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## Climate Change, Environmental Justice and Children's Health: Break the Cycle of Climate Change by Cultivating Future Leaders

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## Climate Change, Environmental Justice and Children's Health: Break the Cycle of Climate Change by Cultivating Future Leaders

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## **Climate Change, Environmental Justice, and Children's Health: Break the Cycle of Climate Change by Cultivating Future Leaders**

### **Children's Environmental Health Disparities: Intersection of Poverty Child Health**

Children are at greater risk from environmental factors than are adults. Children breathe more air, drink more water, and eat more food for their body weight than adults, so their exposure load through polluted air, water, and soil is greater. Furthermore, children's organs and organ systems as well as physiologic and metabolic processes are still developing, so they are more vulnerable to immediate and long-term negative health outcomes.<sup>1</sup>

Children who grow up in poverty are more likely to be exposed to multiple adverse physical, chemical, and social elements in their environment. They are more likely to live in poor neighborhoods where houses tend to be older and therefore more likely to have lead paint. Consequently children in these homes have an increased likelihood of high blood lead levels, several times more than their counterparts in more affluent neighborhoods, resulting in brain damage with cognitive impairment, learning difficulties, attention deficit hyperactivity disorder (ADHD), and behavior problems.<sup>2,3</sup> Also, older houses in these neighborhoods are more likely to have malfunctioning heating and air ventilation systems, if they have them at all, resulting in the development of mold, especially in wetter climates. The presence of mold correlates with a higher likelihood of allergies and asthma and associated adverse consequences on health, including emergency room visits for acute episodes of reactive airway disease, a greater likelihood of absences from school, and more hospitalizations with increased mortality.<sup>4,5,6</sup> The neighborhood environment in poor areas, with crowded houses, greater likelihood of vehicular traffic, poor lighting, and greater likelihood of trash, with little to no green spaces or suitable facilities for recreation, provides the dystopian setting for drug dealing, crime, and violence.<sup>7,8</sup> These realities, along with the reduced access to healthy foods, with greater exposure to foods from convenience stores or fast-food establishments that contain excessive amounts of salt, fat, and high-fructose corn syrup, set the stage for an increased likelihood of malnutrition and obesity.<sup>9</sup>

These adverse health outcomes from malnutrition and its metabolic consequences in obesity and diabetes, as well as asthma, with its need for emergency room visits and hospitalizations, require a good healthcare infrastructure. At the same time, the children may miss school because of illness, and experience lead exposure with resulting cognitive and learning disabilities, requiring a good school system to provide the necessary compensatory educational opportunities.<sup>10,11</sup> Unfortunately, however, in these poorer neighborhoods the healthcare delivery system is wanting, particularly for underinsured children and their families, and the educational system is wanting with school buildings more likely to be in a state of disrepair, and teachers who are more likely to be stressed and less well paid. So, the deficiencies in health and education

infrastructure add further compromise, resulting in adverse health and educational burdens on the children that are cumulative and compounded.<sup>12,13</sup>

In addition, poor neighborhoods especially those with people of color, are more likely to be situated near factories or other sources of pollution and toxic waste, which may result in contamination of the ambient air, water, and soil. All of these conditions, taken together, impact poor children and children of color and their families disproportionately and cumulatively. This inequitable and disproportionate exposure with its dire consequences on physical and mental health, can be viewed as an injustice, specifically an environmental injustice.<sup>2,14</sup> Reaction by communities and advocacy groups against the indiscriminate and often deliberate siting of factories or other polluting facilities near poor neighborhoods resulted in a presidential executive order in 1994 addressing *environmental justice in minority populations and low-income populations*.<sup>15</sup> The executive order has since been supplemented by a succession of legal and political actions culminating in creation of the Office of Environmental Justice within the US Environmental Protection Agency (EPA) in 2017.<sup>16</sup>

