GLOBAL CLIMATE CHANGE
AND CHILD HEALTH

TRAINING FOR HEALTH CARE PROVIDERS

Children's Health and the Environment
WHO Training Package for the Health Sector
World Health Organization
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Notes:
• Please add details of the date, time, place and sponsorship of the meeting for which you are using this presentation in the space indicated.
• This is a large set of slides from which the presenter should select the most relevant ones to use in a specific presentation. These slides cover many facets of the problem. Present only those slides that apply most directly to the local situation in the region.
• It is also very useful if you present regional or local examples of climate change-related health threats and solutions, both adaptation and mitigation.
Learning objectives

• Understand the risks to human health from climate change
• Understand the unique vulnerability of children to the consequences of climate change now and in the future
• Identify adaptive strategies to protect children's health in a changed climate
• Identify the opportunities for health co-benefits from mitigation strategies to prevent worsening climate change in the 21st century and beyond
Outline

1. **Magnitude of the problem**
   - Humans have changed the climate

2. **Effects on children from climate change**
   - Direct health Impacts
   - Ecosystem-mediated impacts
   - Impacts mediated through human institutions

3. **Role of paediatricians in protection of child health**
   - Adaptation strategies
   - Mitigation strategies
   - Education and advocacy

**Note:**
When selecting the slides to include in your presentation, please choose only those of relevance to the region and/or interests of your audience.

This presentation has three parts. The first part is general and sets the stage by discussing major trends in human activities and their broad impact on the global environment and human health. The second part concentrates climate change as one of the most immanent global public health threats. The last part discusses actions from international to individual level which are needed to protect children’s health in a world of ongoing global environmental changes.
We begin with the **magnitude of the problem** of climate change in order to set the stage for the module.
Often paediatricians and other child health care professionals may think of climate change as a global problem well outside of their control or their need to consider on a day to day basis. By integrating climate change in the new General Programme of Work, WHO Director-General Dr Tedros highlights the need to bring climate change into daily, mainstream thinking for all health professionals.

Note: For further information, see: https://www.who.int/about/what-we-do/thirteenth-general-programme-of-work-2019---2023.
It is now beyond the time for confusion or equivocation. Climate change is a reality. The earth is warmer, the sea level is rising, ice is melting and we have abundant direct evidence of these facts. The records of the past 3 decades prove that the earth is warmer and weather patterns are more extreme and less predictable now than in pre-industrial times. This presentation does not detail the science on this fact nor does it detail the many lines of evidence which document it. Those who are interested may find many resources for study including the Intergovernmental Panel on Climate Change (IPCC), the World Meteorological Organization and NASA Global Climate Change: Vital Signs of the Planet among others.

The graphs on this slide show changes in measures of climate change over time. On the top left, change in global surface temperature compared to the average in 1951-1980 is shown from 1880 to 2018. The average surface temperature has increased 0.9°C since the late 19th century with most of the warming in the past 35 years. 18 of the 19 warmest years on record have occurred since 2001, and 2016 was the hottest year measured.

On the right are losses in ice at sea (top) and on land (bottom). Arctic sea ice is measured in September when it reaches its annual minimum, and it is declining at a rate of 12.8% per decade relative to the 1981-2010 average. The top right graph shows average September Arctic sea ice from 1979 to 2017. In Greenland, ice mass has been decreasing since 2002, with most loss occurring since 2009. The average rate of change is now 286 (±21) gigatonnes per year. The bottom right graph shows the size of Greenland’s ice mass from 2002 to 2017.

With melting ice and warming seawater come rising sea levels. The graph on the bottom left charts sea level change from 1993 to 2018, with a current average increase of 3.3 mm per year.

References:

Figures:
- Courtesy NASA/JPL-Caltech
Furthermore, human influence on the climate is virtually certain. The strong consensus of global experts on climate and all earth sciences agree that humans are and have been for decades the major driver of the warming, sea level rise, ocean acidification and changed weather patterns of today. Burning of fossil fuels and deforestation along with other greenhouse gas inputs associated with agriculture and industry have rapidly changed the atmosphere, increased the “thermal blanket” of the earth and warmed the air and the oceans. This familiar graph of the concentration of CO\textsubscript{2} in the atmosphere over hundreds of thousands of years dramatically demonstrates how extraordinary are the times in which we live now. CO\textsubscript{2}, which is the main anthropogenic (human-caused) greenhouse gas, has a long residence time in the atmosphere and is anticipated to remain in the atmosphere for at least 500-1000 years. The latest measurement as of February 2019 showed CO\textsubscript{2} at 411 ppm (parts per million) compared to 280 ppm in preindustrial times. This new reality has health consequences for humans and most other species on the planet.

