CLIMATE CHANGE: A 21st CENTURY PUBLIC HEALTH CRISIS
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Community Medical School

“Climate change is a global health emergency that threatens to
• reverse decades of health and development gains,
• cause widespread human suffering,
• deepen global health inequities, and
• put at risk the environmental and economic systems we depend on for our survival.”

This global Call To Action has now been signed by more than 100 health care organizations representing:
✓ six million health care professionals
✓ over 125 countries.
2019 Top ten threats to human health:

#1 Air pollution and climate change  
#2 Non communicable diseases  
  heart disease, diabetes, cancer  
#3 Influenza  
#4 Fragile and vulnerable settings  
  with minimal health care access  
#5 Antimicrobial resistance  
#6 Ebola and high-threat pathogens  
#7 Weak primary care  
#8 Vaccine hesitancy  
#9 Dengue  
#10 HIV

“Solving the global climate crisis could be the greatest opportunity of our time…”

Reducing air pollution  
Eating less meat  
Driving less  
All have tremendous health benefits  

For a decade and a half, Dr. Patz served as a lead author for the U.N. Intergovernmental Panel on Climate Change (or IPCC)—the organization that shared the 2007 Nobel Peace Prize with Al Gore.
AMA adopts new policies at 2019 Annual Meeting

JUNE 12, 2019
Educating Physicians and Medical Students on the Adverse Health Effects of Climate Change

The AMA adopted policy to ensure physicians and physicians-in-training have a basic knowledge of the science of climate change and an awareness of the associated health risks.

“It is important that current and future physicians are able to describe the risks that climate change poses to human health so that they can counsel their patients on how to protect themselves from the health risks posed by climate change,” said AMA Board Member S. Bobby Mukkamala, M.D.

Impact of Climate Change on Human Health

- Injuries, fatalities, mental health impacts
- Asthma, cardiovascular disease
- Heat-related illness and death, cardiovascular failure
- Malaria, dengue, encephalitis, hantavirus, Rift Valley fever, Lyme disease, chikungunya, West Nile virus
- Forced migration, civil conflict, mental health impacts
- Respiratory allergies, asthma
- Extreme heat
- Air pollution
- Changes in vector ecology
- Increasing allergens
- Water and food supply impacts
- Water quality impacts
- Malnutrition, diarrheal disease
- Cholera, cryptosporidiosis, campylobacter, leptospirosis, harmful algal blooms
Primary climate-related health threats for Vermont

Vermont is expected to continue warming in the future, leading to hotter summers, shorter and milder winters, stronger storms, and more frequent droughts.

- Water and foodborne diseases
- Vectorborne diseases
- Mental health
- Hot weather
- Cyanobacteria
- Extreme storm events
- Air pollution and pollen

Source: Vermont Department of Health, Climate & Health Program
Extreme Heat

Heat causes more deaths in the U.S. than tornadoes, hurricanes, floods & lightening combined

Heat-related health impacts:
- Heat stroke
- Dehydration & kidney injury
- Worsening respiratory & cardiovascular disorders
- Indirect effects: heart attack, suicide, stroke, respiratory illnesses, cognition, worsening diabetes

Most vulnerable populations:
Children, elderly, low-income, outdoor workers, athletes

Sources: CDC, NOAA

**Hot Weather** Already Leads to Increased Illness & Death in Vermont

Average daily emergency department visits for heat complaints in Vermont, by maximum daily temperature, 2004 - 2013

Source: Vermont Early Aberration Reporting System

Error bars indicate 95% confidence intervals
Lack of Acclimation in Vermont

Possible reasons for the relatively low threshold for heat illness in Vermont:

- Limited physiological adaptation due to infrequent hot summer temperatures
- Behaviors are difficult to change when extreme heat is so infrequent
- Many homes/businesses in Vermont are not designed to deal with extreme heat

Source: Denise Alosa, Athletic Trainer
Extreme heat: cases

- Healthy people
  - Marathon, sporting events- heat stroke, dehydration, rhabdomyolysis
- Vulnerable populations
  - COPD, asthma
  - Congestive Heart Failure
  - Stroke survivor
  - Essential hypertension

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Source: Vermont Department of Health, Climate & Health Program
Extreme Storm Events

Health impacts of extreme weather:
- Injury
- Water contamination
- Mold growth & respiratory health
- Indirect effects: long-term mental health impacts