Furthermore, children who grow up in these toxic environments are more likely to be emotionally stressed, with multiple elements of insecurity, including anxiety and fear about the future, that may result in despair and social isolation.<sup>17</sup> The combination of emotional and environmental stresses, particularly if chronic and sustained without reprieve or emotional support, takes its toll on the physiological, neurological, immunological, educational, and psychological well-being of children who grow up in these environments.<sup>18,19</sup> The adverse health outcomes manifest in metabolic and endocrine disturbances that increase the likelihood of obesity and diabetes, and the hemodynamic changes in the cardiovascular system can result in hypertension and heart disease, with risk for strokes in adults. The stresses on the immune system render children vulnerable to infectious diseases, as we have seen with the COVID-19 pandemic,<sup>20,21</sup> and to the development of autoimmune disorders that seriously affect their health as adults. These disparate health outcomes are complicated and compromised by limited access to quality healthcare, further increasing the burden of stress, affecting school attendance and academic performance for children, culminating in difficulty securing and sustaining meaningful employment as adults. These factors contribute to poverty and dependence, or further aggravate poverty status.<sup>17,18,19</sup> The COVID-19 pandemic has taken a great toll on this vulnerable population by adding to the burden on poor families as well as to society.<sup>22,23</sup>

An additional and powerful factor at the intersection of children's environmental health disparities and poverty is the role of racial and ethnic status. The CDC Social Vulnerability Index (SVI) cites *minority status and language* as a category which presumably includes all racial and ethnic groups.<sup>24</sup> The list of vulnerable characteristics, also includes the elements of poverty, such as limited education and unemployment as well as housing situations, and most tellingly it includes *single parent households*. What the SVI does not do, is explicitly recognize specific racial and ethnic groups as a category of vulnerability. Examination of the profile of children in poverty in the US reveals that, child poverty is related to age as well as race and ethnicity. The Children's Defense Fund

reports that the youngest children are the poorest and that nearly three quarters of poor children in US are children of color.<sup>25</sup> More than 1 in 6 children under age 6 were poor and almost half of them living in extreme poverty. The racial and ethnic presentation of children in poverty is most revealing: 30.1% are Black, 29.1% are American Indian/Alaska Native, 23.7% are Hispanic, and 8.9% are White.<sup>25</sup> Thus, the burden of poverty is disproportionately borne by children of color. Furthermore, being from minority populations and being children of color, they face discrimination through covert and overt negative experiences of personal and institutionalized expressions of racism.<sup>26</sup> This has led the current director of the CDC to state that racism is a social determinant of health.<sup>27</sup>

The combined effects of adverse social, emotional, economic, and environmental stresses, along with negative educational experiences, compromise learning and even desire for learning or appreciation of the value of learning, which results in high dropout rates and low graduation rates.<sup>11</sup> Limited education leads to poor employment opportunities or work with low pay. This traps young people in the poorer neighborhoods with older houses in states of disrepair, contributing to exposures to indoor hazards of lead, mold, and other contaminants, with cumulative environmental, social, educational, and economic consequences. This assault of adverse factors on vulnerable children that results in unfavorable health, developmental, and educational outcomes and compromises a child's opportunity for economic and social success can be viewed as an *intergenerational cycle of environmental health disparities* (Figure 1).<sup>28</sup>

