



Primary Care Approaches

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Climate Change: It's Our Problem

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On November 1, 2014, the Intergovernmental Panel on Climate Change (IPCC), a scientific body appointed by the world's governments to advise them on the causes and effects of global warming, released its fifth report, *Climate Change 2014: Synthesis Report* (IPCC, 2014b). The report indicates "continued emissions of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive, and irreversible impacts for people and ecosystems" (p. 18).

Despite the effort by many countries to tackle the problem of greenhouse gases by reducing the amount of fossil fuels used for energy production, the global problem is becoming more acute as developing countries use fossil fuels to support their emerging industries and growing populations. The *Third National Climate Assessment* report (Melillo, Richmond, & Yohe, 2014) indicates the majority of the world's population will feel the impact of climate change, but health effects will be variable in severity and frequency based on geographic location; the local disruptions of the physical, biological, and ecological systems; and the resilience of critical public health infrastructure in the region. Disadvantaged people and communities will experience greater risks associated with climate change (IPCC, 2014a).

The continued warming of the climate is projected to increase the health risks to humans (Patz, Frumkin, Holloway, Vimont, & Haines, 2014). There will be direct impacts associated with increased temperature and extended heat events; health risks associated with extreme weather events and air pollution; and additional indirect health events due to droughts and food shortages – changing animal, fish, and insect habitats; and waterborne and foodborne diseases associated with increased temperatures. On a global level, food and water availability/scarcity may lead to population migration and governmental conflict further

increasing the risk to human health (CNA Military Advisory Board, 2014; Food & Agriculture Organization of the United Nations, 2011; McMichael, Barnett, & McMichael, 2012; United Nations Department of Economic and Social Affairs, 2014). These consequences of climate change have implications for health, especially the health of children (Shea, 2007) and other vulnerable members of our community: those with chronic health conditions, the old, and the disenfranchised on the margins of society due to poverty, language barriers, immigrant status, mental health issues, and lack of access to comprehensive health services (see Figure 1).

The Health Consequences of Climate Change

Extreme Weather Events

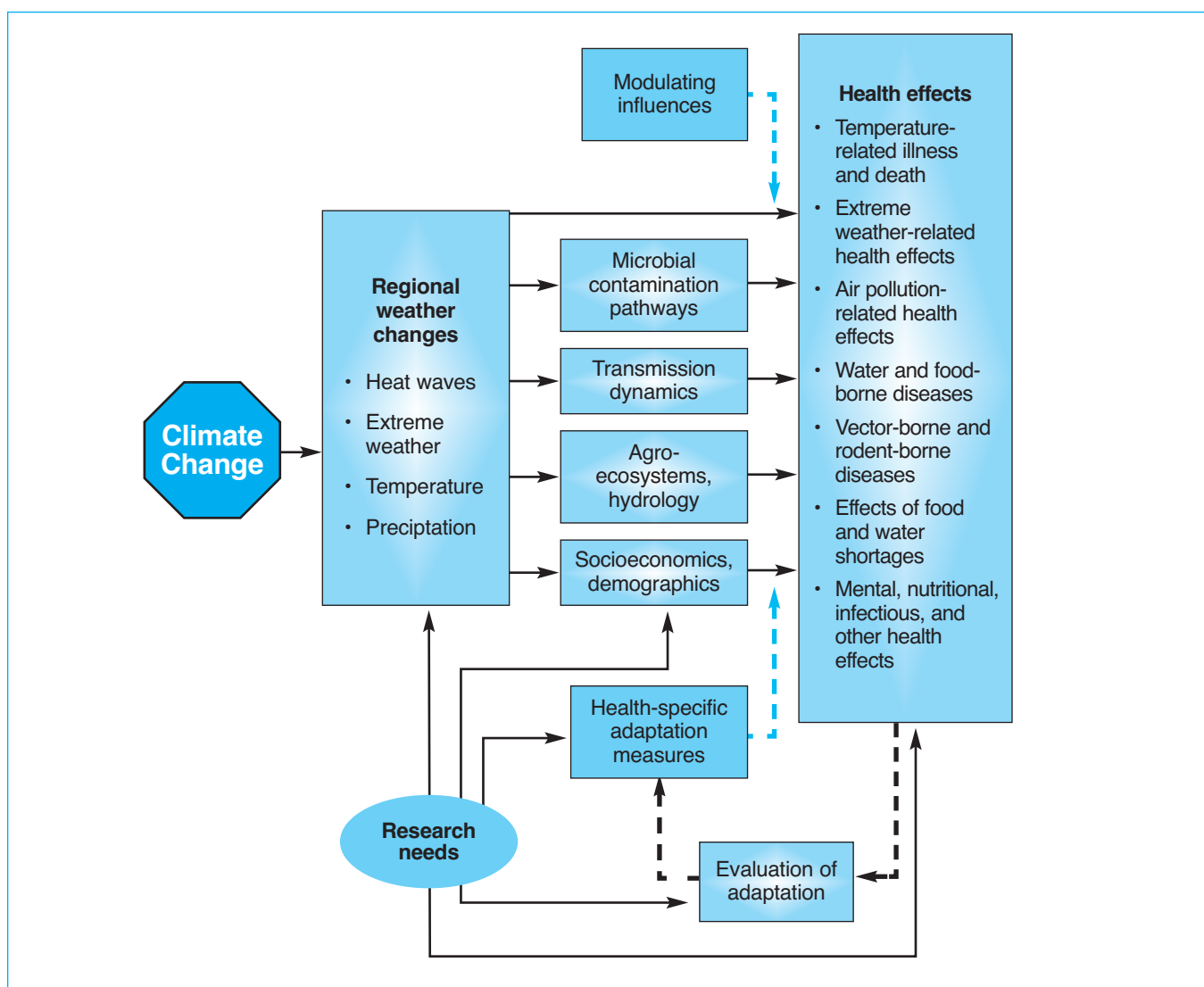
"Impacts from recent climate-related extremes, such as heat waves, droughts, floods, cyclones, and wildfires, reveal significant vulnerability and exposure of some ecosystems and many human systems to current climate variability (*very high confidence*). Impacts of such climate-related extremes include alteration of ecosystems, disruption of food production and water supply, damage to infrastructure and settlements, human morbidity and mortality, and consequences for mental health and human well-being" (IPCC, 2014b, p. 16). The IPCC (2012) warns that warming oceans will likely increase the risk of larger and stronger hurricanes and typhoons able to inflict greater structural and environmental damage with greater human mortality and morbidity. The rising sea level associated with global warming has increased the risk of flooding and tidal surges in many coastal communities. This resulted in major property damage and death in the Northeast when "Super Storm Sandy" hit in October 2012, but this was nothing compared to the devastation and death of over 6,000 people a year later when Typhoon Haiyan overwhelmed Tacloban, Philippines.

