Climate Change and the Effects on Childhood Disease

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About Me

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The lack of attention to children reflects a generally lower level of attention to the human implications of climate change – as compared to the environmental and economic implications. Theory and practice regarding children have long stressed the importance of an integrated approach to development and well-being, and this could well be more broadly applied. Adaptation, in these terms, means considering how to strengthen and support children’s capacity to cope with the full range of risks and adversity associated with climate change, as well as that of the families and communities on which they depend.

Current
Global Warming is not Natural

- yes natural global warming did occur in the past
- natural causes of climate change can be:
  - sun
  - Milankovitch cycles
  - volcanos
  - carbon dioxide

**Fact 1:** CO₂ traps heat and plays a vital role in our climate  
**Fact 2:** Increasing the CO₂ results in more heat being trapped  
**Fact 3:** We have roughly doubled the CO₂ in the atmosphere  
**Conclusion:** Therefore, we are causing the climate to warm  

This is a deductive logical argument. Unless you can show that one of the premises is false or that a logical fallacy has been committed, you must accept the conclusion.

thelogicofscience.com
Climate Change and Human Health: Present and Future Risks  
McMichael et al

By 2100 a.d. increase in temperatures will range from 1.4-5.8 degrees Celcius. The increase will be more at higher latitudes and over land. Global average annual rainfall will increase, though mid latitude and lower latitude land regions will become drier and flooding will likely be more severe. Heat waves, as we know, kill thousands annually.
**Main pathways by which climate change affects population health**

**Temperature Extreme — more hot days**
- Adverse Effect: more heat-related deaths and disease events
- Beneficial Effect: reduced winter deaths and disease events

**Floods**
- Adverse Effect: more injuries, deaths, and other sequelae (infectious diseases, crop loss, housing loss)
- Beneficial Effect: some regions will have reduction of aero-allergens

**Aero-Allergen Production**
- Adverse Effect: increased allergic disorders due to longer pollen seasons
- Beneficial Effect: some regions will have reduction of aero-allergens

**Food Poisoning**
- Adverse Effect: greater risks at higher temperatures (salmonellosis)
- Beneficial Effect: less risk where rainfall is diminished (equatorial areas)

**Water-Borne Infection**
- Adverse Effect: cholera risk amplified by water warming/local flooding
- Beneficial Effect: less risk where rainfall is diminished (equatorial areas)

**Vector-Borne Infections**
- Adverse Effect: mosquito borne infections tend to increase with warming and change in rainfall patterns: heightened transmission. Likewise tick-borne infections, although more complex
- Beneficial Effect: mosquito reproduction and survival could be impaired by altered rainfall and surface water and by excessive heat: reduced transmission. Similar determinants may apply to ticks, snails and other vectors

**Regional Crop Yields**
- Adverse Effect: reductions in many low-latitude and low-rainfall regions
- Beneficial Effect: increases in currently "too-cold" regions may not be sustainable pending further climate changes

**Fisheries**
- Adverse Effect: declines or shifts in local fisheries: proven shortages in poor populations. Portable increased risk of contamination of food supply
- Beneficial Effect: latitudinal shifts of fisheries with ocean warming, may benefit new host populations

**Sea Level Rise**
- Adverse Effect: health consequences of population displacement, lost livelihood, exposure to coastal storm surges, and floods, salinization of freshwater and coastal soil.
- Beneficial Effect: may not be sustainable pending further climate changes