References:

Figure:
• Vostok ice core data/J.R. Petit et al.; NOAA Mauna Loa CO2 record
Now that the stage is set, we will discuss the effects of climate change on children’s health.

Outline

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   - Direct health impacts
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   - Adaptation strategies
   - Mitigation strategies
   - Education and advocacy
This very complicated slide represents a summary of health from climate change and potential for risk reduction through adaptation. It was developed from the literature and expert judgments of health experts at IPCC. The width of the slices represents the relative proportion or burden of disease at the population level in each category. The rings represent risk levels with the darker red colour indicating risks that could be improved by intensive adaptation efforts. Yellow rings represent risks that cannot be changed by aggressive adaptation.

This image is broken down and enlarged in further slides to facilitate understanding and improved visibility, but the essential elements are preserved from the original figure.

Figure:
Beginning at the present, we identify climate change as a powerful disease effect modifier. This means that at current temperatures, existing climate-sensitive health impacts are made worse than in previous times of lower average temperatures and more stable and predictable weather. It is notable that the IPCC health experts considered all of these risks to be manageable with aggressive adaptation strategies, with the exception of some extreme weather events (such as the most severe storms, cyclones, and other catastrophic weather events). In the next few slides, we will explore each category through the lens of children’s special vulnerabilities.

Reference:

Figure:
While ultimately climate change affects everyone and all species, there are specific categories or populations of humans who are initially and currently at higher risk. The most vulnerable people are listed here.

Children fall into all of these higher risk categories, and, in general, children are often among the most vulnerable to harms mediated through environmental exposures (See WHO modules: “Why children” and “Children are not little adults”). Climate change, as it affects risk of existing conditions and diseases, follows this same pattern. An analysis of the impact of climate change on disability-adjusted life years found that 88% of the burden of disease fell on children under five years of age in both developed and developing countries. An additional 5% of the burden falls on children between five and 14 years of age. Only 6% of the burden falls on people above the age of 15 years. Paediatricians and others who care for children’s health must recognize this reality.

**Note to user:** If there are images specific to your region, please substitute them. If you have data from your region, please add them as appropriate.

**References:**

**Figure:**
- © WHO / SEARO / Payden
This heavy burden of disease derives from several major differences between children and adults. Children are not just little adults when it comes to environmental exposures in general and climate change in particular. We often divide their vulnerability into the four general categories shown here. Depending upon the climate-related health hazard, these generic vulnerabilities explain the excess burden of disease suffered by children in different ways. Throughout this presentation, we will return to these categories to help highlight why child health care workers and public health practitioners should be especially concerned for the children under their care.

Using the IPCC climate-related health impact categories, we will explore how children are affected in the following series of slides.
The 5th Assessment Report of the IPCC has organized the health impacts of climate change as shown on this slide. Each of these categories are explored in the following slides with emphasis on how children are at increased risk.

Reference:
We begin with the direct impacts on health from climate change.
Heat-related mortality and morbidity are the most obvious of the direct health impacts from climate change. While heat deaths occur primarily in the elderly, a recent systematic review found increased vulnerability in young children as well. A growing literature is documenting risks to children from increasing ambient heat. In the very young this is likely due to an immature thermal regulatory system as well as infant’s dependence upon adults to keep them in safe environments, and may significantly explain the higher risk in this age group.

The graphs shown here come from a 30-year study in Canada that found a strong association between high temperatures and SIDS deaths, particularly in the three to 12 months age group. Odds ratios for SIDS (y-axis) are plotted against maximum temperatures (y-axis) shown in blue, with the dotted lines showing the 95% confidence intervals; odds are relative to 20°C. Infants age one to two months are shown on the top and infants age three to 12 months on the bottom. Graphs on the left show odds ratios for SIDS based on previous day temperatures while graphs on the right show odds ratios for SIDS based on say day temperatures. For the bottom right graph, with maximum same-day temperatures of 29°C and above, there was a 2.78 times greater chance of SIDS events in infants age three to 12 months relative to when maximum temperature was 20°C. Note, this was a single study and an attempt to replicate this result by a group in Vienna was not successful.

