans, resilient health-care infrastructure, occupational protection, urban cooling, social protection, and improved regional data. We must adopt a sociomedical approach to climate-related disease burden, as these are not evenly distributed. But rather are shaped by social determinants, political vulnerability and unequal adaptive capacity. It is, therefore, a public-health necessity and a moral imperative to bolster climate-health preparedness in MENA

**Keywords:** Climate change; Sociomedicine; Heat vulnerability; Health inequity; MENA region

## Introduction

Climate change is a pressing challenge for human health and well-being, as highlighted by the 2022 report of the Intergovernmental Panel on Climate Change (IPCC) (1). The impacts are being felt differently by different parts of the world, with developing countries experiencing earlier and more severe consequences (2). The Eastern Mediterranean and Middle East (EMME) region of the World Health Organization (WHO) is particularly vulnerable to health threats posed by climate change (3). Extreme heat associated with climate change is expected to pose significant threats to health and productivity (3). In the Arabian Peninsula, summer maximum temperature records have increased dramatically and are now routinely above 50°C in some areas (4). Maximum temperature records in other parts of the EMME population are also increasing (5).

In this context, this work focuses on the Middle East and North Africa (MENA) region: an area characterized by high levels of heat exposure, significant inequities in health, and disparities in adaptive capacity (6). The MENA region exhibits the world's highest increase in extreme heat since 1980, leading the globe in extreme-heat aggravation and with the widest share of the population experiencing heat risk (7). The region faces among the world's highest baselines for drought, where climate change is exacerbating existing vulnerabilities (8). Urbanisation is exceeding infrastructural capacity and formal economic opportunity, and regions afflicted by conflict are simultaneously cooling and calorically degrading (9). These socioecological considerations influence health and dial through direct, indirect, and social-mechanistic pathways (10).



## Conceptual Framework: Climate Change, Health, and Social Determinants

Climate change is a major driver of health risks that threatens the well-being of populations worldwide (11). For their part, high temperatures significantly raise the incidence of heat-related morbidity, mortality, and other health risks in many countries, including the Middle East and North Africa (MENA), where climate data suggest continuing warming and increased exposure to extreme heat events (12). The region is characterized by vast social inequalities, placing lowest socio-economic groups and the poorest urban populations at the greatest risk of health impacts related to extreme heat (13). Accordingly, heat and climate stress strongly interact with multiple social determinants of health, each of which can serve as a major risk or protective factor influencing the health burden associated with high temperatures (14).

Several determinants related to climate and health equity increase vulnerability to extreme heat and climate change in MENA (15). Institutional capacity is weak across most countries in the region, with major public health infrastructures that cannot deliver effectively in times of crisis (16). Vulnerabilities such as inadequate institutional preparedness, gaps in surveillance, and insufficient access to climate-health information exacerbate climate impacts (17). Many vulnerable subpopulations experience additional inequities, including poor housing quality, limited health literacy, and inadequate access to basic infrastructure, which heightens exposure and sensitivity to heat and amplifies health burdens (18). Moreover, the interplay between social determinants may lower resilience and prompt cascading failures, particularly among at-risk or marginalized groups, leading to a compounding of climate-health impacts at each stage of the disaster cycle from prevention to rehabilitation (19).

## Regional Heat Trends and Environmental Exposures in the Middle East and North Africa

Temperatures across the MENA region are rising faster than the global average. The eastern Mediterranean and Middle East, comprising Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syria, Turkey, the United Arab Emirates, and Yemen, are particularly affected (1). Over the last fifty years, average temperatures have increased by 1.5 °C, precipitation has decreased by 11.7%, and the frequency of extreme heat events has multiplied by 4.5 (11). These shifts are expected to escalate in severity, with projections of a rise up to 6 °C by 2100 under higher emission scenarios (10). Historical data and future projections reveal pronounced regional disparities, consistent with global trends (20).