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**Infectious Agents**

- Many infectious agents, vector organisms, non-human reservoir species, and rate of pathogen replication are sensitive to climatic conditions.
- Both salmonella and cholera bacteria, for example, proliferate more rapidly at higher temperatures, salmonella in animal gut and food, cholera in water. In regions where low temperature, low rainfall, or absence of vector habitat restrict transmission of vector-borne disease, climatic changes could tip the ecological balance and trigger epidemics. Epidemics can also result from climate-related migration of reservoir hosts or human populations.
- Studies in south Asia and South America (Venezuela and Columbia) have documented the association of malaria outbreaks with the ENSO cycle. In the Asia-Pacific region, El Niño and La Niña events seem to have affected the occurrence of dengue fever outbreaks. Similarly, inter-annual (especially ENSO-related) variations in climatic and environmental conditions in Australia affect outbreaks of Ross River virus disease.
- The effect of rainfall is more complex. For example, in tropical and subtropical regions with crowding and poverty, heavy rainfall and flooding may trigger outbreaks of diarrhea, whereas very high rainfall can reduce mosquito populations by flushing larvae from their habitat in pooled water.
Typhus

- Right now the state of California has an outbreak of typhus.
- There were 124 cases in 2018 in LA alone.
- Trash piles + rats + increased temperatures = outbreak.
- Symptoms: fever, chills, headache, myalgia, eschar at the bite site, AMS, lymphadenopathy, rash (25-50%) trunk to extremities.
- Treatment: doxycycline. Adults: 100mg BID, Children under 100 lbs: 2.2 mg/kg BID for 3 days.

Malaria

- Vivax and falciparum most prevalent in US.
- Originally described by Hippocrates — named the cycling fever (tertian, quartan, subtertian, quotidian).
- The American Public Health Association (APHA) formed in 1872 increased sanitation and hygiene.
- Office of Malaria Control in War Areas established in Atlanta in 1942 to limit malaria and typhus in military bases — became the CDC.
- Invention and use of DDT decreased mosquito populations to negligible levels. Last known locally infected case in 1950.
- Worldwide there are approximately 200 million people infected annually with 600,000 deaths.
- Increases in temperature and water accumulation, from flooding and rains, is likely to cause increased numbers of mosquitos increasing risk of malaria.
- In children, malariae malaria can cause fatal kidney damage.

Bukkuri A. The history of malaria in the United States: how it spread, how it was treated, and public responses. MOJ Anat Physiol. 2016;2(3):82‒87. DOI: 10.15406/mojap.2016.02.00048

Dengue

- Flavivirus with 4 serotypes — most commonly transmitted by Aedes mosquitos.
- High transmission rates from August until November.
- Dengue outbreaks have been recorded on the east coast since the late 1700s.
- Recent outbreaks in Texas, Florida, and Hawaii.
- Most infections in the US come from travelers.
- Endemic in Puerto Rico.
- 40% of the world's population live in areas with risk of dengue transmission.
- 30 fold global increase in incidence in the past 50 years.
- 400 million people infected yearly.

Cholera

- Vibrio cholerae infection of small intestine
- Generally passed by not washing hands, dirty water, undercooked seafood, poverty
- Watery diarrhea lasting days, vomiting and muscle cramps—dehydration and electrolye imbalance
- Affects 3-5 million people worldwide annually and causes 30,000-130,000 deaths per year
- Young children in endemic areas are most affected with incidence rate close to 1 in 10


Lyme Disease

- Lyme disease is the most common disease spread by ticks in the Northern Hemisphere. It is estimated to affect 300,000 people a year in the United States and 65,000 people a year in Europe.
- A 2005 study using climate suitability modeling of I. scapularis projected that climate change would cause an overall 213% increase in suitable vector habitat by the year 2080, with northward expansions in Canada, increased suitability in the central U.S., and decreased suitable habitat and vector retraction in the southern U.S. A 2008 review of published studies concluded that the presence of forests or forested areas was the only variable that consistently elevated the risk of Lyme disease whereas other environmental variables showed little or no concordance between studies.
- Overall climate and primary host population determine the localities where ticks will thrive. However, studies have been conducted which correlate tick population to climate change and their behavior to weather patterns.