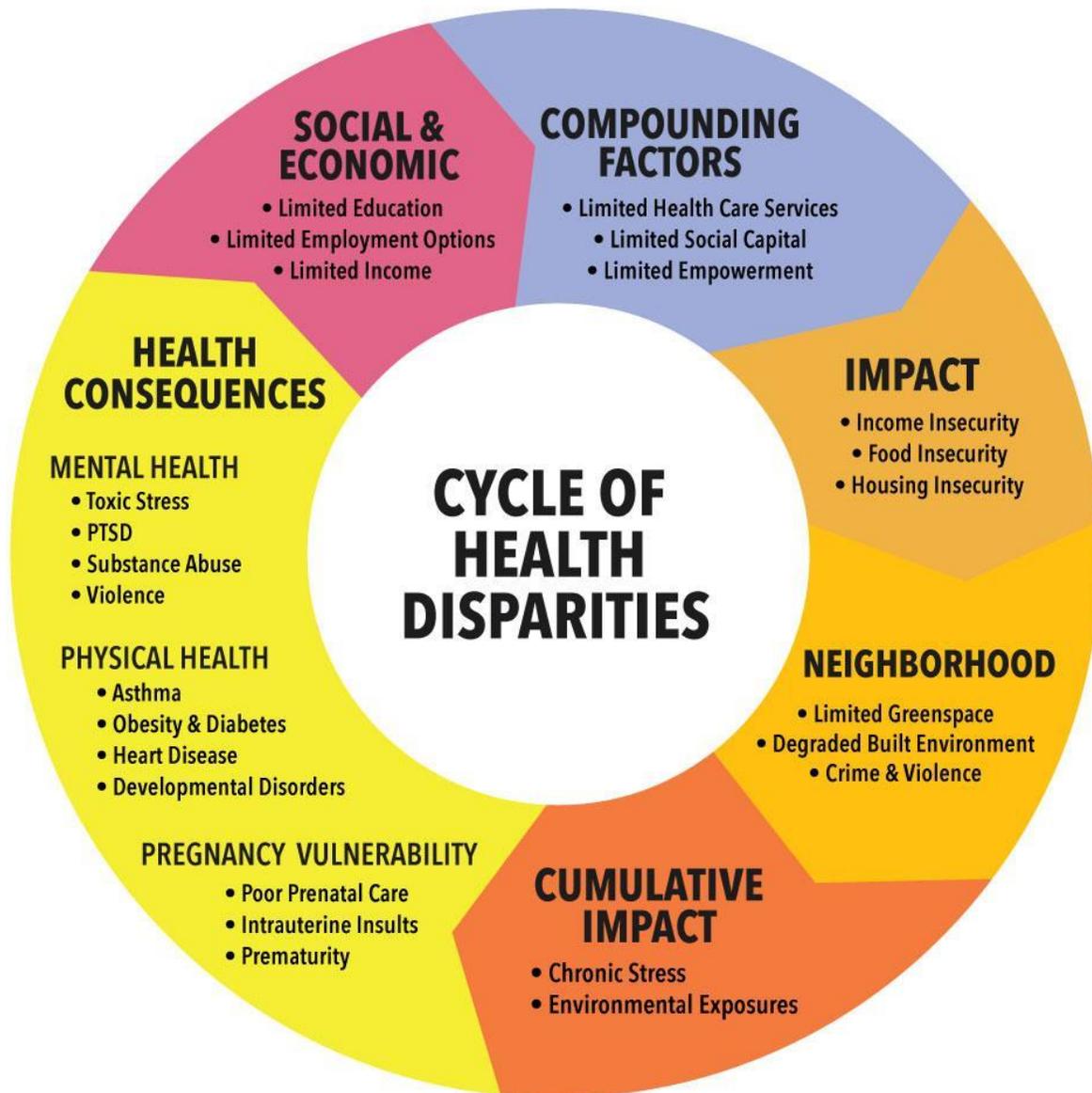


Figure 1. Cycle of environmental health disparities.<sup>28</sup>

### **Making a Difference: Breaking the Cycle of Children’s Environmental Health Disparities**

The cycle of health disparities focuses on the role of poverty and discrimination on the health and well-being of children. The elements in the cycle diagram represent the collective, cumulative, sequential, and consequential components in the ecology of social, economic, environmental, racial, and political determinants of health.<sup>28</sup> Any intervention that effectively reduces disparities can be viewed as “breaking the cycle.” These interventions may come at a macro level, such as the federal Civil Rights Act of

1964, which outlawed discrimination on the basis of race, color, religion, sex, or national origin and required equal access for all citizens to public places and employment.<sup>29</sup> It also enforced desegregation of schools and the right to vote. Although the Act did not end discrimination, it did take the struggle for equal access to natural and national resources to the next level and opened the door to further progress.

### **Federal Intervention to Break the Cycle**

The most dramatic of these national efforts to break the cycle was the *War on Poverty*, embodied in the Economic Opportunity Act of 1964.<sup>30</sup> This Act proposed establishing a variety of social programs aimed at facilitating education, health, employment, and general welfare for impoverished Americans. At the time, the national poverty rate exceeded 20%, and children were literally starving from lack of food. In response to the Act, Congress passed legislation that transformed American schools, launched Medicare and Medicaid, and expanded housing subsidies, urban development programs, employment and training programs, food stamps, Social Security, and welfare benefits.<sup>31</sup> Policymakers began to fund K-12 education, established the basic contours of today's college aid and loans for low- and moderate-income students, and launched Head Start, among other innovations. They converted Food Stamps from a pilot project into a permanent program, expanded housing assistance for low-income families, and took initial steps toward creating today's housing voucher program to help low-income families afford modest private housing.<sup>32</sup>

These efforts dramatically reduced the poverty rate over the next 10 years by almost half; however, as a result of the political and economic changes since then, the poverty rate has crept up to almost 20% again. Still, the situation for children and families in poverty is better today because of programs launched at that time and that continue in some form today, such as Head Start, Neighborhood Youth Corps, Community Action Program, Upward Bound, and many others serving low-income families. In addition, the Supplemental Security Income (SSI) program for low-income families was introduced in 1972.<sup>33</sup>