Heat exposure patterns are complicated by the rapid growth of dense urban centres. The urban heat island phenomenon, in which cities become hotter than surrounding rural areas, exacerbates exposure (15). Planning and public health measures that account for urban heat islands are underdeveloped (21). Agriculture, construction, manufacturing, and transportation–warehousing sectors require substantial outdoor exposure, posing health risks and reducing productivity (22). Rising temperatures contribute to higher rates of heat-related illness, mortality among outdoor workers, and reduced economic output (23).

Water scarcity poses an additional threat to health and well-being, undermining both physical and mental health (24). Agricultural, industrial, and municipal activities have degraded inland water bodies, leading to declining water quality and increasing salinity (25). Climate change has intensified dust events caused by high winds, drought, and vegetation loss, while growth in the already extensive desert dust region is projected in tandem with rising temperatures (26).

### 3.1. Urban Heat Islands and Infrastructure

High ambient air temperatures can cause serious detrimental health effects (27). The urban heat island (UHI) effect, in which metropolitan areas record significantly higher daytime and nighttime temperatures than surrounding rural areas, shows savagely hotter immediately after sunset (28). The most crucial urban heat island attributes are the so-called surface urban heat island, when constructed

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materials such as pavements heat up and release heat slowly after sunset, and the green urban heat island, when vegetation cools and heats up faster than surrounding urban materials (29).

Research in Cairo suggests an incomplete implementation of cooling and heat-resistant materials within the 2016–2022 design code aims at mitigating UHI effects, and analysis quantifies the indoor temperature rises experienced in an unconditioned fabricated-metal-building office space during an extended heat wave (30). The high population density in some areas of Cairo concentrates heat during the day; although midnight indoor air temperatures in a typical high-density area exceed 34°C, the rural centre receives nighttime cooling through the entire week, remaining below 31°C (31).

### 3.2. Occupational and Outdoor Heat Exposure

Climate change will likely have a negative impact on workers and others who spend a significant amount of time outdoors (32). Most studies of the effects of climate change on health and safety do not consider outdoor workers (33). As climate change progresses, and the effects are most notably evident in the most vulnerable groups, these workers and those who govern their environmental health and safety should be given more attention (34). The increase in extreme heat has serious implications for the health and safety of outdoor workers (32).

Disaster recovery and emergency response are traditional components of climate-stress exposure, yet mitigation remains paramount (35). Occupational exposures to climate stress and their consequences on well-being, productivity, and sustainable economies remain underappreciated (33). Outdoor workers in various sectors are already experiencing the effects of climate change, often exacerbated by protective clothing that can contribute to heat stress (36). Excessive environmental heat, particularly during hot weather, is an important climate-change hazard for outdoor workers and others, such as schoolchildren and the elderly (37).

Once air temperatures exceed 37 °C, workers must lose excess body heat through evaporative sweating, which becomes increasingly difficult as humidity rises and clothing restricts evaporation (38). To prevent heat stroke, work rate must be reduced, breaks increased, and fluid intake augmented (39). On many sites, palatable, cool water may be lacking, contributing to dehydration, exhaustion, and fatigue (40). Heat stress, discomfort, and fatigue diminish alertness and work capacity, complicating human–machine interactions and raising the potential for injuries (40). Numerous workplaces in the MENA region lack adequate tools for monitoring heat stress, and information is frequently restricted to general daily weather forecasts, which do not capture prevailing local conditions experienced directly by workers (41).

### 3.3. Water Scarcity, Air Quality, and Related Health Threats

Drought conditions affected more than 60 percent of the region’s agricultural land and the highest population of livestock at the national level both under the risk of heat and water scarcity as reported by FAO (42). Prolonged drought, shifts in the length of the dry season to the warmest period of the year, increased land degradation, overexploitation of groundwater systems, decreased water flow from transboundary rivers, and reduced rainfall are projected to undermine the natural resilience of agricultural systems and threaten food access and security in an increasing number of vulnerable circumstances (43). A reduction in the availability of irrigation water and the return of long-duration drought could lead to the loss of geographical areas suitable for agriculture and livestock production in certain countries and therefore increase the risk of famines (44). Fuel- and food-price inflation aggravated by climate shocks may trigger food protests leading to political turmoil and destabilizing effects on health (45).