- Ixodes pacificus is found in the western region of the United States and in southwestern Canada. Although most prevalent in California, the tick has also been found in five other western states. These include Oregon, Washington, Utah, Nevada, and Arizona.
- Ixodes pacificus has also been recorded in British Columbia.
Lyme Disease

- In the past two decades, we have seen increases in both the overall numbers of Lyme disease, anaplasmosis, and babesiosis cases, and the geographic ranges of disease-endemic areas.

- The northern limit of the ticks' ranges has been attributed to either too few days during the warm part of the year with temperatures exceeding thresholds that allow for physiological processes to proceed, or to cold temperatures in the winter limiting survival.

- Both ticks are also absent from much of the Great Plains and the Intermountain West, presumably due to conditions that are too dry for these ticks to thrive.

- The fact that this tick is successfully established in areas with a very wide range of local climates—from Florida to southeastern Canada—raises the possibility that plasticity in temperature-dependent and independent determinants of the life cycle phenology may be present.

- Laboratory studies indicate that temperature determines whether or not, and to what extent, *I. scapularis* can move to seek hosts, whereas humidity determines how high ticks quest above ground level, where their resource for re-hydration exists; and for how long they can remain actively host-seeking before retreating to re-hydrate (Clark 1995, Vial and Smith 1998, Ogden et al. 2004). Clark (1995) determined that the average temperature thresholds under which movement and coordinated movement by *I. scapularis* ceased were 9.8 and 13.9°C, respectively.


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Lyme Disease

- Since 1991, when standardized surveillance and reporting of Lyme disease began in the United States, case counts have increased steadily.

- A key question for the extreme Northeast, Upper Midwest, and Southeastern Canada is to what extent climate warming will result in spread and increased abundance of Peromyscus mice, deer, and *I. scapularis*, thus potentially placing new human populations at risk as well as resulting in increased transmission intensity in areas where *B. burgdorferi* already is established.

- Current models are showing a decrease of *I. scapularis* in the southeastern United States with increased projection of the habitat to midwestern states.

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Snowfall

http://www.thorntonweather.com/noaa/snow.php
Flooding

- Floods are low-probability, high-impact events that overwhelm physical infrastructure, human resilience, and social organization.

- From 1992 to 2001, there were 2257 reported disasters due to droughts or famines, extreme temperature, floods, forest/scrub fires, cyclones, and windstorms. The most frequent natural weather disaster was flooding (43%), killing almost 100,000 people and affecting over 1.2 billion people.

Health Consequences

- Some health consequences arise during or soon after the flooding (such as injuries, communicable diseases, or exposure to toxic pollutants), whereas others (malnutrition and mental health disorders) occur later. Excessive rainfall facilitates entry of human sewage and animal wastes into waterways and drinking water supplies, potentiating water-borne diseases.

Food Insecurities

- One of the great public health achievements in modern history is the steep acceleration in global food production over the past six decades. Despite historic growth in global food demand, rates of undernutrition have fallen. Mostly due to technological innovations, including the development of higher-yielding grain varieties, production of synthetic fertilizers and pesticides, and mechanization of agricultural labor. Roughly 40% of Earth's ice-free land surface is used as cropland and pasture. Irrigation uses 66% of annual water withdrawals and is the single largest human use of water.

- Climate change is associated with increasing temperatures and more extreme rainfall; it alters relationships among crops, pests, pathogens, and weeds; and it exacerbates several trends including declines in pollinating insects, increasing water scarcity, increasing ground-level ozone concentrations, and fishery declines.

- Global land temperatures 2006–2015, were 1.0°C (1.8°F) warmer than the twentieth-century average.

- Climatic shifts may provide either a drag or a boost to ongoing yield trends. Existing estimates suggest that climate trends since 1980 have reduced global production by approximately 5% for maize and wheat whereas net global production of soybeans and rice has remained unaffected.

- Global pollinator declines would increase child mortality and birth defects from vitamin A and folate deficiency, and also increase the risk of heart disease, stroke, diabetes, and certain cancers in adults as a result of reduced dietary intake of fruits, vegetables, nuts, and seeds.