Adverse birth outcomes including preterm births and still births are increased with greater ambient heat. Similarly, emergency department visits and hospitalizations for renal and electrolyte disturbances, lower respiratory disease, heat stroke and heat exhaustion increase with hotter temperatures.

Child labour in agriculture and other outdoor child labour puts the young at special risk during periods of intense heat. Adolescent athletes are a special group who have been studied in the USA where heat stroke deaths have doubled in the past decade.

References:
  • See Ahdoot et al. for a full list of references.
Figure:
A second category of direct impacts are those related to increases in extreme weather events such as drought and fire, storms and floods, and extreme precipitation. A warmer atmosphere holds more water, and warmer oceans fuel more intense storms. Changes in precipitation patterns enhance both drought and flood. In all of these conditions, children, particularly the very young, are at increased risk of death and injury because they are physically dependent upon adults to protect them and remove them from dangerous situations. As these events become both more severe and more frequent in a warmer, less stable climate, more and more children will be exposed to danger and harm. A 2013 UNICEF UK report indicated that the world’s poorest children are up to 10 times more likely to suffer from climate-related disasters than children from wealthier circumstances.

Severe weather events have many effects on child health. Women and young children are more vulnerable to the acute impacts of natural disasters and famines; they are 14 times more likely to die in a disaster than are men. Floods cause child injuries and death by drowning, and also compromise clean water supplies, fostering epidemics of diarrhoea.

Weather disasters devastate homes, spawning refugee communities that are likely to have poor public health. Basic life support systems, including water, forests and other natural resources, may also be undermined by climate change. Food production and availability are impaired by droughts and floods. Children are especially vulnerable to the emotional trauma caused by sudden changes in living routines and social networks, and the social disruption, economic damage and population displacement caused by weather disasters can impair their psychological and social development.

**References:**

**Image:**
- Desmond Simon / Unsplash
Children’s vulnerabilities to heat and weather disasters are listed on this slide.

Some more subtle ways children suffer disproportionately include early and prolonged disruption of education which may affect adult employment and success. Early trauma from climate-related disasters disrupting family and community may cause long term psychological harm and mental health issues.

Adolescent risk taking behaviour can lead to increased and dangerous heat exposure during work or athletics.
Now we will discuss health risks mediated through ecosystems.
Climate change affects ecosystems upon which humans and all living creatures depend. These ecosystem mediated impacts, as identified by the IPCC health experts, fall into several categories, the first of which is air quality. Poor air quality is especially dangerous to children because they spend more time outside than adults do, are more physically active, breathe more air per unit body weight and have immature and developing lungs susceptible to damage. With climate change, we expect air pollution-related illness to increase by at least several mechanisms.

First, in a hotter world, ground-level ozone will increase. Ozone is a powerful irritant that causes inflammation and what is sometimes called a “sunburn of the lungs”. In asthmatics, ozone triggers more frequent and more severe asthma attacks, as measured by emergency room visits for asthma. There is evidence that ozone can contribute to developing new asthma with long-term exposure. Ozone production increases with temperature (even without additional precursors), so in a hotter world, there will be more ozone pollution.

**Note to user:** WHO has a teaching module on ambient air pollution and children's health with additional details, available at: [http://www.who.int/ceh/capacity/training_modules/en/](http://www.who.int/ceh/capacity/training_modules/en/).

**Reference:**
The second category of air pollution related illness derives from population driven increased energy production. If we meet increased demand by burning more fossil fuels, all major air pollutants will go up. We will see increased particulates, nitrogen oxides, sulfur dioxide, volatile organic hydrocarbons and, of course, more ozone. There is robust evidence that childhood exposure to these specific air pollutants is related to decreased lung growth and permanent decrements in pulmonary function as well as increases in respiratory infection, asthma, infant and all age mortality, miscarriages, preterm birth and low birth weight. Mercury, which comes from burning coal, also ends up in the food chain and threatens the development of the brain and nervous system.