A decay of ambient air quality already affects the daily lives and well-being of residents across MENA, including increased concentrations of particulate matter (PMs) and other hazardous substances (H<sub>2</sub>S, ammonia) across multiple cities significantly affecting health over different time periods (46). Public exposure and health risks to dust storms and related phenomena have heightened in both frequency and intensity across MENA weather (1). Severe indoor and outdoor air pollution amongst different countries across the region constitute a new socio-economic and health hazard with the deterioration of existing mitigation measures (47). The environmental and allied impacts of various armed conflicts across the MENA-region have led to a new class of pollutants and the emergence of epidemiological-pathological respiratory manifestations impacting more rapidly in exposed young

male individuals without such exposures amongst Fertility-Related Health—prolonged bombardments tangentially affecting the female fertility cycle far less compared to non-conflict zones area (46).

## Vulnerable Populations and Health Inequities

Populations particularly susceptible to heat stress include the very young ( $\leq 4$  years), the elderly ( $\geq 65$  years), and those with chronic illnesses (48). Gender-specific disparities complicate assessments of vulnerability, as men generally experience greater outdoor exposure, yet women face higher susceptibility across multiple health endpoints (1). Although overall regional mortality and morbidity rate effects remain uncertain, population aging coupled with other climate and non-climate stressors, including conflict and displacement, threatens to increase vulnerability across many countries (48).

Occupational and recreational settings further expose young people and economically active semiskilled and unskilled workers, especially in the construction and agricultural sectors, contributing to additional heat-related health risks and productivity losses (49). Intracity analysis underlines the amplifying influence of socio-economic and housing factors on heat exposure (50). Living in poorly segregated urban regions, inadequate housing materials (or absence of air conditioning) increase indoor heat exposure; alongside restricted access to primary health care, these drive the accumulation of comorbidities posing additional health risks from climate-related stress (2).

### 4.1. Age and Demographic Risk Profiles

Age is a fundamental risk factor for heat vulnerability, with rising global temperatures projected to contribute to a significant increase in heat-related deaths (51). As documented in modelling exercise projections, the Middle East and North Africa region has the highest share of its population projected to be exposed to at least six heat-related deaths per million inhabitants due to global warming (1). Zero-exposure and continued-development scenarios both indicate that, as of 2019, older people represented the largest share of the region's population exposed to heat-related mortality, at 57.9% (52). Age-related and demographic risk profiles—including age-specific climate-linked mortality rates and sex-disaggregated populations—indicate that older adults, as well as children aged 0–4, are at heightened risk of climate-linked mortality (53).

### 4.2. Socioeconomic Status, Housing, and Access to Care

Socioeconomic status, housing conditions, urban density, and access to healthcare services amplify the disproportionate burden of heat exposure on health in the MENA region. Low-income households often occupy inadequate and poorly ventilated structures, which exacerbate heat-related health impacts (54). Exposed individuals report significant discomfort associated with temperature–humidity combinations below the thresholds that typically trigger public health warnings in more temperate locations. Furthermore, limited access to affordable air conditioning hinders adaptation (54).

High population growth, internal migration, and influxes of refugees and displaced people intensify the challenges associated with housing (55). Among the ten least urbanised countries in the region, three—Algeria, Sudan, and Morocco—experience fast urban expansion, and in four out of six countries with significant urban growth, most of the increase takes place in cities already exceeding the UN definition of “prone to urban agglomeration” (56). Rapid metropolitan population growth stresses infrastructure and expands informal housing, complicating compliance with building codes, water supply, sanitation, sewerage, and solid waste disposal (57). An average of 49.5 % of populations in MENA countries have been classified as living in inadequate housing, with the figure reaching as high as 92.0% in Djibouti (55).

### 4.3. Migrants, Refugees, and Conflicted Regions

Extreme weather events, including intense droughts and dust storms, have become more frequent in the MENA region due to climate change (58). These events have consequences for livelihoods, food security, health, and social stability and are linked to rising incidences of internal displacement and migration (58). Countries affected by the 2011 Syrian drought experienced increased emigration, and intense droughts in North Africa are contributing to migration, in-cycle migration within countries, and urbanisation 90. Approximately 3 million Syrian nationals and 1 million non-Syrian migrants entered Turkey between 2011 and 2022. Over 830 000 migrants arrived in Europe in 2015, around a third of whom were from Syria (54).