- Crops grown at elevated CO2 also exhibit lower concentrations of important minerals. CO2 concentrations of 550 ppm can lead to 3–11% decreases of zinc and iron concentrations in cereal grains and legumes and 5–10% reductions in the concentration of phosphorus, potassium, calcium, sulfur, magnesium, iron, zinc, copper, and manganese across a wide range of crops under more extreme conditions of 690 ppm CO2. In addition, roughly 1.4 billion children ages 1–5 and women of childbearing age, which represent 59% of the world total in these groups, live in countries where current anemia rates exceed 20% of the population and where dietary iron intake is expected to decrease by 3.8% or more as a result of these CO2-mediated changes.

Wild Fires

- For the West, bigger wildfires and a lengthening “fire season” have combined with population growth and building in burn zones to destroy more people and property, as seen in California’s recent devastating wildfires and fierce burns in Colorado this summer. The record-low mountain snow in southern Colorado and higher temperatures accelerated a climate shift toward aridity that favors frequent ignition.

- The cumulative forest area burned is increasing rapidly. And federal wildfire analysts calculated that the 24 million acres burned across the West between 1984 and 2015 was twice what would have burned had global warming caused by humans not happened.

- Meanwhile, recent surveys show spruce beetles infested another 202,000 acres of Colorado forest, pushing their total damage above 1.7 million acres. This follows the ravaging of 3.7 million acres of forest by mountain pine beetles. Rising temperatures help inspects proliferate in out-of-balance forests, especially as winters pass without extended sub-zero temperatures, Lester said.

- Forests naturally function as “a great carbon sink,” Lester said. “But now they’re a big carbon source. … We’re going to have to suppress some fires. We’re going to have to do some active management. We’re going to have to do something with fire as a prescribed burn tool.”
Air Pollution

- 2013 study showed women who conceived in areas with high concentrations of NO and CO had a nearly double risk of giving birth to a child with neural tube defects.
- 2017 study at Cincinnati Children's Hospital found that peri-conception exposure to air pollution, specifically fine particulate matter, moderately increased risk for birth defects - most commonly abdominal wall defects and hypospadias.

**Periconception Exposure to Air Pollution and Risk of Congenital Malformations. Ren, Sheng et al. The Journal of Pediatrics, Volume 193, 76 - 84.e6**

Respiratory Issues

• Respiratory illnesses cause 20% of under-five deaths worldwide. A number of factors are involved, not all affected by climate change. However, changes in mean temperature and precipitation can increase the number of forest and bush fires, which affect air quality for thousands of miles, generally increasing the number of people experiencing respiratory difficulties.

• Changing pollen counts, fungal growth and molds related to flooding, and increases in ozone and other pollutants also increase rates of pneumonia, upper respiratory diseases, and asthma. Asthma has doubled worldwide over the last 15 years, with the greatest increases among children, and asthma deaths increased by 20% from 2000 to 2016.

Heat Waves

• Extreme weather events include periods of very high temperature, torrential rains and flooding, droughts, and storms. Over time, regional populations adapt to the local prevailing climate via physiological, behavioral, and cultural and technological responses. However, extreme events often stress populations beyond those adaptation limits. Understanding the health risks from these events is important because the future frequency and intensity of extreme events is expected to change as both climatic means and variability change.

• Populations typically display an optimum temperature at which the (daily or weekly) death rate is lowest. Mortality rates rise at temperatures outside this comfort zone. This figure shows a typical U-shaped relation. The trough represents the comfort zone; the steeper (right-side) arm of each line shows the mortality increase at hot temperatures, and the shallower (left-side) arm of each line shows the increase with colder temperatures.

• Positive association between heat waves and mortality, with elderly people (who have diminished physiological capacity for thermoregulation), especially women, being the most affected. Other research indicates that mentally ill people, children, and others in thermally stressful occupations or with pre-existing illness are also vulnerable. The striking mortality excess (about 30,000 deaths) during the extreme heatwave of August, 2003, in Europe, especially France, attests to the lethality of such events.