Reference:
A third category of air quality related impacts has to do with aeroallergens. Children have a high prevalence of allergic rhinitis and allergic asthma. Evidence suggests that this is rising in both developed and developing countries. Climate change is exacerbating this problem through several ecosystem mediated processes.

With both increased temperatures and increased atmospheric CO₂, we are documenting a variety of changes in allergens. In many areas in the world, blooming seasons are prolonged because of later first frosts and earlier thaws. Ziska et al. documented an overall increase of ragweed growing season from 13 to 17 days depending upon latitude. Similar findings exist for other important aeroallergens associated with human sensitivity and disease. Children have a high prevalence of respiratory allergies, and more prevalent allergic asthma triggers due to climate change translates into more disease.

Research has also shown that in higher CO₂ environments, plants produce not only more pollen, but more allergenic proteins. Thus, both by increased length of blooming time and enriched allergen production, children with allergic disease and allergic triggers to their asthma will be more likely to suffer symptoms for longer and more intensely as the climate continues to warm.

As with all climate-related health threats, regional difference are highly variable. The very complex interactions of allergic pollens, weather and climate have been reviewed in a recent statement of the World Allergy Organization.

References:

Image:
- © WHO / Antonio Suarez Weise
Why children are heavily affected by air quality

- **Unique and different exposures**
  - Physical location lower to the ground and less mobile

- **Unique vulnerabilities**
  - Higher respiratory rate so more exposure to pollutants in air
  - Lungs growing and developing until age 8
  - CNS growing and developing especially early
  - Allergen exposures and immature immune system

- **Longer lifetimes to develop long-latency diseases**
  - Asthma and lower respiratory function
  - Carcinogens and neurodevelopmental toxicants
  - Impact from disruption of education

- **Dependence upon adults for protection**
  - Minimal effect on schedules, activities and laws

Air quality is particularly important to children.
Another example of ecosystem mediated impacts is water-borne infection. In the developing world, unsafe water is a major problem at all times, likely to be exacerbated by water scarcity and temperature effects due to climate change. Globally, there are nearly 1.7 billion cases of childhood diarrhoeal disease every year. It is the second leading cause of death in children under five years of age, causing 441,000 under five deaths annually. WHO estimates that by 2030, climate change will be responsible for an additional 48,000 deaths in children under fifteen years of age annually despite anticipated improvements in child health. This impact will be concentrated in South Asia and Sub-Saharan Africa.

Even in fully industrialized countries with well-developed public health infrastructure and early warning systems, there is correlation between heavy rain events and waterborne illness. Very few household water and sanitation technologies are currently resilient to climate change, which will damage urban infrastructure and reduce water availability.

Finally, diarrhoeal disease is highly sensitive to climatic conditions and shows strong seasonal variations in many locations. The usual positive correlation of diarrhoeal disease with temperature reflects the fact that most cases in tropical developing countries are caused by bacteria, entamoebae and protozoa, all of which are favoured by high temperatures. As well as meteorological influences on microbial exposures, child diarrhoeal disease may also increase because drinking water becomes contaminated by toxins from warming-induced algal blooms. Future changes in mean climatic conditions and in the occurrence of extreme weather events are likely to significantly affect the incidence of diarrhoeal disease in children.

Note: There are WHO modules on Water and Sanitation and Hygiene that build on this information.

References:
Like water-borne infections, food-borne infections are also likely to increase with climate change. This is partly because of changes in eating behaviour including more outdoor food preparation and dining, and partly because many food-borne pathogens grow faster in warmer weather. There will be more children with diarrhoea and likely more hospitalizations for dehydration.

Reference:

Image:
• © WHO / Jim Holmes
Under the conditions of rapid warming, changed precipitation patterns and altered humidity, vector-borne pathogens and subsequent diseases patterns will also change. This figure from IPCC expresses graphically how complex these relationships are. It shows data on selected vector-borne diseases from 2008 to 2012, their distribution, burden of disease and various global and local climate sensitive components. Dengue was associated with climate variables at a high level of confidence at both global and local levels; malaria and haemorrhagic fever with renal syndrome were positively associated with climate variables at the local level with high confidence. The complexity of the slide highlights the importance of local and regional preparedness and response.