### **Other Large-Scale, Long-Term Projects to Break the Cycle**

#### *Perry Preschool Project*

In 1962 a study was launched focusing on poor African American preschool children in Ypsilanti, Michigan with a view to boosting their cognitive skills. Children were randomly assigned to the study group or the control group. In the study group, the children, aged 3-4 years, would spend time in a classroom for 2½ hours a day, and teachers would visit the children's homes for on weekends about 1½ hours per visit, for 2 years. When the investigators looked at the children's performance at 10 years of age, the results showed little difference between the study and control groups. But when economist and Nobel laureate, James Heckman examined academic, social, and economic characteristics of the groups as adults, he found that adults from the treatment group were much more likely to graduate from high school, much more likely to earn a living,

much more likely to go on to college, and much less likely to commit crime than the adults from the control group. As an economist, he concluded that, by the time the participant is 27 years old, society saved \$7 to \$12 for every \$1 invested, and that \$13 are saved for taxpayers by the time the participant is 40 years old, and that there is a \$16 total return including increased income to the participants.<sup>34</sup> In addition, the benefit extended to other family members and successive generations, in that the children of the study group participants are more likely to have a high school degree and to be employed, and less likely to have been arrested.<sup>35</sup>

### *Moving to Opportunity*

Moving to Opportunity (MTO) was an ambitious project of the Department of Housing and Urban Development (HUD) in 1994-1998.<sup>36</sup> MTO was an experiment to see if moving people from severe poverty to a place of less poverty would change their lives for the better. HUD identified 4,600 families at 5 sites of severe poverty in Baltimore, Boston, Chicago, Los Angeles, and New York. Families were randomly assigned to 1 of 3 groups: (1) Experimental: housing vouchers restricted to low-poverty (<10%) Census tracts; (2) Section 8: conventional housing vouchers, no restrictions; and, (3) Control: public housing in high-poverty (50% at baseline) areas. Investigators then examined how well the children and families were doing in terms of their personal well-being, social capital, education, and economic status, at various times after the move. Initial outcome measures were unremarkable and not significant; in fact, the early data suggested a negative impact on some groups. But when the investigators divided the groups of children by the age at which they moved, either before 13 years of age or after 13 years of age, they found that the children who had moved to improved housing in a less poor area before age 13, performed better in all measures than those who did not move. Those who moved after age 13 not only did not do as well as those who moved before 13 years, but they also did less well than the controls in some measures. The conclusion was that the children who move out of high poverty areas into lower poverty areas under age 13 years, do better academically and earn more than the controls and more than those who move after 13 years of age.<sup>36</sup>

These 2 examples clearly illustrate the benefit of large-scale long-term investments in early-childhood education and in enhancing the social and economic environment. Furthermore, they demonstrate benefits, not only for the children involved and their futures, but also for their families, their communities, the next generation, and for society at large. This is what is meant by breaking the cycle of poverty, improving social and economic circumstances, and reducing health disparities.

### **Small-Scale Break the Cycle Projects**

Above we have given examples of breaking the cycle with major overhauls in federal policies that continue to provide significant benefits for families in poverty and their children. We have also seen how focused efforts at moderate scales can demonstrate

improvement in potential for children from poor socioeconomic backgrounds to become successful contributing members of society. Our next example is different from the above examples in 2 ways. First, the projects are small in scale and scope and limited in time and expectations, so the outcomes may not be seen as sweeping. The second difference is that a significant part of the program is to raise awareness, provide guidance and perspective, and cultivate a set of skills among the younger generations of academics, researchers, professionals, and advocates to prepare them to deal with society's challenges ahead. The skill sets include creative thinking and problem solving, applying research to the challenge, modeling the critical process of community engagement, encouraging the development of communication skills in discussing the research project, presenting the results at a national meeting, and writing a manuscript for publication. Thus, the intent of this program is not only to break the cycle, but to cultivate new leaders who will help to shape the future by improving the social and economic circumstances for vulnerable children and thereby, significantly reducing children's health disparities.