POLLUTION DOWN, LUNG HEALTH UP

Air quality in the Los Angeles basin, as measured in five cities by USC researchers, improved over two decades. That provided a more healthful environment for children’s growing lungs.

<table>
<thead>
<tr>
<th>Air Pollution</th>
<th>Children’s Lungs</th>
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<tbody>
<tr>
<td>Nitrogen oxide</td>
<td>In 1998, nearly eight of 100 15-year-olds had significant lung deficits.</td>
</tr>
<tr>
<td>Fine particles</td>
<td>By 2011, only about 3 1/2 of 100 15-year-olds had significant lung deficits.</td>
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</tbody>
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33% reduction in nitrogen oxide and 47% reduction in fine particles.

Source: USC Children’s Health Study

USC Graphics by Molly Zale
Those most at risk from increasingly frequent and intense heat waves are the elderly and the very young, who sweat less and have more surface area relative to body mass. Research in São Paulo found a 2.6 per cent increase in mortality rates in children under 15 for every degree increase above 20°C – similar to the increase for those over the age of 65 (2.5 per cent).

Southwest getting hotter
Temperatures increased across almost all of the Southwest region from 1901 to 2016, with the greatest increases in southern California and western Colorado. This map shows the difference between 1896–2016 average temperature and 1901–60 average temperature.

Vulnerability to the Health Impacts of Climate Change at Different Life Stages
- Airborne pregnant women: chronic lung conditions and preterm birth
- Young children: asthma, allergies, and asthma exacerbations
- Older adults: cardiovascular disease, respiratory illness, and heat-related illness
- The behavior and activities of older children increase their risk of exposure to heat-related illness, dehydration, and violence-related disease, and respiratory effects from air pollution and allergens.
Some More Obvious Changes

- Subsistence hunting and fishing have been much harmed by recent climate changes in Alaska, through stresses on fish and wildlife driven by warming of air and sea, sea ice retreat, and ecosystem shifts.
- Some actions taken in response to the advent of climate change also entail health risks. Sea level has risen moderately in recent decades, and population relocation from some of the lowest-lying Pacific islands is starting to take place. Such displacement often increases nutritional, physical, infectious disease, and mental health risks.
- One manifestation of global warming over the past 50 years is an increased duration of heat waves in Alaska, Canada, central and eastern Europe, Siberia, and central Australia (data for South America and Africa are unavailable).
- Tick-borne (viral) encephalitis in Sweden has reportedly increased in response to a succession of warmer winters over the past two decades.

Risks for Children

- Over the last 25 years, extreme weather events, including heavy rainfall, heat waves, droughts, floods, cyclones and hurricanes, have contributed to injury, illness, impoverishment, displacement, hunger and death for hundreds of millions of people, often with particular implications for children.
- Children, especially young children, are in a stage of rapid development and are less well equipped on many fronts to deal with deprivation and stress. Their more rapid metabolisms, immature organs and nervous systems, developing cognition, limited experience and behavioral characteristics are all at issue here. In addition, their exposure to various risks is more likely to have long-term repercussions than with adults.
- In many urban areas, the risks children face are bound to be intensified by climate change. Most of the people and enterprises at most serious risk from extreme weather events and rising sea levels are located in urban slums in low-income countries, which are often in the most hazardous areas – flood plains or other areas at risk of floods, places at risk from landslides, sites close to industrial wastes, and areas unserved by the kind of infrastructure that can be strengthened and adapted to withstand more extreme conditions.