The health consequences associated with extreme weather events include death, often from drowning or traumatic injury, and post-disaster health consequences, such as infections, complications from chronic health condi-

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The **Primary Care Approaches** section focuses on physical and developmental assessment and other topics specific to children and their families. If you are interested in author guidelines and/or assistance, contact Patricia L. Jackson Allen at pat.jacksonallen@yale.edu

Figure 1.
Climate Change and Health



Source: World Health Organization, 2003.

tions, and mental health and behavior problems (IPCC, 2012). Frequently, the recovery from extreme weather events is long and complicated by loss of housing and community infrastructure, such as health facilities and schools. Children are particularly vulnerable to these disruptions in their lives and have limited cognitive ability to understand what has happened and why. Post-traumatic stress disorder is a common mental health consequence of extreme weather events (Patz, Frumkin, Holloway, Vimont, & Haines, 2014).

Excessive precipitation also increases the risk of water- and vector-borne infectious diseases (Gage, Burkot, Eisen, & Hayes, 2008; Melillo et al., 2014; Reman & Hamburg, 2008). Diarrheal diseases due to contaminated water from flooded septic systems or contaminated water from large agriculture or industrial sites can occur after flooding (Nichols, Lane, Asgari, Verlander, & Charlett, 2009). Water-

borne illness outbreaks are associated with increased precipitation (Curriero, Patz, Rose, & Lele, 2001) and foodborne illnesses are associated with increased ambient temperature (Rose et al., 2001), both of which are projected to increase with climate change. Children, especially young children, are particularly susceptible to gastroenteritis and dehydration. In the United States, these conditions can usually be successfully treated by our health care system, but globally, millions of children under five years of age die as a result of contaminated water each year (United Nations Department of Economic and Social Affairs, 2014).

Standing water and warm temperatures are ideal breeding grounds for mosquitos that can increase disease burden in humans. Diseases, such as West Nile virus, malaria, Dengue fever, and Chikungunya, have now been reported in southern portions of the United States, and the habitat

for the disease-carrying mosquitos is expected to enlarge due to climate change (Nasci, 2014; Streit, Yang, Cavanaugh, & Polgreen, 2011). Tick-borne diseases, such as Lyme disease, Rocky Mountain spotted fever, anaplasmosis, and babesiosis, have also spread over greater regions of the United States, but the effect of climate change on the spread of tick-borne conditions is unknown (Centers for Disease Control and Prevention [CDC], 2014a, b).