Most vulnerable populations:
Children, elderly, low-income, communities in floodplains

Sources: CDC, VT Department of Health Climate & Health Program
Irene Impacts in Vermont

- six deaths
- mold growth in water logged buildings
- extensive property and infrastructure damage, power outages, and other service disruptions
- wellheads submerged and contaminated by floodwaters
- 30 public water systems issued boil water notices
- 17 wastewater treatment facilities reported compromised operations
- septic system failures, fuel spills, other hazardous contamination
- over $10 million estimated damage to crops and farmlands
- $150 million overall cost to Vermont, and 7-10 billion overall
Extreme storms: cases

- Irene survivor:
  - Days of being stranded in her home w/o:
    - electricity
    - Access to fresh food
    - clean water
  - triggered depression

- Mold concerns in COPD patient
- Farmers

- Victims of natural disasters are at an increased risk of anxiety, depression, PTSD, and suicide.
- Up to 54% of adults and 45% of children suffer depression after a natural disaster.
- Forty-nine percent of the survivors of Hurricane Katrina developed an anxiety or mood disorder, and 1 in 6 developed PTSD. Suicide and suicidal ideation more than doubled.
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- Mental health
- Hot weather
- Cyanobacteria
- Extreme storm events
- Air pollution and pollen

Source: Vermont Department of Health, Climate & Health Program

Air pollution & respiratory health

Air pollution causes
- 7 million deaths per year globally
- 200,000 premature deaths per year in the U.S.

Main climate-related concerns:
- Tropospheric Ozone
- Wildfire smoke
- Allergenic pollen
- Mold & moisture in buildings

Health impacts of air pollution:
- Respiratory illness (COPD, asthma)
- Aggravated cardiovascular illness
- Increased allergy-related illness

Most vulnerable populations:
- Children, elderly, low-income, pre-existing conditions, pregnant women & fetal health (pre-term delivery, low birth weight), people living near highways

Sources: CDC; World Health Organization, 2014; Ciaizzo et. al, 2013; American Lung Association
Even Western fires can affect Vermont

Source: National Oceanic and Atmospheric Administration; Jared Ulmer, VDH

Respiratory allergies
Longer warm season and more CO₂ increases **pollen**

Sources: University of Minnesota Global Health Center; VT Department of Health Climate & Health Program
Air pollution: cases

- More allergies, new cases, more extreme reactions
- Asthma, bronchitis, COPD patients suffer
- Chronic cough
- Cardiovascular disease

Source: US GCRP 2016, adapted from Ziska 2011

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Source: Vermont Department of Health, Climate & Health Program
Vector-borne Diseases

Relationship to Climate Change
- Increased temperatures & precipitation/humidity increase habitat and breeding success of vectors (e.g. mosquitoes, ticks)

Examples:
- Malaria (more than 400,000 deaths each year globally)
- West Nile virus
- Zika virus
- Lyme disease

Most vulnerable populations:
Children, elderly, low-income, outdoor workers

Sources: CDC, WHO

Source: Lancet Countdown, 2018
Vector borne diseases: cases

- Lyme disease - dramatic increase in:
  - cases
  - concerns
  - mental health impacts
- Anaplasmosis
- West Nile
  - "West Nile virus has been found in all counties of Vermont and continues to be detected in mosquitoes each year. However, it is a relatively rare cause of illness in people. Twelve cases in Vermont residents have been reported since 2011." - Vermont Dept. of Health
- Zika concerns
Primary climate-related health threats for Vermont
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Water and food-borne diseases
-矢状病毒病
-极端风暴事件
-空气污染和花粉

Cyanobacteria

Climate-related health effects:
- 被饮水和食物中的病原体污染
- 被污染化学物质污染在洪水中的水
- 接触到 cyanobacteria 毒素在地表水

Vulnerable populations:
- 与受污染水和食物接触的人

Sources: CDC; WHO

Water and food-borne illness

Relationship to Climate Change
- 洪水事件可能导致受污染水源
- 增加年降水量水平和变暖温度导致藻华/ cyanobacteria

Climate-related health effects:
- 被饮水和食物中的病原体污染
- 被污染化学物质污染在洪水中的水
- 接触到 cyanobacteria 毒素在地表水

Vulnerable populations:
- 与受污染水和食物接触的人

Sources: CDC; WHO
Heavy rains can increase contaminated runoff into drinking and recreational waters, leading to illness