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Climate-change effects exacerbate the socio-economic stresses already generated by armed conflicts and prolonged instability in several Middle Eastern countries (59). The Eastern Mediterranean and Middle East region hosts some of the world's largest refugee-carrying and internally displaced populations, reflecting long-standing regional crises and conflicts (48). High refugee-to-host population ratios can destabilise health systems, create congestion and overstretch, and impede equitable access to health services for both internal and external migrants (60). Furthermore, the dominant role played by non-State actors in these crises can complicate humanitarian responses (61).

### Health Outcomes Attributable to Heat and Climate Stress

People living in the Eastern Mediterranean and Middle East, especially high-risk groups, are already experiencing adverse health impacts from climate change; these impacts are expected to worsen as climate change continues (62).

Globally, the cardiovascular and respiratory health relevance of high ambient temperature exposure is widely recognized (63). At elevated temperatures, dose-response objectives correlate with both morbidity and with mortality from respiratory and cardiovascular diseases, specifically related to high levels of PM<sub>10</sub> and SO<sub>2</sub> air pollution (64). Furthermore, there is cumulative evidence of an association between high ambient temperature and increased risk of occurrence, severity, and mortality from heat-related illnesses, with lag effects that may extend to several weeks after exposure (65). Despite growing concern over the effects of climate change on human health, particularly in vulnerable populations, well-documented studies on the health impacts of climate change in the region remain scarce (66).

#### 5.1. Cardiovascular and Respiratory Morbidity

High temperatures, air pollution, and elevated pollen counts have been identified as trigger factors for acute cardiovascular and respiratory morbidity (67). There is a clear dose-response relationship between temperature and cardiovascular mortality; an increase of 1 °C above the threshold is associated with a rise of 4.7% in cardiovascular-related deaths in the United States (67). During heat waves, the cardiovascular system must cope with excess heat load and higher blood viscosity due to dehydration, potentially exacerbating pre-existing conditions (68). The elderly and those with chronic cardiovascular diseases, diabetes, and obesity are more susceptible to heat; people living in informal settlements are also at risk (69). Air pollution (high ozone particles, nitrogen dioxide, and particulate matter), pollen (especially ragweed), and exposure to the *Aedes aegypti* mosquito have been mentioned as major trigger factors for cardiovascular morbidity and mortality (68).

#### 5.2. Heat-Related Illnesses and Mortality

Rising temperatures in the Middle East and North Africa affect health systems and human health (70). A significant part of the health impact results from heat-related physical disorders such as heat stress and reduced thermoregulation, which lead to a range of illnesses and deaths (1). These are consequences of ongoing warming in the region and chronic exposure to high ambient air temperatures (71). The possibility of heat stress and related health impacts in the region is increased by such climatic factors as elevated average temperature, shorter recent cold periods, higher variability of both daily maximum and minimum temperatures, and longer duration of heat extremes (70). The climate-induced reduction of average wet-bulb globe temperatures is a further exacerbating factor (72).

#### 5.3. Mental Health Impacts and Stress-Related Disorders

The consequences of exposure to climate change pose a significant threat to mental well-being in the Middle East and North Africa (MENA) and can aggravate pre-existing disorders (73). Direct stressors include prolonged extreme heat, drought, flooding, loss of biodiversity, and intensified dust storms, while indirect consequences emerge from reduced food and water security, damage to health infrastructure, and loss of cultural identity due to displacement (74). In the MENA region, rising temperatures, intensifying desertification, declining freshwater reserves, depletion of natural resources, and deteriorating air quality challenge daily adaptive capacity (75). Urban settings with small green areas and limited access to recreational facilities exacerbate residents' vulnerability (74). Perceived deterioration of living conditions in urban areas contributes to the emergence of urban madness, characterised by increased rates of substance addiction, violence, and propensity for suicide (76).