The IPCC (2014a) reports the percentage of the global population experiencing water scarcity and the percentage experiencing major river floods are expected to increase over the 21st century. The United Nations Department of Economics and Social Affairs (2014) reports that the scarcity of water already affects regions of every continent. The western United States is currently experiencing an unprecedented drought. This drought will affect food production with rippling effects on food prices and availability. In less developed countries, the lack of access to safe, fresh, adequate water supplies for consumption, hygiene, sanitation, and livestock and agricultural use impedes economic development, leads to food shortages and malnutrition; children, especially those under the five years of age, are most often affected. Populations experiencing severe drought and food scarcity often migrate to other areas in search of water and food, thus increasing stress on neighboring countries and global political unrest (McMichael et al., 2012).

Extreme Heat Events

IPCC (2014b) indicates climate change will *very likely* cause longer and more frequent heat waves by the end of the 21st century. Extreme heat events, unusually hot weather conditions that last for several days potentially affecting human health, are the leading cause of weather-related deaths (CDC & National Center for Environmental Health, 2013) and lead to increased emergency room visits and hospitalizations (Lin et al., 2009; National Oceanic and Atmospheric Administration [NOAA], 2014). Although extreme heat events affect people all over the world, some of the most dramatic recent heat waves have occurred in the United States and Europe. Current climate change projections indicate increasing hot weather and extended heat events in multiple sections of the United States (Greene, Kalkstein, Mills, & Samenow, 2011; O'Neill & Ebi, 2009; Patz, et al., 2014). Urban centers trap heat, increasing the heat-related risks in densely populated cities, especially among the poor, children, those with impaired physical or mental health, and the elderly (O'Neill & Ebi, 2009). Heat cramps, heat exhaustion, and heat stroke are significant health risks to children who may not recognize the early signs of these conditions or be able to independently seek shelter and fluids (Balbus & Malina, 2009).

Air Pollution

Climate change is projected to harm human health by increasing air pollution. High temperatures increase ground level ozone and smog, small particulate matter pollutants, and oxides (nitrogen, sulfur, and carbon), all of which are byproducts of fossil fuel combustion in the air. The United Nations Environmental Programme (2014) has identified air pollution as the world's worst environmental health risk, and the International Agency for Research on Cancer (IARC) has classified outdoor air pollution as a cancer-causing agent (Straif, Cohen, & Samet, 2013). Particulate matter 2.5 micrometers or less in diameter are especially harmful because they can travel further down into the lung fields,

causing damage to small airways (Ebi & McGregor, 2008; Gauderman et al., 2004; Melillo et al., 2014). Asthma exacerbations during periods of increased ambient air pollution are a common occurrence due to elevated particulate matter and the irritant/allergic quality of ozone and oxides. Children are especially vulnerable to air pollution because their lungs are developing, they breathe at a higher rate per minute than adults, spend more time outside, and participate in more vigorous activity than adults (Kim & American Academy of Pediatrics, Committee on Environmental Health, 2004). In addition, maternal prenatal exposure to air pollution has been associated with an increase in premature births (Holstius, Reid, Jesdale, & Morello-Frosch, 2012; Wilhem et al., 2011) and low infant birth weight (Kim & American Academy of Pediatrics, Committee on Environmental Health, 2004), both with potential risks to respiratory health in infants.

Regional droughts as a result of long periods of record heat and limited precipitation have increased the risk of major forest fires. Smoke from these wild fires contains abundant particulate matter, carbon monoxide, and various volatile organic compounds, precursors to ozone and smog, which are spread over major areas downwind of the fires, resulting in increased incidence of asthma exacerbation and respiratory illness (Elliot, Henderson, & Wan, 2013).

Airborne Allergens

Warming temperatures result in more frost-free days and prolonged flowering time and pollen release from allergic plants (Melillo et al., 2014). Higher pollen concentrations and longer pollen seasons increase allergic symptoms and asthma exacerbations in children (Ariano, Canonica, & Passalacqua, 2010; Darrow et al., 2012). Excessive rainfall in certain regions and rising temperatures increase the growth of molds, fungi, and bacteria in living spaces, increasing the likelihood of pediatric allergies as a result of these aeroallergens (Institute of Medicine [IOM], 2011; Mendell, Mirer, Cheung, Tong, & Douwes, 2011). Climate change is most likely contributing to the incidence, prevalence, and severity of atopy, asthma, and other respiratory conditions in children (Shea, 2007).