### *Break the Cycle Program*

*Break the Cycle of Children's Environmental Health Disparities* (Break the Cycle) is an annual, collaborative interdisciplinary research and training program involving university students in academic tracks that address the impact of adverse social, economic, and environmental factors on children's health, development, and education. Each participating student develops a project that focuses on an element in the cycle diagram (figure 1) that will reduce the exposure of children to adverse environmental factors and/or protect children from those exposures. In the fall semester of each year, invitations are distributed to faculty and students at multiple universities and a variety of schools and disciplines. Students are invited to submit an abstract of the project they intend to undertake. The collection of submissions is scored by the Break the Cycle faculty and the 10 abstracts with the highest scores are selected to participate in the program. Selected students are expected to work with mentors at their university to complete their projects in the required time. Both the student and mentor are expected to participate in monthly conference calls to provide an update of their projects, obtain guidance and insight from the Break the Cycle faculty, and to participate in presentations and discussions around selected topic areas such as health literacy, community engagement, environmental justice, and related topics. At the end of the project period, in the Spring Semester, the participants are expected to present their work at an annual national conference. In addition, they are also required to write a paper on their work for publication, which is edited by the Break the Cycle faculty and other selected subject experts. All student projects in any given year are published in a journal supplement designated exclusively for Break the Cycle papers, and their work is also published in a book series on public health. Thus, each student (1) has the opportunity to do a project that addresses children's environmental health disparities, (2) has the opportunity to deliver a presentation at a national conference, and (3) has 2 publications for their Resume or Curriculum Vitae. These 3 products of the program

inform the students about children's environmental health disparities, and provide them with the skill set and encouragement to explore what role they can play in reducing children's health disparities and promoting health equity for all children.<sup>37</sup>

Since the inception of Break the Cycle in 2004-2005, we have had 16 annual programs totaling about 150 students from about 50 university departments, including medicine, nursing, public health, environmental health, biology, psychology, education, sociology, anthropology, city planning, nutrition, public administration and planning, law, and economics. We have also had students from universities in Latin America, Africa, and Europe. Publication of the student papers have been compiled into 12 journal supplements and 12 books on public health.<sup>38</sup>

### *Student Feedback from Participation in the Program*

An early survey of program alumni showed that the students derived significant benefit from all aspects of their participation, including conducting a research project, preparing and delivering a presentation, and writing a manuscript that helped further their academic or employment opportunities. Students reported an increase in knowledge about children's environmental health and about environmental health disparities, as well as the value of being exposed to different perspectives from the other student projects. Many past students reported that the program significantly influenced their career choice.<sup>39</sup>

In a recent Emory University survey of past students looking at what components of the program they found most useful, the students rated the opportunity for development of a manuscript and publication the highest, followed by meeting with their mentors and attending the monthly conference calls. Furthermore, over 60% reported that they would pursue additional research in children's environmental health disparities. (Break the Cycle program evaluation of student experiences on career trajectory. Emory University April 29, 2021)

### *Feedback from Conference Participation*

In a survey of attendees from the most recent Annual Break the Cycle conference (April 2021), there were 58 responses, which represented about a third of all attendees. Of the respondents 46% were students and 25% were current or past Break the Cycle students or mentors, 75% were not involved in the program, and 75% attended for professional learning and development. Of the respondents 52% said it was comparable to previous conferences they had attended, 48% said it was of high quality, and none reported low quality. Almost 80% of respondents indicated that they would use the information learned at the conference to improve their work. When asked what they were interested in, 27% of respondents indicated presenting at a future conference and sharing information about the program in their network. (Break the Cycle Conference Survey Evaluation Report 2021).

### *Mentor Feedback*

We obtained feedback from 2 mentors who had supported more than one student over the past years and who provided the following comments:

*It really has been a pleasure and a privilege to mentor students in the BTC program. I have mentored at many levels (undergrad, postbac, masters, and doctoral) and I think that one of the strengths of the program is that all these students become a cohort and can learn from each other, at their various stages--the more advanced students become role models for the ones just starting out. The students can see how their work fits in to a larger body of literature and a larger effort to reduce and eliminate children's environmental health disparities. For some students, I think their own research may seem small on its own but being part of this program allows them to put their work in the context of area of research where change is sorely needed--and their work can be part of this change. I have found that there are very few spaces in academic training where students can develop their skills and interests in such a supportive environment. The students themselves are the ones who continue on after the BTC program to push for change--your impact on a whole generation of future scientists is really an amazing legacy for this program. I feel lucky to have played a small part in it. (Herbstman JB. Columbia University Mailman School of Public Health. Personal Written Communication, August 2021)*