Climate change is changing the pattern of vector-borne disease because insects and rodents respond quickly to changes in temperature and moisture by migrating and increasing in numbers. The reproduction and survival of blood-feeding vector organisms, such as mosquitoes and ticks, are greatly affected by climate and other ecological factors. Higher temperatures, changes in precipitation, and altered climate variability may therefore change the distribution of vector-borne diseases, both spatially and seasonally. Immunologically naive populations may thus face unfamiliar pathogens. In some locations, climate change may actually lead to decreased vector-borne disease transmission because of reduced rainfall or excessively high temperatures.

In general, without strong public health defences, the anticipated increases in range and seasonality of pathogens and their vector organisms will cause a greater incidence of various infectious diseases. Children are particularly susceptible to malaria, dengue fever and various forms of encephalitis. For example, the prevalence of these vector-borne diseases is likely to increase with climate change because increases in temperature:

1) accelerate vector life cycle
2) shorten incubation time of the parasite in the vector and
3) prolong transmission seasons.

Furthermore, higher temperatures will change the range of vectors both in latitude and altitude.

Reference:

Figure:
Malaria is the world's most serious vector-borne disease. Five species of *Plasmodium* parasites are responsible for transmission, mostly via the *Anopheles* mosquito. Almost half of the world's population are at risk of malaria in 87 malaria-endemic countries.

Children experience disproportionately high levels of both morbidity and mortality from malaria. Young children have little specific immunity to malarial species and may therefore suffer yearly attacks of debilitating and potentially fatal disease. Children are also more susceptible to cerebral malaria and severe anaemia, which can lead to death. 61% of all malaria deaths occur in children under five years of age.

Malaria incidence is nonlinearly related to temperature, and small increases in temperature can lead to major increases in malaria cases. Increased temperatures may expand the geographical range of conditions conducive to malaria transmission, both to higher altitudes and to higher latitudes. Further, elevated temperatures, in combination with conducive patterns of rainfall and surface water, may extend the transmission season in some locations.

**Reference:**
Paediatricians are very familiar with the unique susceptibilities of children to many infections. Climate-related infections are no different.

It is critically important for providers who take care of children to anticipate changing patterns of disease as the climate changes locally. Response should be both to institute preventive public health measures as well as be prepared to treat children who contract these food-, water- and vector-borne diseases.
The final IPCC category is climate-related health effects mediated through human institutions.

These are perhaps the most difficult problems for paediatricians and other clinicians to approach. Climate change represents a serious challenge to reaching long-term aspirations of alleviating food and water insecurity, global peace and equality, all of which dramatically affect not just children’s growth and development but their very survival. While not directly related to patient care, these challenges serve as motivation to those who work on behalf of children and future generations. They are reviewed very briefly in the following slides.
More complex health impacts from climate change are significantly mediated by the status and trajectories of human institutions. For children, nutrition is one of the most critical determinants of health. The ability of a child to be well-nourished depends upon access to a wholesome and nourishing food supply. Agricultural production can be reduced by high temperatures and changes in precipitation resulting in both lower quantity and lower quality of food. Farm worker productivity may also be seriously impaired by excess heat. Indeed, climate change is already a threat in places that are most food insecure. Food price, food production, level of development, level of poverty and baseline health all play a role in getting children enough high quality foods.

Not only farm workers but all outdoor workers may be at risk for heat stress and there will be both productivity and health consequences going forward. As the globe continues to warm, there may be areas where outdoor ambient temperature reaches levels that are physiologically intolerable for humans, precluding outdoor occupations.

Mental health may be compromised due to local, regional and global responses to progressive climate change and represent both acute and chronic stressors. As resource availability changes and in some cases declines, conflict is possible and forced relocations may indeed occur.

Reference:

Image:
- © WHO / Jim Holmes
Having completed the review of effects on child health from climate change, we now come to the specific role of the paediatrician in responding to the health threats from climate change. These can be organized in three categories: adaptation strategies to climate change that will protect children, mitigation strategies to climate change that will protect future generations and education and advocacy strategies that will promote awareness and engage larger numbers of colleagues, families and citizens in addressing climate change.
This is one of the most important points of this module. Because the climate has already changed and will continue to change for at least two decades no matter what the global response is, adaptation is absolutely critical. The health risks we have just explored will increase as the planet continues to warm and weather events become increasingly dramatic and unpredictable. The physics of the climate system is such that even if we were to stop all GHG emissions now, the temperature would continue to rise as the system equilibrates. IPCC has named this equilibration time as the “Era of committed climate change”. These target-style graphs show the projected relative proportion (the width between the arrows) of each health threat as well as the magnitude or number of people affected by the number of circle segments. The critical thing to understand from these circles is that the dark red circles represent the amount health impacts can be reduced with a higher level of adaptation than we are using now. If we do nothing, the poor health outcomes increase dramatically. If we collectively work to develop robust adaptive strategies, these can be reduced to the smaller yellow circles (the unavoidable increased health hazards), thus saving lives and preserving health for many.

