

# **Climate Change: Health Impacts on Children and Mitigating Measures**

## **by Poonam Ahluwalia<sup>1</sup>, Sangeeta Gupta, Manish Kumar and Jatin Talwar**

### **Abstract**

Climate change refers to any significant change in measures of climate (such as temperature, precipitation or wind) lasting for an extended period (decades or longer). It is different from global warming in the sense that global warming is the increase in the average temperature of the Earth's near-surface air and oceans. Climate change increases these hazards by worsening air quality, stimulating more extreme weather events, creating conditions that favor increases in food-borne, water-borne and vector-borne infections, and enhancing heat stress conditions. It is widely believed and accepted that children will bear a disproportionate adverse health burden resulting from climate change as because of physical, physiologic and cognitive immaturity; children are more sensitive than adults to harm from environmental hazards. In this study, an attempt has been made to summarize the latest conclusions on climate change and discuss its main health effects with a primary focus on children's health. The study also lists out the mitigating measures suggested by different agencies/ studies to combat the issue.

### **1.0 Introduction**

Scientists all over the world are urging countries/ governments to help control the pace of climate change with a great urgency. Climate change refers to any significant change in measures of climate (such as temperature, precipitation or wind) lasting for an extended period (decades or longer).<sup>[1]</sup> It is different from global warming in the sense that global warming is the increase in the average temperature of the Earth's near-surface air and oceans.<sup>[2, 3]</sup> It is widely believed and accepted that children will bear a disproportionate adverse health burden resulting from climate change as because of physical, physiologic and cognitive immaturity; children are more sensitive than adults to harm from environmental hazards.<sup>[4]</sup>

### **2.0 The climate change issue**

The Intergovernmental Panel on Climate Change (IPCC) has stated "Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations".<sup>[5, 6]</sup> In short, a growing number of scientific analyses indicate (but cannot prove), that rising levels of green house gases (GHGs) in the atmosphere are contributing to climate change (as theory predicts). In the coming decades, scientists anticipate that as atmospheric concentrations of GHGs continue to rise, average global temperatures and sea levels will continue to rise as a result and precipitation patterns will change.

Using reliable computer models, most answers related to the change in climatology can be answered, but incomplete understanding of major influences (such as melting of glaciers and response of ocean currents) remains a grey area. This may lead to overly conservative predictions. Scientists have predicted that at the very least, warming will continue throughout the 21st century due to the long residence time of already emitted atmospheric GHGs and the slow response time of oceans. Climate effects are

---

<sup>1</sup> Corresponding author (email- [poonama@tce.co.in](mailto:poonama@tce.co.in); [poonamkahluwalia@yahoo.co.in](mailto:poonamkahluwalia@yahoo.co.in) )

expected to vary by region and be most dramatic in higher latitudes and coastal areas. Rainfall and freshwater availability, average temperatures, agricultural growth zones and sea level all are expected to change. Ecological and human health consequences can be anticipated and some are already being measured, particularly at the poles.<sup>[7, 8]</sup>

### **3.0 Health impacts on children**

Children are likely to suffer dis-proportionately from the direct and indirect health consequences of a rapidly warming world.<sup>[9]</sup> The World Health Organization recently estimated that 34% of all childhood illness in the world (compared to 24% of all age illness) and 36% of deaths in children under the age of 14 are due to modifiable environmental factor.<sup>[10]</sup>

The potential associations of climate change and child health can be organized into three categories. First, environmental changes associated with anthropogenic greenhouse gases can lead to respiratory diseases, sun burn, melanoma, and immunosuppression. Second, climate change may directly be able to cause heat strokes, gastrointestinal diseases, and psychosocial mal-development. Third, ecological alterations triggered by climate change can increase rates of malnutrition, allergies and exposure to myco-toxins, vector borne diseases (malaria, dengue, encephalitides, and Lyme diseases) and emerging infectious diseases.<sup>[11]</sup>

Because of physical, physiologic and cognitive immaturity, children are more sensitive than adults to harm from environmental hazards. Climate change increases these hazards by worsening air quality, stimulating more extreme weather events, creating conditions that favor increases in food-borne, water-borne and vector-borne infections, and enhancing heat stress conditions<sup>2</sup>. Air quality is threatened via at least three mechanisms: heat-driven increases in ground-level ozone, energy production-driven increases in particulates and other fossil fuel-related air pollutants, and changes in aeroallergens. Ground level ozone is formed by the action of sunlight on nitrogen oxides and volatile organic compounds emitted from motor vehicles and other sources. Ozone production is favored<sup>[9]</sup> at high temperatures even without additional precursor pollutants. Ozone exposure increases the rate and severity of asthma attacks and may play a causal role in asthma onset when exposures are high and prolonged.<sup>[13, 14]</sup> This represents a large health threat to children with asthma and to those at risk of developing asthma.