*I have been a mentor and advisor for students in the Break the Cycle (BTC) project since its inception. I have had two doctoral students participate in the program, and one of those students had her own doctoral student participate. It was so helpful for my beginning doctoral students to have a mentor outside of our university who could listen and respond to their ideas on their initial research projects. I have also been a proponent of the international and multi-state participants in BTC. For my doctoral students, this was the first time they were exposed to the research of professionals from other countries. Hearing about issues that are multifaceted from across the US and the globe makes one appreciate the interconnectedness of our world. Having recently completed Fulbright projects in Mongolia and Sri Lanka, I was able to take useful information from BTC to share with my counterparts internationally. I was also able to visit one of the pediatricians who I met through BTC when I was visiting in South America. My web of connections through BTC is strong! (Gallagher PA. Georgia State University. Personal Written Communication, August 2021.)*

### **Climate Change and Children's Health Disparities**

The legacy of centuries of human exploitation with the indiscriminate consumption of natural resources, and a lack of will to take good care of our collective human residence, has resulted in the degradation of the ecological balance of our planet. The result of the cumulative alterations in our environment is the heating up of our planet and its consequences, which are experiencing today and characterizing as Climate Change. The challenging phenomenon of climate change is that it is progressing

inexorably and is disturbingly self-perpetuating. For example, temperature increases that have a profound direct impact increasing local heat index also have indirect impacts on weather patterns. The more extreme weather events include floods and droughts, affecting agriculture and agricultural productivity, increasing the likelihood of wildfires that consume millions of acres of forests, reducing tree coverage, and reducing carbon dioxide extraction from the atmosphere, further increasing the heat index.<sup>40</sup>

Although the manifestations and adverse consequences of climate change are universal and indiscriminate, they affect children more than adults, and especially children from poor and disadvantaged black, brown, and indigenous communities to a greater degree and with a more consequential adverse outcomes.<sup>41-44</sup>

Extreme heat affects all stages of childhood. Newborns are more likely to be premature or low birth weight if their mother is exposed to extreme heat in pregnancy.<sup>45</sup> Infants and children risk dehydration more rapidly with the added complications of electrolyte imbalance, and renal disease.<sup>46,47</sup> Older children are vulnerable during rigorous outdoor athletic events.<sup>48</sup> Children in low-income and under-resourced communities are less likely to have green spaces with parks and trees to provide relief, less likely to have heat warnings, cooling centers, accessible health interventions, or air conditioning and are not readily able to relocate to cooler climates.<sup>49</sup> Evidence shows that children living in the same city can experience vastly different ambient temperatures in any heat event, and that children in low-income and racially diverse blocks of the neighborhood will experience more heat, compounded by limited resources to escape from the heat.<sup>50</sup>

Longer pollen seasons can affect length and severity of asthma in children, increasing already-severe disparities in asthma prevalence and mortality outcomes by race and ethnicity.<sup>51</sup> As growing seasons change, and as droughts and dust storms increase the presence and concentration of potentially toxic airborne particles, and as flooding leads to indoor mold growth, children are increasingly likely to be exposed to harmful toxins and allergens.<sup>52,53</sup> In addition, as the warmer, insect-friendly climate expands northward, there is wider geographic exposure to vector-borne diseases such as Lyme disease, West Nile virus, and other serious viruses and pathogens.<sup>54</sup>

Children are also uniquely vulnerable to environmental effects of disaster events, which are more often than not, magnified for poor and disadvantaged children who live in under-resourced communities and whose families are less able to prepare, adapt, or relocate.<sup>55,56</sup> As an example, children are more vulnerable to environmental effects of smoke from the dramatic increase in prevalence, intensity and range of wildfires, which can be dispersed over wide areas by the wind and the effects are often magnified for poor and disadvantaged children.<sup>57,58</sup>

A public health crisis of global proportions such as climate change bears witness to the disproportionate impact on the same overburdened communities that have always suffered. Considering the intergenerational cycle of health disparities, and the likelihood of cumulative impact on children who are already socially, economically, and

environmentally besieged, they are exquisitely vulnerable to the additional insults wrought by climate change. The disproportionate infection rate and death rate affecting these vulnerable populations during the COVID-19 pandemic are harbingers of the patterns of morbidity and mortality we can expect with the relentless force of climate change.<sup>20,59</sup>