*E. coli* detections increase after heavier precipitation

<table>
<thead>
<tr>
<th>Precipitation preceding water sample:</th>
<th>none</th>
<th>0.01 - 0.5&quot;</th>
<th>0.5 - 1&quot;</th>
<th>1 - 1.5&quot;</th>
<th>1.5 or more</th>
</tr>
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<tbody>
<tr>
<td>Public drinking water</td>
<td>0.1%</td>
<td>0.12%</td>
<td>0.21%</td>
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<td></td>
</tr>
<tr>
<td>Private well water</td>
<td>2.7%</td>
<td>2.9%</td>
<td>4.4%</td>
<td>5.7%</td>
<td>6.7%</td>
</tr>
<tr>
<td>Recreational water</td>
<td>2.0%</td>
<td>6.4%</td>
<td>8.3%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Ulmer, J, VDH

Warmer water temperatures increase risk for cyanobacteria blooms that can produce harmful toxins

Change in Lake Champlain temperature, 1964-2009
Water and Food-borne illness:
cases

- Statewide: 500 cases of food/water borne illness
- Cases *increase* with climate related events
  - Diarrhea, malnutrition
- Irene:
  - wellheads submerged and contaminated by floodwaters
  - 30 public water systems issued boil water notices
  - 17 wastewater treatment facilities reported compromise
  - septic system failures, fuel spills, hazardous contamination
  - over $10 million estimated damage to crops and farmlands
- Irene survivor in clinic: scarcity, trauma
- Farmers with devastating damage to their crops
- cyanobacteria-algal blooms
  - rashes, sore throat, liver problems, death of animals
  - Missisquoi valley, Lake Champlain

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Vermont is expected to continue warming in the future, leading to hotter summers, shorter and milder winters, stronger storms, and more frequent droughts.

Source: Vermont Department of Health, Climate & Health Program
Mental health impacts

Climate-related health effects:
- Anxiety, depression
- Post-traumatic stress disorder
- Increased aggressive behavior & domestic violence
- Sleep disorders
- Solastalgia

Vulnerable populations:
People predisposed to mental illness, people who experience a traumatic event (e.g. flood, wildfire)

Long-term mental health impacts of Irene

“Once you live through something, it’s always there.”

“It’s hard for my husband to talk about. He still wears it very close. On rainy days he’s looking out the window and checking the river levels. A nervous wreck. And he knows that it’s not going to happen. And I have to remind him it was a freak storm.”
- Resident of Waterbury 5-9 years

Source: Christine Carmichael, PhD
Mental health: cases

- Hopelessness, despair, eco-anxiety
- Depressed/anxious patients, youth especially
- Disaster survivors
  - climate grief
  - anx/depression/PTSD
- Farmers

Source: Carmichael, Danks & Vatovec, in preparation.
Addressing the climate crisis is the greatest health opportunity of our time.

Human flourishing is dependent upon a healthy environment

- clean air
- clean water
- biodiversity
- resilient ecosystems
- green spaces
- stable climate

References: Healthy Communities By Design (2007).
A healthy environment

- clean air
- clean water
- biodiversity
- resilient ecosystems
- green spaces
- stable climate

...depends on human actions

Reducing air pollution
Eating less meat
Driving less

All have tremendous health benefits

“Solving the global climate crisis could be the greatest opportunity of our time...”

Health Institute, during a grand-rounds program at the AMA headquarters in Chicago. He added that three ways to attack global warming—reducing air pollution, eating less meat and driving less—all

For a decade and a half, Dr. Patz served as a lead author for the U.N. Intergovernmental Panel on Climate Change (or IPCC)—the organization that shared the 2007 Nobel Peace Prize with Al Gore.
Fine particulate emissions sources in Vermont

- Residential Wood Combustion: 64%
- Agriculture: 9%
- Road Dust: 7%
- Waste Disposal: 5%
- Non-Road Equipment: 3%
- On-Road Vehicles: 2%
- Commercial/Institutional Biomass: 2%
- All other combined: 7%

Data source: EPA, 2014 National Emissions Inventory
Residential wood heating is the top PM$_{2.5}$ contributor in VT

![Relative Emissions of Fine Particles]

Source: EPA

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Why physicians see climate change as a health emergency

**SEPTMBER 20, 2019**

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- Reducing air pollution
- Eating less meat
- Driving less