Both population growth and warmer climate is expected to create increased energy demands. The likely consequence is that the society will meet this demand by burning more fossil fuels to create the electricity needed to power air conditioners. This would result in increased concentration of all major air pollutants – including ozone.

Studies clearly show that childhood exposure to specific air pollutants is related to decreased lung growth and permanent decrements in pulmonary function as well as increases in respiratory infection, asthma, infant mortality and all age mortality, miscarriages, preterm delivery and low birth weight.<sup>[13]</sup>

Indian coal-based power plants release around 63 tonnes of mercury every year (assuming 0.25 ppm of mercury content in the Indian coal).<sup>[15]</sup> The mercury from the burning of coal also ends up in the food chain and threatens the neurologic development of fetuses and young children.

<sup>2</sup> Heat stress condition can be defined as the situation when the body is unable to cool itself by sweating and several heat-induced illnesses such as stress or exhaustion and sometimes the more severe heat stroke can occur.<sup>[12]</sup>

It is also expected that climate change will result in changes in the quantity, quality and distribution of pollens and other aeroallergens.<sup>[16]</sup> For example, poison ivy grown at high concentrations of CO<sub>2</sub> is more allergenic.<sup>[17]</sup> The production of many allergens such as ragweed pollen increases with increased CO<sub>2</sub> concentration.<sup>[16]</sup> Thus, asthma and allergies are likely to be worsened regionally in a warmer world. To the degree that allergy plays a role in the causation of asthma, we can expect that more asthma will result from increases in aeroallergen exposure.

Sixty-eight percent of outbreaks of waterborne illness in the US over the past 45 years were associated with rainfall above the 80th percentile.<sup>[18]</sup> In India also we have been experiencing more and more instances of disproportionate rainfall. Infants and small children are at higher risk for complications and hospitalization from infections resulting from flooding due to disproportionate rainfall. Also, food borne infections are likely to increase as food-borne pathogens grow faster in warmer weather. More diarrhea and more hospitalizations for dehydration are the expected outcomes. In a 6-year study from Peru, researchers found an 8% increase in hospitalizations for diarrhea with every degree centigrade increase above the normal average temperature.<sup>[19]</sup> A study from Canada shows a correlation between peak temperatures and peaks in cases of campylobacter, E coli and salmonella infections.<sup>[20]</sup>

As children consume more water per body mass than adults, they face a greater exposure to water borne pathogens. Because children's immune systems are less developed and they become dehydrated more quickly than adults and rehydrate less efficiently, they are more likely to die from dehydration.<sup>[11]</sup>

Patterns of vector-borne<sup>3</sup> illness are expected to change with changes in climate. Insects and rodents respond quickly to changes in temperature and moisture by migrating and, reproducing more rapidly during favorable conditions, often resulting in localized "plagues." Temperature increase accelerates the vector's life cycle and shortens the incubation time of parasites living in the vector. Warmer weather and failure of winter kills is likely to prolong the transmission season and change the range of vectors in latitude and altitude, resulting in more illness. Amplification of West Nile Virus, for example, is associated with warmer winters and spring drought. Some of these illnesses are particularly devastating to children. Malaria, for example, causes 350-500 million illnesses per year and more than one million deaths, mostly in young children. "Home grown" malaria clusters in the developing/ industrial nations over the past few years are believed to be a result of global warming-related vector-borne illness.<sup>[22]</sup>

Although the cold-related deaths are expected to decline, heat-related deaths are likely to increase. This is a concern primarily for the elderly; infants and small children as they are at greater risk than the average adult to suffer from heat stroke and death under extreme temperature conditions. Very small children are vulnerable because they do not have fully developed temperature regulation mechanisms and are unable to change their environments without help from the adults. Older children and adolescents spend more time<sup>[13]</sup> in vigorous activity outdoors and thus have higher exposures. However, the incidence of heat-related mortality is believed to be declining in countries like the US despite increasing temperatures. This may be due to the widespread availability of air conditioning.<sup>[23]</sup> This adaptive technology requires higher energy use and comes at a cost