Climate-related stressors affect mental health at individual and collective levels: climate events and the perceived satisfaction of socio-economical, material, and psychological needs can lead to a long-lasting deterioration of individual and collective well-being (77). Psychotropic consumption as a proxy for mental health issues observed a follow-up increase in the percentage of psychotropic drug consumption per capita; the four largest drugs consumed were antidepressants, anxiolytics, antipsychotics, and stimulants (62). Higher levels of urbanization and hotter climate classify Middle Eastern and North African countries as more vulnerable to heat-related morbidity (78). Changes in climatic and weather conditions and the frequency of extreme temperature events have also modified the seasonality of specific pathologies such as heat stress strokes (79).

The studies suggest that failure to address the sociomedical crisis of hazardous temperature and other climate change risks exposes MENA populations to a heightened vulnerability of impacts on health, with the effect on mental health being a major concern (80). Consideration of the wider literature points to urban living as a particularly important risk factor for heat health issues (81). Analysis of regional mental health impacts entails a focus on urban contexts, where heat stress is especially acute (82).

## Health System Capacity and Adaptation Strategies

Among the required health systems functions for responding to climate-related health problems, the three most relevant in the context of the MENA region's exposure to high temperatures and the associated health consequences are systems to (1) prepare for climate-related threats, including surveillance and early warning; (2) implement countrywide health temperature action plans and related public health actions; and (3) ensure health systems remain resilient to the pressures of temperature and climate change (83). National cross-sectoral policies increasingly aim to integrate health considerations into urban planning (3).

Preparedness encompasses broad preparedness, surveillance, and early warning systems. Overall, MENA region countries demonstrate varying levels of early warning capacity for temperature-related health risks and need to strengthen these systems (84). Only a few countries report receiving any climate-related alerts. While the health systems of MENA countries exhibit considerable experience in addressing heat-related health threats, significant opportunities exist to improve coordination spanning sectors and responses and to adapt guidance and sectors covered to the specificities of the regional climate-health interface (85). Countries such as Morocco have developed comprehensive heat action plans that articulate a mix of public health, climate adaptation, and community engagement approaches to promote health and environmental adaptation; adoption of similar frameworks remains desirable (1).

Protecting health during heat waves and extreme temperature events requires maintaining the health infrastructure, human resources, or institutional capacities sufficient to respond to the associated increase in health care demand. MENA region countries vary widely in their healthcare infrastructure and systems capacity to respond flexibly to manage surge health services demand (86). Consequently, degrees of health-security resilience to climate change differ (87). The escalating frequency of heat stress-related impacts on human health calls for urgent intersectoral dialogue, multilevel collaboration, and a societal response framework capable of confronting the rapidly evolving climate-health nexus (88).

### 6.1. Preparedness, Surveillance, and Early Warning Systems

Substantial capacity and preparedness gaps exist in many countries in the region regarding the surveillance and early warning systems necessary to support effective heat adaptation responses and protect vulnerable populations (89). Several collaborative efforts are aiming to enhance regional capacities for detecting and responding to such threats (48).

Approximately 60% of the population in the eastern Mediterranean and the Middle East is at risk for infectious diseases influenced by climate change, with threats expected to increase under global warming scenarios (89). Mediterranean climate and seasonal patterns, the considerable volume of water stored in surface lakes, and the presence of infectious agents and vectors mean that waterborne and water-hygiene-related pathogens are of particular concern (30). Sustained temperatures above 20 °C favour the survival of viruses that are transmitted through the faecal-oral route, and drought conditions