### *Natural Disasters and Children's Health Disparities*

One consequence of climate change is increased frequency, intensity, and destructive potential of extreme weather events and natural disasters, such as heat waves, droughts, hurricanes, floods, wildfires, thunderstorms, ice storms, hailstorms, and even a polar vortex. These weather-related phenomena are destructive to the natural environment, the built environment, and the lives and livelihoods of the residents of the affected communities. The toll of these events is massive in terms of financial costs, which run into the billions of dollars per event,<sup>60</sup> as well as death rate and the disruption and dislocation experienced by the most vulnerable children living in the most vulnerable communities.<sup>55,56,61</sup> These children not only experience direct physical injury from the event, but also suffer long-term from the traumatic experience, from the loss of everything they have known, from the loss of family members, and from the dislocation and struggle to settle into unfamiliar and maybe even hostile places. These adverse experiences can result in significant mental health problems, affecting their learning and education, that can last a lifetime and may limit their potential for success and productivity as adults.<sup>62</sup> Children in disasters tend to do better if their parents do better, in contrast, children from communities beset by poverty and racism, with a lower level of baseline health and family stability, the consequences of disasters have a disproportionate effect on mental health as well.<sup>63</sup>

Thus, children from poor and minority communities, who are predominantly children of color, are the most vulnerable to environmental hazards and to the complex forces of climate change. The cumulative impacts of adverse social, economic, physical, chemical, and psychological exposures have a more powerful effect on children at the intersection of poverty, racism, and climate change.

### *Global Disparities in Children's Environmental Health*

Although the manifestations of climate change are experienced at a local level, the implications are global, and the people most affected are those who have limited resources, of which the most vulnerable are the children. The World Health Organization projects that there will be 77,000 to 131,000 additional deaths in children under 5 from climate-related undernutrition in 2030, contributing to 45% of total deaths in children <5 years old.<sup>64</sup>

The World Bank tracks populations around the world who are forced to leave their homes because of climate-related disruptions on their lives and livelihoods, particularly

in agricultural areas. They project that the worsening conditions of climate change in three densely populated regions of the world could see over 140 million people move within their countries' borders by 2050, creating a looming human crisis.<sup>65</sup> The United Nations office on migration reports that 1 in every 8 migrants worldwide is a child and that these children are disproportionately vulnerable to violence, abuse, exploitation, trafficking, and detention, all of which are intensified for unaccompanied or separated migrant children.<sup>66</sup>

## Cycle of Climate Change

Climate change is a phenomenon of gargantuan proportion and scope, which poses an existential threat to planetary health and life on earth as we know it.<sup>67,68</sup> Conceptually, climate change can be viewed as a self-perpetuating cycle that needs to be broken to restore planetary and human health (Figure 2). One disturbing self-perpetuating example in the cycle, is the heat and drought in the western part of the US, where the trees have become like kindling and successive and fierce fires have engulfed millions of acres of forest. The destruction of the forest exposes the bare earth to the sun and increases the heat that causes water vapor to evaporate, further drying the vegetation and making it more flammable. Furthermore, the fires reduce the available foliage that would consume atmospheric carbon dioxide, which then accumulates, increasing greenhouse gases, and further aggravating temperature rise and climate change.

To halt or reverse this degree of climate change requires actions of corresponding magnitude at global levels, such as major reduction and rapid elimination of the use of fossil fuels, worldwide protection of natural lands and oceans, sustainable agriculture, changes in our eating habits to reduce dependence on meat from livestock, reduction in waste with reuse and recycling, and increased use of solar and wind energy. These and many other strategies have evolved during global climate talks over many years, culminating in the Paris Climate Agreement in 2015, a legally binding international treaty on climate change.<sup>69</sup> The agreement was adopted by 196 parties, with a goal of limiting global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels with reduction in greenhouse gas emissions as soon as possible to achieve a climate-neutral world by mid-century. Its implementation requires urgent active participation of all signatories to develop policies and effect *economic and social transformation, based on the best available science*.<sup>70</sup> The Agreement proposed 5-year reviews of progress which would have been in 2020, so we are alarmingly behind schedule.