---

<sup>3</sup> A vector-borne disease is one in which the pathogenic microorganism is transmitted from an infected individual to another individual by an arthropod or other agent.<sup>[21]</sup>

when the energy derives from more fossil fuel combustion. This results in a vicious cycle of more air pollution, which causes more air pollution-related illness, greater GHG emissions, and more global warming. Even if we abruptly reduced GHG emissions to zero, enough excess energy is stored in the climate system to guarantee at least another 0.6° C temperature increase in this century.<sup>[24]</sup> Depending on how rapidly we react; the world of the future could be radically different from the world we know now.

Initially, poor children in developing countries are likely to suffer disproportionately because of their limited capacity/ resources to adapt to climate change. Ultimately, however, climate change is a global problem with global consequences. If the pattern continues as usual – with industrialized and rapidly developing countries using traditional fossil fuels – we are likely to witness crises in food and water supply, large scale species extinctions, forced migrations of populations because of dramatic sea level rise, drought, and loss of natural resources. These stresses will have major global economic impacts.<sup>[25]</sup>

#### **4.0 Mitigating measures**

Fully protecting children from impacts of climate change would require cessation of global environmental change<sup>[11]</sup>, which as summarized in the study are majorly influenced by GHG emissions. Many scientists believe that there may be a “tipping point” temperature that, if exceeded, could trigger catastrophic change over a relatively short period of time (perhaps a few decades) unless action is taken to change current trends.<sup>[26]</sup>

Anthropogenic GHG emissions are the major cause of climate change. The most important GHG is carbon dioxide (CO<sub>2</sub>), responsible for more than 60% of cumulative anthropogenic warming globally, and more than 90% of the warming over the last 10 years.<sup>[27]</sup> Historically, annually and per capita, the US produces more GHGs than any other country in the world.<sup>[28]</sup> In 2005, almost 39% of US CO<sub>2</sub> emissions came from residential and commercial buildings (of these 74% were from electricity generation and the rest from natural gas and fuel oil used for cooking and heating). Transportation generated 33% of CO<sub>2</sub> emissions (60% of these are from personal vehicle use) and industry was responsible for the balance 28%.<sup>[29]</sup> Since 1990, US CO<sub>2</sub> emissions from transportation, residential and commercial sources increased by 25%, 31.5% and 34.6% respectively, while they have decreased by 3.1% from industrial sources.<sup>[29]</sup> Thus choices made on a daily basis are, in aggregate, major components of the US emissions story. The same is in fact true for other nations as well. How and what we drive, how we light and heat our offices, and how we build our houses all make a difference. Hence, there is reason for hope.

Using current technologies that can be deployed rapidly, scientists and policy analysts have developed approaches to stabilizing and reducing GHG emissions over the next decades. For example, the Carbon Mitigation Initiative at Princeton University proposed a plan based on their initial goal to prevent doubling of CO<sub>2</sub> from pre-industrial levels (the doubling is a level above which it is believed that dangerous climate change is highly likely) to buy time to develop additional clean energy and carbon sequestration technologies for future reductions. To achieve this, they proposed solutions based on available energy efficiency and other technologies.<sup>[30]</sup> Another analysis has suggested that

deployment of aggressive energy efficiency programs for buildings and vehicles would be sufficient to offset energy emissions growth for the next 30 years.<sup>[31]</sup>

Many nations are committed to aggressively developing renewable energy sources such as wind and solar power. Other approaches and technologies are proposed and are being developed. But to avoid accelerating toward the “tipping point”, action must begin now on known, straightforward GHG reduction strategies.<sup>[16]</sup> Responding to climate change on a personal level will often require changes in long-established practices – these changes may be difficult for some. However, any progress towards averting climate change is a step towards health risk reduction, and step worth taking. Many of the actions that mitigate GHG have major long term benefits. Energy efficiency saves money on energy bills. Reducing auto dependence promotes physical activity and helps fight obesity. GHG reductions will improve air quality and save lives, hospital visits and money. In many ways, actions to respond to the challenges of climate change are win-win activities. Awareness regarding the issue may serve as a key factor in our preparation for climate change, and helping the situation through choices in the office, hospital and our personal and public life. Through individual, community, and national policy changes, the rate of climate change can be slowed.