All have tremendous health benefits

For a decade and a half, Dr. Patz served as a lead author for the U.N. Intergovernmental Panel on Climate Change (or IPCC)—the organization that shared the 2007 Nobel Peace Prize with Al Gore.
Active transportation (e.g. biking, walking) and healthier diets of sustainably-grown foods will improve human health… and - **bonus** - they both reduce greenhouse gas emissions

- 47% of adult Vermonters do not meet recommended physical activity levels
- 20% of adult Vermonters report not participating in any physical activity
- 61% of adult Vermonters do not consume recommended minimum of 2 fruit servings per day
- 70% of adult Vermonters do not consume recommended minimum of 3 vegetable servings per day

Sources: healthvermont.gov/3-4-50 & cdc.gov Vermont State Profile
Meeting Vermont’s transportation goals will also benefit our health

If we can meet the transportation goals in Vermont’s Comprehensive Energy Plan, we can expect the following benefits by 2050:

- **2,000 lives saved** due to more physical activity, cleaner air, and safer roads.
- **$1.1 billion** in costs avoided from reduced health care costs and increased productivity.
- **38% less CO₂** from passenger vehicles, due to less driving and more efficient vehicles.

**What are the goals?**
- 80% electric vehicles by 2050
- Reduce driving alone by 20%*
- Increase walk, bike, and bus trips by 100%*

*by 2030, compared to 2011

Source: Vermont Department of Health

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Increasing walking and biking benefits health much more than electric vehicles

<table>
<thead>
<tr>
<th>Lives saved</th>
<th>50</th>
<th>2,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health costs avoided</td>
<td>$10 million</td>
<td>$1.1 billion</td>
</tr>
</tbody>
</table>

Electric vehicles are critical for reducing greenhouse gas emissions

| Less CO₂ from vehicles | 32% | 38% |

Source: Vermont Department of Health
Amount of CO2 emitted per kilometer traveled
Includes full life cycle of each mode, even the food required to power a person biking.

Sources: European Cyclists Federation; Bike Portland.
Home weatherization benefits for health

Weatherization improves home conditions that affect health

Wx improves the home
- Reduced energy bills
- Improved temperature control
- Improved indoor air quality
- Enhanced safety
- Reduced humidity
- Reduced mold
- Reduced pest intrusion

Wx benefits health in many ways

<table>
<thead>
<tr>
<th>Health benefits...</th>
<th>...are associated with these improvements to home conditions.</th>
<th>Strength of evidence*</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Health</td>
<td>$&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$</td>
<td>High</td>
</tr>
<tr>
<td>Productivity</td>
<td>$&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$</td>
<td>High</td>
</tr>
<tr>
<td>Social Health</td>
<td>$&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$</td>
<td>High</td>
</tr>
<tr>
<td>Upper Respiratory</td>
<td>$&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$</td>
<td>High</td>
</tr>
<tr>
<td>Asthma</td>
<td>$&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$</td>
<td>Medium</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>$&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$</td>
<td>Medium</td>
</tr>
<tr>
<td>Financial Stress</td>
<td>$&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$</td>
<td>Medium</td>
</tr>
<tr>
<td>Mental Health</td>
<td>$&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$</td>
<td>Medium</td>
</tr>
<tr>
<td>Health Care Utilization &amp; Costs</td>
<td>$&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$</td>
<td>Medium</td>
</tr>
<tr>
<td>Accidental Injury</td>
<td>$&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$</td>
<td>Low</td>
</tr>
<tr>
<td>Infectious Disease</td>
<td>$&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$</td>
<td>Low</td>
</tr>
<tr>
<td>Neurological</td>
<td>$&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$ $&lt;$</td>
<td>Low</td>
</tr>
</tbody>
</table>

*Published evidence about the indoor environmental quality and health impacts of Wx was reviewed to identify the expected effects. The strength of evidence for each finding was based on the quality and amount of evidence available.

Source: Vermont Department of Health

Estimated health-related benefits

The estimated 10-year economic benefit per household is nearly three times greater than the initial expense.