Remembering that children bear almost all the health burden from climate change, paediatricians are essential experts to be included at all levels of adaptation strategy development and implementation.

Reference:

Figure:
The power of adaptation is illustrated in this case study from Bangladesh. It is an example offered as a proof of concept for adaptation; that even very large problems can be collectively managed. While not specifically in response to climate change, Bangladesh has made dramatic improvements in disaster preparedness over the past 40 years. As a particularly vulnerable area to flooding, storm surges and wind damage from frequent cyclones, Bangladesh (previously East Pakistan) assembled a multi-sector, multi-pronged approach to disaster preparedness which has saved lives. General disaster education, aided by increased literacy rates, better prepared the public for cyclone situations; early warning systems, from high-tech information to bicycle-relayed messaging, alerted them to imminent danger; and shelters gave people a safe place to go during cyclones.

The dramatic reduction in lives lost from similar or worsening storms, despite population increase of 30 million in that time period, is testimony to the power of adaptation. This example is powerful and heartening, considering that the risks from climate change are guaranteed to increase over the next several decades even if global response to reducing GHG emissions is robust and swift.

References:

Image:
• © WHO. This map is an approximation of actual country borders.
Role of health care workers

**Direct patient care**
- Optimize immunizations and access to care
- Teach use of UV, heat, air quality indices, early warning systems and responses
- Identify vulnerable individuals in the practice

**Work with local public health officials to collaboratively**
- Develop a local "climate-related health risk profile"
- Develop low toxicity vector control programs
- Improve disease reporting and surveillance

**In the community**
- Protect drinking water supply and quality
- Support local agriculture
- Develop broad partnerships and programs across sectors

Given that adaptation is necessary and can be extremely effective from the previous example, paediatricians have a unique role in planning and response on behalf of children. Vulnerable groups, such as mothers, infants and children, require special attention in patient care, disaster planning and community efforts. This can be an exercise in collaboration between multiple sectors as illustrated here with examples.
Each location and region has its own complement of health risks, so all adaptation strategies must be specific for a particular area. At a minimum, all adaptation strategies should include those listed on the slide.

**Note to user:** Please include locally relevant projects or problems and actions relevant for your audience.

For paediatricians, adaptation should always include specific consideration of children’s vulnerabilities and needs. Paediatricians and all maternal and child health professionals should be integral parts of planning and implementing these strategies at all levels from local to global.
Paediatricians and other child health care providers are uniquely situated to highlight children and their needs. This can be done by identifying appropriate child-centred resources like the WHO Atlas on children’s health and the environment, and bringing these into consideration during planning and implementation of adaptation plans.

Collecting real world stories of the impact of climate change on children and using them to help illustrate and emphasize the importance of including considerations of children in all planning can be a very powerful strategy available to health care providers.

Paediatricians are also in an ideal position to work with teams of parents, teachers and child-care workers along with local authorities to ensure that plans protect the health and wellbeing of children.

Finally, health care professionals can use the long tradition of anticipatory guidance to develop educational materials on climate adaptation strategies, such as using air quality indices, heat warnings and emergency preparation, that specifically address the special needs of children.

**Image:**
- © WHO / SEARO / Sanjit Das
An example of an adaptation strategy spreading in the USA are the Extreme Heat Response Programs at the local level. They involve using the heat health watch warning systems to initiate response programs.

- Activate telephone heat hotlines can be a source of public advice.
- Alert neighbourhood volunteers, family members and friends to check on each other.
- Provide public air-conditioned buildings and transportation to these facilities
- Work with local schools and child care facilities to protect at-risk individuals
- Coordinate with local utility companies to ensure that service to residential electricity customers is not shut off during a heat wave.