#### **4.1 *What Health Professionals Can Do* <sup>[32]</sup> *for adapting to Climate Change and help control its health impacts***

*In your practice-* Maximize immunizations; educate your families on use of heat, air quality and UV indices; working with local public health officials; engage in disaster preparedness & response planning; develop low toxicity approaches to vector-borne disease threats; and, augment surveillance of climate-related infectious diseases.

*In your community/region-* Protect local drinking water sources; support local, organic agriculture; and, advocate for greener energy power sources

#### **4.2 *What Individuals Can Do* <sup>[32]</sup> *for adapting to Climate Change and help control its health impacts***

*In your practice-* “Green” your office and hospital and in case of new building construction, use the Green Guide for Health Care (GGHC) and consider LEED certification; implement institute policies to reward coworkers who bike/walk/carpool/use public transport (e.g. more flexible work hours to accommodate public transportation schedules); develop educational materials and educate workers and their families about actions to reduce climate change; educate associates on climate-related health problems; and, explore ways to do more by phone and electronically.

*In your home-* Switch to compact fluorescent bulbs; turn electrical equipments OFF when not in use; adjust your thermostat; do an Energy Audit; and, set computers to automatically shift to lower power states or to turn off after extended periods of inactivity.

*In your travels-* Walk and bike more; change to a more fuel efficient car; use carpool; and, use public transport.

#### **4.3 *What Government Can Do* <sup>[11]</sup> *for adapting to Climate Change and help control its health impacts***

Government should favor economic incentives to lower the levels of GHGs, such as emission trading system/ clean development mechanisms and subsidies to clean technologies.

## References

- [<sup>1</sup>] Climate Change [<http://earthobservatory.nasa.gov/Library/GlobalWarmingUpdate/> ]
- [<sup>2</sup>] Global Warming [<http://www.epa.gov/climatechange/glossary.html> ]
- [<sup>3</sup>] Global Warming: Wikipedia [[http://en.wikipedia.org/wiki/Global\\_warming](http://en.wikipedia.org/wiki/Global_warming) ]
- [<sup>4</sup>] American Academy of Pediatrics: Global Climate Change and Children's Health. Embargo Release Date: Monday, October 29, 2007; 1149-1152.
- [<sup>5</sup>] US EPA. Climate Change Science - State of Knowledge. [<http://www.epa.gov/climatechange/science/stateofknowledge.html> ]
- [<sup>6</sup>] IPCC Working Group III. Climate Change 2007: Impacts, Adaptations and Vulnerabilities. Summary for Policy Makers [<http://www.ipcc.ch/SPM13apr07.pdf> ]
- [<sup>7</sup>] Richter-Menger J, Overland J, Proshutinsky A, et. al: State of the Arctic, October 2006, NOAA. [<http://www.arctic.noaa.gov/soa2006/> ]
- [<sup>8</sup>] British Antarctic Society. Climate Change Position Paper, July 2007. [[http://www.antarctica.ac.uk/Key\\_Topics/Climate\\_Change/ccps.html](http://www.antarctica.ac.uk/Key_Topics/Climate_Change/ccps.html) ]
- [<sup>9</sup>] Bunyavanich S, Landrigan CP, McMichael AJ, et. al: The Impact of Climate Change on Child Health. Ambulatory Pediatrics, 2003; 3:44.
- [<sup>10</sup>] Pruss-Ustun A, Corvalan C: How Much Disease Burden can be prevented by Environmental Interventions? Epidemiology, 2007; 18:176.
- [<sup>11</sup>] Bunyavanich S, Landrigan CP, McMichael AJ, Epstein PR,: The Impact of Climate Change on Child Health, Ambulatory Pediatrics, Volume 3, number 1: January February 2003: 44-52.
- [<sup>12</sup>] OSHA document related to heat stress [<http://www.osha.gov/Publications/osh3154.pdf> ]
- [<sup>13</sup>] Kim J and the American Academy of Pediatrics Committee on Environmental Health. Ambient Air Pollution: Health Hazards to Children Pediatrics, 2004;114:1699. [<http://pediatrics.aappublications.org/cgi/content/full/114/6/1699> ]
- [<sup>14</sup>] McConnell R, Berhane K, Gilliland F, et al: Asthma in exercising children exposed to ozone: a cohort study [published correction appears in: Lancet 2002; 359:896]: Lancet, 2002; 359:386.
- [<sup>15</sup>] Down to Earth: Coal-based power plants pollute most [[http://www.downtoearth.org.in/full6.asp?foldername=20070415&filename=news&sec\\_id=34&sid=42](http://www.downtoearth.org.in/full6.asp?foldername=20070415&filename=news&sec_id=34&sid=42) ]
- [<sup>16</sup>] Beggs PJ: Impact of Climate Change on Aeroallergens: Past and Future: Clin Exp Allergy, 2004; 507.
- [<sup>17</sup>] Mohan JE, Ziska LH, Schlesinger WH et. al: Biomass and Toxicity Response of Poison Ivy (toxicohendron radicans) to Elevated Atmospheric COs: PNAS, 2006;103:9090.
- [<sup>18</sup>] Curriero FC, Patz JA, Rose JB, et al: The association between extreme precipitation and waterborne disease outbreaks in the United States, 1948-1994. American Journal of Public Health, 2001; 91:1194.