Mental Health Risks Associated with Climate Change

Extremes related to climate change, such as extended heat events, flooding, droughts, or hurricanes/typhoons, expose children to varying degrees of traumatic events and family and community disruption. The degree of exposure to the extreme weather event and the disruption in family cohesiveness generally determines the risk and level of psychological stress in children. Injury, illness, bereavement, and loss of one's home and community all contribute to the mental health stress associated with disastrous weather events (Davidson & McFarlane, 2006). Research evaluating mental health in people in the New Orleans metropolitan area post-hurricane Katrina determined that a high percentage of residents experienced anxiety-mood disorders and post-traumatic stress disorder (Galea et al., 2007). These disorders were strongly associated with experiencing physical injury or illness as a consequence of the hurricane, family unit disruption, and property loss. Unfortunately, mental health services are often disrupted for prolonged periods of time after disasters, further affecting the health and recovery of children and families.

Global Geopolitical Risks to Health Associated with Climate Change

The accelerated rate of climate change poses a severe risk to global political stability (CNA Corporation Military Advisory Board, 2014). As the world's population continues to grow, and the impact of climate change affects available food, water, and energy resources, political power struggles for control of these resources are a likely scenario (CNA Corporation Military Advisory Board, 2014).

The CNA Corporation Military Advisory Board (2014) strongly recommends that the United States assume a global leadership role in abating climate change where possible and prepare for the projected impacts of climate change. The report concludes that the projected impacts of climate change must be integrated into national planning for security, disaster management, infrastructure stability, food, water, and energy resources.

The Role of Advanced Practice Nurses

Pediatric nurses must be aware of the health consequences of climate change to provide appropriate and anticipatory care to children and families, educate the community regarding health risks associated with climate change, and lobby for public health planning to address the anticipated health consequences of climate change. Increased air pollution poses health risks to all people, but individuals with respiratory conditions (such as asthma and chronic pulmonary disease), cardiovascular compromise, the elderly, and the very young have increased risks associated with air pollution. Children and families with increased risks should be counseled on the hazards of air pollution and encouraged to reduce activity and remain inside, preferably in air-conditioned facilities, during high air pollution days. They should be taught how to use governmental Air Quality Index ratings (<http://airnow.gov/index.cfm?action=aqibasics.aqi>) to guide their daily activity. School nurses should also monitor the Air Quality Index, as well as students' activity and respiratory symptoms. Children with asthma can be instructed to increase their treatment frequency for short-acting beta₂ adrenergic (albuterol) to address the air pollution and prevent an asthma exacerbation.

Weather forecasting has provided some ability to plan for extreme weather events and initiate evacuation to a safer location. However, the area affected by an extreme weather event is often large, and evacuation is not feasible. After an extreme weather event, the devastation can be so great that community infrastructure and health care services can be disrupted for prolonged periods of time. It is important for pediatric nurses to educate their families, especially those with chronic health conditions, on planning for disasters and the possible disruption of health care services. Disaster planning information and guidelines are available on government websites (<http://www.ready.gov/make-a-plan>) and can be shared with families. It is important that children have adequate supplies of their medications to manage their chronic health conditions for a period of one to two weeks and know how to use them appropriately if symptoms increase. Local emergency responders should have a list of people with complex health conditions so in the case of extreme weather events, they can be targeted for emergency services.

Extreme heat events are the leading cause of weather-related deaths in the United States (CDC & National Center for Environmental Health, 2013). Extreme heat events require a concerted public health response to offer cooling stations and health care for all people who need these services, including children and families who are poor, isolated, illegal immigrants, or are cognitively or mentally impaired. Public health announcements warning of the serious consequences of excess heat exposure, signs and symptoms of heat stress, and the need for limiting activity and increasing fluid consumption should be developed and broadcast widely. Pediatric nurses should be part of this community planning process to assure the needs and vulnerabilities of children and adolescents are addressed.

As climate changes alter the regions infested by certain types of mosquitos and ticks, pediatric nurses will need to expand their knowledge regarding vector-borne conditions, the symptoms, diagnosis, and treatment. Obtaining a travel history on people being seen for fever, rash, or other unidentified symptoms is always important. The CDC publishes biennially the *CDC Health Information for International Travel* (CDC & Brunette, 2014), an excellent guide for identifying and treating possible vector-borne conditions or conditions caused by water contamination.

Pediatric nurses should add their voices, as respected professionals, to the public and political discourse on climate change. IPCC (2014a) clearly outlines the impacts, vulnerability, and adaptations needed to address climate change. This is not just a political issue. It is a health problem, and as pediatric nurses, we need to be actively involved in promoting the public health benefits of controlling greenhouse gases and planning for the health consequences of climate change (Haines et al., 2009).

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