This intervention also advocates special care of other vulnerable populations, including the elderly, those experiencing homelessness and outdoor labourers.

- Work with local “aging agencies” to educate at-risk elderly individuals.
- Conduct outreach to at-risk individuals experiencing homelessness.
- Modify or cancel outdoor labour.

Local medical infrastructure must be augmented enough to ensure adequate ER and in-patient capacity for those who slip through the cracks of the above.

Reference:

The crucial next set of actions to respond to the threats of climate change is mitigation. Adaptation and developing climate resilience is not enough. What we do now as a global society about GHG emissions, energy choices, land use choices and population control will determine how much climate change will occur in the second half of the 21st century and beyond. Notice that in this “era of climate options” IPCC draws the risk profile for a 4°C temperature rise – the rise anticipated if we continue along current emissions pathways without any new adaptation or mitigation. The health risks become enormous and many beyond our capacity to adapt.

**Note**: The width of the slices represents the relative proportion or burden of disease at the population level in each category. The rings represent risk levels with the darker red colour indicating risks that could be improved by intensive adaptation efforts. Yellow rings represent risks that cannot be changed by aggressive adaptation.

IPCC also discusses “adaptation limits” – temperatures above which human adaptation is not possible. There are physiological limits to human heat tolerance which could ultimately make some areas of the globe uninhabitable. unchecked, severe climate change may cause millions to be displaced from homes putting more pressure on areas still suitable for human populations. There are also likely limits to food production and human nutrition; as IPCC states, “there may be a threshold of global warming beyond which current agricultural practices can no longer support large human civilizations”.

Any adaptations that depend heavily on infrastructure, such as large-scale air conditioning, put populations at heightened vulnerability to outages and failures.

Moreover, many experts believe that the effects of climate change will not be smooth and linear. Rather, there may be tipping points after which a system changes dramatically and irreversibly, significantly affecting human health and welfare. These non-linear changes cannot easily be anticipated and, once they occur, could have serious consequences.

Thus, our future remains unknown and depends greatly upon human choices to mitigate climate change now. There is an urgent need to curtail GHG emissions globally and increase CO₂ sinks (natural places where CO₂ is sequestered, such as forests and soils) as much as possible now to keep warming to a manageable minimum.

**Reference**:
Figure:

According to IPCC, a “business as usual” approach, also known as baseline or Representative Concentration Pathway (RCP) 8.5, to climate change, which does not involve mitigation strategies, will likely result in a global average surface temperature rise to 4°C above preindustrial times. This is shown in red in the figure. Alternatively, a low-emission mitigation scenario is shown in blue, RCP2.6, where temperature increase is limited to 1°C. Medium-emission scenarios are noted on the right with RCP4.5 and RCP6.0. In order to have “climate options”, we must do more than adapt: we must mitigate and actively redesign the human footprint on the planet.

Reference:

Figure:
Often people feel discouraged and helpless in the face of a global problem. The astonishing and empowering reality though is that a large portion of the global carbon footprint comes from individual activities. Because these choices are under our personal control, we as individuals can effect change, up to almost half of the global problem.

The per capita carbon footprint is much higher in industrialized nations compared to footprints in developing nations. Thus, mitigation of climate change in most developed countries will focus on contraction, which is using less energy and eliminating waste, and transition to low- or no-carbon energy. In developing countries, mitigation will involve climate proofing the country as it develops with clean energy and sustainable practices.
Mitigation, particularly in the industrialized world, must include changes in personal actions and choices. The paediatric community, accustomed to anticipatory guidance, primary prevention and health values, can be leaders at the local level in mitigation as well as adaptation. There are many ways to proceed. Some ideas include:

1. **At the personal level:** calculate your carbon footprint. One of many resources to do so is [https://www.carbonfootprint.com/](https://www.carbonfootprint.com/). Then, work to reduce your carbon impact and tell the stories.

2. **At the paediatric practice level:** “green” your paediatric offices and institutions, educate colleagues, staff, parents and patients about climate change and effective mitigation strategies.

3. **At the political level:** educate local decision makers on the potential health threats to children from unchecked climate change in your area and the importance of proactive, preventive measures. Become politically engaged to champion mitigation and adaptation strategies that require government assistance.