- [<sup>19</sup>] Checkley W, Epstein LD, Gilman RH, et al: Effect of El Nino and ambient temperature on hospital admissions for diarrhoeal diseases in Peruvian children. *Lancet*, 2000; 355:442.
- [<sup>20</sup>] Fleury M, Charron DF, Hold JD, et. al: A Time Series Analysis of the Relationship of Ambient Temperature and Common Bacterial Enteric Infections in two Canadian Provinces: *International Journal of Biometeorology*, 2006 50:385.
- [<sup>21</sup>] CIESIN: Changes in the Incidence of Vector-borne Diseases Attributable to Climate Change [<http://www.ciesin.org/TG/HH/veclev2.html> ]
- [<sup>22</sup>] CDC. Documents Related to Investigations of Locally Transmitted Malaria. [[http://www.cdc.gov/malaria/cdcactivities/docs\\_transmission.htm](http://www.cdc.gov/malaria/cdcactivities/docs_transmission.htm) ]
- [<sup>23</sup>] Davis RE, Knappenberger PC, Michaels PJ, et. al: Changing heat-related mortality in the United States. *Environ Health Perspect*, 2003; 111:1712.
- [<sup>24</sup>] Hansen J, Nazarenko L, Ruedy R, et. al: Earth's Energy Imbalance: Confirmation and Implications. *Science*, 2005;308:1431.
- [<sup>25</sup>] McMichael A, Githeko A. Human health. In: McCarthy JT, Canziani OF, Leary NA, et. al., eds. *Climate Change 2001: Impacts, Adaptations, and Vulnerability*. Geneva, Switzerland: Intergovernmental Panel on Climate Change, 2001:453-485. [[http://www.grida.no/climate/ipcc\\_tar/wg2/pdf/wg2TARchap9](http://www.grida.no/climate/ipcc_tar/wg2/pdf/wg2TARchap9) ]
- [<sup>26</sup>] Meehl GA, Stocker TF, Collins WD, et.al: 2007 Global Climate Projections. In: *Climate Change: The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report to the Intergovernmental Panel on Climate Change* [Solomon S, Qin D, Manning M, et. al. (eds). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2007. [<http://ipccwg1.ucar.edu/wg1/wg1-report.html> ]
- [<sup>27</sup>] World Meteorologic Organization. WMO Greenhouse Gas Bulletin: The State of Greenhouse Gases in the Atmosphere using Global Observations up to December 2005. [<http://gaw.kishou.go.jp/wdcgg.html> ]
- [<sup>28</sup>] Hansen J, Sato M. Ruedy R, et. al: Dangerous Human-made Interference with Climate: a GISS ModelE Study. *Atmos Chem Phys*, 2007; 7:2287.25
- [<sup>29</sup>] US EPA. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005. [<http://www.epa.gov/climatechange/emissions/usinventoryreport07.html> ]
- [<sup>30</sup>] Pacala S, Socolow R: Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technology: *Science*, 2004; 305:968.
- [<sup>31</sup>] Kutscher C.F: Tackling Climate Change in the U.S. Potential U.S. Carbon Emissions Reductions from Energy Efficiency and Renewable Energy by 2030. American Solar Energy Society, January 2007. [<http://www.ases.org/climatechange/> ]
- [<sup>32</sup>] Climate Change and Children's Health: What Health Professionals Need to Know and What We Can Do about It. [<http://www.healthandenvironment.org/?module=uploads&func=download&fileId=418> ]