<table>
<thead>
<tr>
<th>Benefit category</th>
<th>Primary beneficiary</th>
<th>First-year benefit</th>
<th>10-year benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal and electric energy cost savings</td>
<td>Household</td>
<td>$1,174</td>
<td>$11,740</td>
</tr>
<tr>
<td>Reduced impacts of asthma, cold, and heat*</td>
<td>Household</td>
<td>$276</td>
<td>$2,762</td>
</tr>
<tr>
<td>Reduced fine particulate emissions</td>
<td>Public</td>
<td>$1,026</td>
<td>$10,255</td>
</tr>
<tr>
<td>Total</td>
<td>Household + public</td>
<td>$2,476</td>
<td>$24,757</td>
</tr>
</tbody>
</table>

*More benefits are expected but could not be quantified, such as better mental and social health, fewer accidental injuries, and increased productivity.

Visit health.vermont.gov/climate to learn more about these findings and estimated impacts.

Source: Vermont Department of Health
Actions to improve health & minimize greenhouse gas emissions

Personal level...moving beyond lightbulbs

✓ Make active transport a habit
  • Walking for 15 minutes a day can boost life expectancy by up to 3 years
  • On average a car emits 1 pound of CO2 per mile driven

✓ If you do drive, go slower
  • Driving at 60 mph is 20 – 25% more efficient than driving at 75 mph (and it only takes 5 minutes longer for every 25 miles)

✓ Eat less meat
  • Appropriately planned vegetarian diets are associated with longer life expectancy (up to 8 years) and lower risk of several chronic diseases
  • One pound of beef releases 26 pounds of CO2
  • Red meat, processed meats are probable carcinogens (IARC)

Source: University of Michigan Center for Sustainable Systems
Actions to improve health & minimize greenhouse gas emissions

Personal level...moving beyond lightbulbs

✓ Weatherize your home
  • Reduce exposure to mold & indoor air pollutants **Efficiency Vermont $$
✓ If you heat your home with wood, convert to an EPA-certified woodstove
  • Reduce particulate matter emissions and breathe easier

Actions to improve health & minimize greenhouse gas emissions

Personal level...moving beyond lightbulbs

✓ Keep a “consumption and waste” journal – identify ways to cut-back
  • Electricity: 5.906 metric tons CO₂/home – how much is wasted?
  • U.S. landfills released an estimated 148 million metric tons (163 million tons) of CO₂ equivalent to the atmosphere in 2014 alone
  • Food waste: up to 40% of food grown in the U.S. is wasted...releases GHG emissions when landfilled

✓ Gardening and/or support local agriculture (CSAs, farmer’s markets...decrease food miles)
Actions to improve health & minimize greenhouse gas emissions

Personal level...moving beyond lightbulbs

✓ Choose activities that are known to increase happiness with a minimal carbon footprint
  • Physical activity
  • Connect with friends & family
  • Keep learning
  • Help others
  • Practice mindfulness

Actions to improve health & minimize greenhouse gas emissions

Community level

✓ Vote
✓ Share your voice
  • Write state and national representatives
Green Mountains?
Vermont GHG data shows we are not doing our part

"Based on forecasted emissions data for 2017 and 2018, GHG emissions are expected to increase further over the next two years."

Actions to improve health & minimize greenhouse gas emissions

Community level

- Vote
- Share your voice
  - Write state and national representatives
  - Write an editorial
  - Talk to friends & relatives about climate change & health
- Support people-centered planning and avoid urban sprawl in your town
  - Support initiatives for active transport
- Build community
  - Check on neighbors during heat and other weather events
  - Join or support a related organization
  - Support sustainable businesses in your area
- Sign the call to action if you are a medical provider: climatehealthaction.org
Resources & Next Steps

- Background information on climate & health
  - IPCC: https://www.ipcc.ch/
  - CDC: https://www.cdc.gov/climateandhealth/default.htm
  - Lancet Countdown: https://www.lancetcountdown.org/
  - VDH: https://www.healthvermont.gov/environment/climate
  - Department of Defense Climate change report 2019: https://media.defense.gov/2019/Jan/29/2002084200/-1/-1/1/CLIMATE-CHANGE-REPORT-2019.PDF
  - Project Drawdown

- Healthcare-related organizations focusing on climate & health
  - Medical consortium on climate and health: https://medsocietiesforclimatehealth.org
  - VTCHA: https://www.vtcha.org/
  - Health Care without Harm (U.S./Canada): https://climatecouncil.noharm.org/
  - My Green Doctor: http://www.mygreendoctor.org/
  - Physicians for social responsibility: https://www.psr.org/
What questions do you have?

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