Climate Change and Urban Children: Impacts and Implications for Adaptation in Low- and Middle-Income Countries
https://journals.sagepub.com/doi/pdf/10.1177/0956247808096125

- Nutritional risk as a result of disasters tends to be low if children were previously well nourished and if the acute malnutrition associated with the event does not go on for too long. After Bangladesh’s 1998 floods, when families were unable to compensate over time for the shortage of food and the deterioration in health conditions, flood-exposed children failed to experience the “catch-up” growth common after a shock, remaining shorter than unexposed children from the same neighborhoods.
- Children in the critical 12–24 month-old age group during the drought in the early 1980s were found 13 to 16 years later to have an average loss of stature of 2.3 inches. Their potential loss in life time earnings was calculated to be 14%.
- Abundant research relates lower cognitive capacity and performance to undernutrition; and behavior and social relationships may also be affected. The lack of specific nutrients, such as iodine, iron or zinc, related to accessibility of certain foods, also hampers development. Children’s mental growth can be affected also by intestinal parasites, diarrheal disease and malaria, all factors, as noted, that can be expected to increase with climate change. Maternal health, nutrition and stress levels during pregnancy are also related to children’s lower cognitive performance and language ability later on.
- Vector borne - The most serious threat is malaria. 50% of the world’s population is now considered to be at risk, a 10% increase in the last decade. More than 90% of the burden is in Africa, where 65% of mortality is among children under five. Malaria results in chronic anemia, increases the severity of other diseases and more than doubles the mortality rate for children under five.

WHO COP24 Special Report: Health and Climate Change - 2018
According to the most conservative estimates, children under 14 are 44% more likely to die because of environmental factors than the population at large. The same gap exists for morbidity, and it increases greatly when the potential loss of healthy life years is considered.

- A study of flood-related mortality in Nepal, for instance, found the death rate for children to be double that of adults, with pre-school girls five times more likely to die than adult men.

- Overall death rates for young children continue to drop in most parts of the world due to improved health care, immunization rates and environmental conditions. But for many of the children most at risk from the biggest killers – diarrheal and respiratory diseases, malaria and malnutrition – the situation is likely to worsen with some of the effects of climate change.

- In slower onset disasters such as droughts and famines, mortality rates are also more extreme for young children. A situation such as this is commonly defined as an emergency when crude mortality is 1 / 10,000 per day, and under-five mortality is double that.

- The IPCC projects that climate change will increase the burden of diarrheal disease in low-income countries by approximately 2–6% by 2020.

- Children in Africa born in drought years, for example, are significantly more likely to be malnourished or stunted (in Kenya, 50% more likely to be malnourished, and in Niger, 72% more likely to be stunted).

- But malnutrition is also closely tied to unsanitary conditions and to children’s general state of health. Frequent bouts of diarrhea and infestations of worms, for instance, mean impaired absorption and a loss of nutrients. When children are malnourished, their vulnerability to infection is greatly increased and a vicious cycle results. A chronically malnourished three or four year-old may be at a permanent disadvantage, becoming both physically and mentally stunted becoming both physically and mentally stunted.

As we just learned about ACEs

The shock and distress of extreme events, as well as the deprivations and humiliations of displacement or slow recovery, can be profoundly debilitating. Children’s psychological vulnerability and resilience in the face of hardship depend on their health and internal strengths, but also on household dynamics and levels of social support. Age is just one of many factors mediating the experience of adversity; some children may actually be more resilient than their elders, but their lack of social power within family and community can also leave them especially vulnerable to hardship.

- are we the big polluters? are we the ones who are making all the problems?

- No. Studies show that everyday consumers in the US have very little effect on climate change.

- the majority of climate change is caused by energy production and agriculture.

- however, we, as Americans and doctors, have a big voice and can create change.

- The USA has been a leader in so many areas the world-over for decades. What is stopping us now?
The lack of attention to children reflects a generally lower level of attention to the human implications of climate change – as compared to the environmental and economic implications.

WHO Top 10 Threats to Global Health in 2019

1. Air pollution and climate change
2. Noncommunicable diseases
3. Global influenza pandemic
4. Fragile and vulnerable settings
5. Antimicrobial resistance
6. Ebola and other high-threat pathogens
7. Weak primary health care
8. Vaccine hesitancy
9. Dengue
10. HIV