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can lead to higher concentrations of these microbiological agents in untreated sewage and increased evaporation from surface-water bodies (3). Floods and extreme weather events disrupt water supply systems, allowing microbial pathogens in sewage to penetrate water distribution networks (90). Rising global temperatures further support the widespread transmission of viruses like hepatitis A, which already cause disease outbreaks (91). Examples of initiatives include the Middle East Consortium on Infectious Disease Surveillance operating across Israel, Jordan, and the Palestinian Authority, and the Cyprus government's climate change coordination project in the eastern Mediterranean and the Middle East region (92). Climate change adaptation measures such as sustainable irrigation practices remain essential to minimize the expansion of salinity into the soil and aquifer systems and facilitate sustainable agricultural and surface-water management. Addressing the knowledge gaps related to infectious disease risks under climate change, including measurement and prediction, is another priority (93). Ensuring the safety and protection of drinking-water supplies and foodstuffs, especially for meat, seafood, and dairy products, involves a combination of farm-level interventions, safe food-handling practices, and public education (94). Regular monitoring of water quality is critical, especially following severe climatic events such as floods and prolonged droughts (95). Additional adaptation measures such as desalination, wastewater recycling, and virtual water trade can help alleviate water scarcity (96). Supporting enhanced access to healthcare services for vulnerable populations in developing countries like Iraq and Yemen is also essential (97). Increased funding by wealthier regional countries and international donors is necessary to support training, research, and health interventions, with recent investments from the European Union and global agencies indicating positive progress (98).

### 6.2. Heat Action Plans and Public Health Interventions

The Ahmedabad Heat Action Plan represents South Asia's initial comprehensive system for early warnings and preparations regarding extreme heat events (99). It outlines medium- and long-term initiatives to bolster readiness, facilitate information exchange, and coordinate responses aimed at mitigating the health impacts of high temperatures on at-risk populations (100). Initial measures concentrate on enhancing public awareness and outreach at the community level, establishing a straightforward early warning mechanism, and equipping healthcare practitioners to identify and address heat-related ailments (101). The Early Warning System activates heat alerts based on specific temperature thresholds correlated with distinct colour codes employed in public communications (102).

Climate change influences human health through diverse pathways that affect both communicable and noncommunicable diseases (103). Although developed countries account for a larger share of greenhouse gas emissions, the health consequences are felt more acutely in less developed settings, particularly North Africa and the Middle East (2). In these regions, the establishment of an explicit public health agenda is essential, concentrating on the amelioration of risk factors associated with noncommunicable diseases and the promotion of lifestyle modifications geared toward enhancing overall health and well-being (104).

### 6.3. Healthcare Infrastructure Resilience and Workforce Training

Healthcare infrastructure must be resilient to climate hazards such as extreme heat, flooding, and storms if climate-related health challenges are to be addressed (3). Urban hospitals in particular will need to operate sufficiently during extreme weather events and the COVID-19 pandemic, since they are the primary places in which to receive acute heat-relief interventions, despite lockdowns that have prevented health ministries from reaching out to sectors still exposed to high environmental risks (105). If health systems are to maintain minimum service continuity after, for example, extreme rainfall or severe heat goes beyond short-term prevention strategies hours, weeks or months before—either directly during or upward changes in demand in the aftermath of a municipal or national level pandemic or extreme weather event due to adherence to preventive behaviours that curtail demand targeted, the existing welfare of the national workforce can be delayed or even reversed (48). Training emergency room professionals in charge of austerities, exposure tracking, hot season-augmented ventilation, and resource sharing beforehand allows for the mobilization of alternative disciplines whenever such acute climate stress creates significant public or institutional health vacuums (105).

## 7. Policy, Governance, and Equity-Oriented Approaches

Policy, governance, and management recommendations must address the regional context of heat risk and guide global and national economic recovery (106). Expansion of regional “One Health” framework to incorporate climate-health interactions is also essential, including the establishment of cross-ministerial climate-health networks and the integration of environmental and health data across sectors (107).

Equity-oriented strategies within climate adaptation and health policy should focus on deeper integration of social protection and equitable access to health services (108). Social protection mechanisms already operating at national and regional scales could further link health and climate resilience planning (109). Particular strategies include enhanced usage of health impact assessments in national adaptation planning to properly account for vulnerable groups, co-designing resilience financing models for both climate adaptation and health progression, and redirecting universal health coverage (UHC) financing to the unmet health needs of vulnerable populations (110).

Equity-oriented adaptation planning demands better disaggregation of national or urban adaptation financing data by sector, recipient type, or vulnerable population (111). Science-driven identification of climate impacts on population at risk and groups facing UHC demands, in addition to monitoring capacity tracking of climate adaptation finance, represent critical research gaps (112). Variability of climate-related risk across population categories invites screening analyses of equity-oriented datasets (113). Climate-health collaborations should apply ethical lenses to citizen-science dataset designs, openly derived variables from social media, and multi-party procurement model architectures to accommodate privacy concerns and counter the influence of the private sector (114).