The Collaboration for Health and the Environment ([https://www.healthandenvironment.org/](https://www.healthandenvironment.org/)) is one of several organizations emphasizing actions that can be taken by health professionals to address environmental stressors. Health Care Without Harm ([https://noharm.org/](https://noharm.org/)) is another.

**Image:**
- Noah Buscher / Unsplash
From the health perspective, the urgent need for mitigation of greenhouse gases provides opportunities for health co-benefits through climate protection strategies. The following slides have examples of possible positive strategies that benefit health and reduce climate change, in a developed country and in a developing country.

In the USA, becoming less car dependent will help fight the obesity epidemic in adults and children and clean the air of major pollutants. Air pollution is a major threat to child health as we have seen previously.

Moving away from electronic entertainment reduces demand for energy and reinvigorates social interactions which reduces isolation, anxiety and depression.

Purchasing from local producers will reduce the long distance transportation of food. Eating fresh and plant-based foods will reduce emissions from production, storage and distribution of food; improve nutrition; and reduce the risk of a number of serious health conditions. Instilling healthy eating habits in children has lifelong benefits to health.

Energy efficiency at home and in the office saves money, liberating wasted dollars for other uses including medicines and medical care for those in need.

Paediatricians can be leaders in finding these win-win scenarios and encouraging action at all levels in order to capitalize on them.
Many families in India still rely on polluting fuels for home energy. Adopting clean renewable energy and establishing local electrical grids will provide necessary power to families while also preventing emissions. Reducing air pollution will avert associated diseases and death.

Developing public transport and cycling networks improves environmental health through reduced air pollution, less noise, fewer injuries and promotion of active transport.

Use of solar hot water and water conservation reduces air pollution by not using polluting fuels to heat water. The technology can also save money, which can be used for other health or development goals.

Traditional diets in India often feature foods from low on the food chain, sourced locally and organically. Maintaining these practices can prevent energy expenditure in agricultural mass production and distribution.

Paediatricians are in a power position to be able to promote these win-win scenarios to their patient families, colleagues and local officials.
Furthermore, many communities are talking about the triple bottom line: Planet, Profit, and People. Mitigation strategies can feature triple wins.

A new trend in the health literature is attempting to compare cost of mitigation to health benefit savings at the global and regional levels. In most cases, the health benefits significantly outweigh the costs of mitigation within just a few years. In other words, the health benefits pay for the costs of mitigation. This tends to be most dramatic in the least developed nations where health benefits are many fold greater than costs of mitigation.

Image:
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There is reason to be hopeful. The Paris Climate Agreement, adopted on 12 December 2015, marks the beginning of a new era in the global response to climate change. The world now has a global climate agreement that will have a major public health policy impact as countries take action. As stated in the agreement, the right to health will be central to the actions taken.

The Agreement not only sets ambitious goals to keep global temperature rise well below 2°C, but also commits countries to strengthen adaptation. This includes implementing plans that should protect human health from the worst impacts of climate change, such as air pollution, heat waves, floods and droughts, and the ongoing degradation of water resources and food security. It commits partners to finance clean and resilient futures in the most vulnerable countries.

The impacts of global environmental change on child health span a wide spectrum, including respiratory health, temperature regulation, trauma, nutrition, development, allergy, infectious disease, and mental health. Nevertheless, there remains a serious lack of empirical data on how climate change specifically affects child health. Much of this knowledge gap reflects the fact that global climate change is a recent and inherently slow process. Furthermore, scientific and popular consensuses have only recently converged in recognizing that climate change and other global environmental changes require both research and policy attention.

We need more research on how changes in temperature, precipitation and extreme weather events, and their resultant ecological changes, affect children’s health. Many aspects of physiology and metabolism of children differ markedly from those of adults; health impacts of climate change in children are likely to be distinctive.

To protect children fully from these health consequences will require a substantial change in our pattern of economic activities and our technology choices. By better understanding the range and extent of risks posed by climate change and other global environmental changes, we will strengthen the contribution of the health sciences to sustainable management of the biosphere.

Reference:

Image:
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Progress can and must be made in addressing current and future threats to children’s health from global climate change. This quotation is from the Bangkok Statement and emphasizes the urgent need to safeguard children’s environmental health.

We must address the threats to children’s health from climate change because we hold our future in our hands — and it is our children.

Reference:

Image:
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