### 7.1. Cross-Sector Collaboration and Urban Planning

Climate change threatens health through social, economic, and cultural pathways, exposing populations to heat stress, poor air quality, and shifting vector ecology (115). A recent assessment of climate-sensitive diseases in Ethiopia and Ghana illustrates the degree of vulnerability (115). To begin closing health adaptation gaps, safeguarding systems—such as water, food, energy, and health—must be prioritized (48). Integrating climate change and health governance to promote secure and sustainable development requires a transdisciplinary approach transcending sector silos (116).

### 7.2. Social Protection, Financing, and Access to Care

Social protection reduces vulnerability by providing safety nets against food insecurity and income loss, thereby influencing access to health care and basic services (117). Climate shocks disproportionately affect the poor, leading to diminished mental and physical health (1). Climate stress can adversely impact educational attainment (19). The poor in several MENA economies lack effective unemployment benefits, pension schemes, and social assistance (118). Growing human pressures on the environment raise food insecurity and reduce access to safe drinking water, which correlate with health problems such as obesity, diabetes, hypertension, cardiovascular disease, and mental disorders (16). In an analysis of the ensuing stress and income losses across various MENA nations, food insecurity rose with diminished household welfare and dampened educational attainment (119).

### 7.3. Data Systems, Research Gaps, and Ethical Considerations

The MENA region lacks heat-health research and needs reliable, open, and comparable data across various themes and dimensions (120). Organizing and linking available datasets into a systematic database would strengthen regional evidence (121). Essential themes include (1) contemporary climate trends (temperature, precipitation), correlated environmental exposures, and climate change projections; (2) vulnerability indicators for age, socioeconomic status, housing conditions, healthcare access, displacement, and others; (3) health impacts attributable to heat and other climate factors; (4) health system capacities; (5) policy measures and adaptations; (6) case-study documentation across countries, cities, sectors, or subpopulations (122).

To address equity concerns, data on migration, refugee flows, occupation types or sectors, indoor versus outdoor work patterns, access to shelters, coping practices, and enforcement of protection measures are crucial (1). Promoting data sharing in both directions, from international organizations to regional agencies and among countries, would further amplify the impact of global datasets (123). Existing platforms such as the MENA Health Observatory and Health Information Systems can facilitate research harmonization, knowledge exchange, and coordination at the regional level (124).

## Conclusions

Climate change represents one of the most significant factors threatening public health in the Middle East and North Africa (MENA). The region experiences extreme temperatures, humidity, and other environmental stressors such as water scarcity, dust storms, air pollution, and heat waves. The increased frequency and intensity of these climate events have severe implications for health systems, leading to a range of illness, injury, mortality, and socioeconomic disruption. Vulnerable populations, including migrants, refugees, people with disabilities, and those in humanitarian settings, face their effects most acutely. The prevalence of violence, armed conflict, political and economic instability, and protracted humanitarian crises pose additional challenges for the operationalization of policies, governance frameworks, and standards that safeguard and promote health.

People with specific vulnerabilities face heightened exposure to climate change and limited options for protection. Water scarcity and pollution exacerbate pre-existing health burdens in these disadvantaged groups, limiting opportunities for climate change mitigation and adaptation. Parties affected by climate change emphasize that vulnerable groups not only require assistance with capacity-building and critical actions (e.g., safe water provision) but also call for the recognition of their agency and contributions. Addressing these determinants therefore remains a public health priority for MENA countries facing staggering new challenges.

To combat the serious and far-reaching climate-health crisis in MENA, action must concentrate on five strategic intervention priorities: risk characterization, monitoring, and vigilance; outreach to climate-sensitive sectors and promotion of climate-sensitive investments; multi-sectoral engagement to enhance societal adaptation and resilience; health-system capacity-building and preparedness; and expansion of the knowledge base, data systems, and research networks on climate change and climate-sensitive health risks across the region.

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