As we discussed with the Cycle of Health Disparities above, leaving the approach to a governmental edict alone is unlikely to result in all the necessary changes required to achieve the goal. It requires many approaches at many levels to be ultimately successful, and this cannot be left to chance. As it is, the youth of today who will inherit the earth of tomorrow, are anxious, if not fearful, of what awaits them. It is not accidental that a global spokesperson for climate awareness, Greta Thunberg, is a 16-year-old from Sweden, and was the *Time* magazine Person of the Year in 2019.<sup>71</sup> Youth from all over the world are

advocating action on climate change.<sup>72</sup> On the UNICEF website on Youth for Climate Action are a number of quotes from young people around the world, including a 16-year-old girl from Tanzania named Gertrude, who was quoted as saying: "You might think that we are too young to know about the risks and realities of climate change. But we see its effects in our daily lives".<sup>73</sup>

Thus, not only do we need to reverse the trend in global warming, but we need to protect and defend the most vulnerable of our societies who are children and, of those, children from low-income communities, and low-resource countries, the majority of whom are children of color.

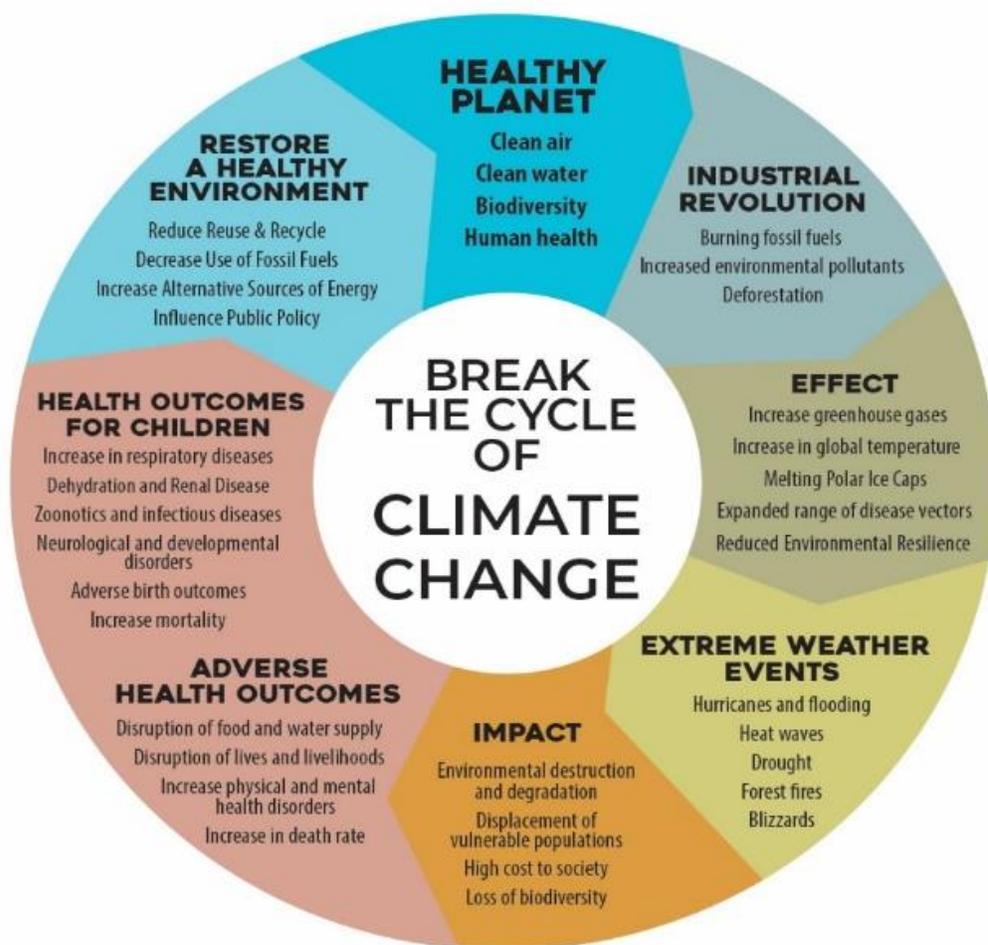


Figure 2. The Cycle of Climate Change<sup>38</sup>

*Break the Cycle of Climate Change for Vulnerable Children: Cultivating Students for Future Leadership*

Our plan to address this challenge is to focus on youth by developing an intense mentoring program for students from academic institutions serving vulnerable communities on a global scale. We will start in the US with Historically Black Colleges and Universities (HBCUs), Tribal Colleges and Universities (TCUs), and Hispanic Colleges and Universities (HACUs). The students will be invited to explore the complex interactions and systems of climate change, environmental justice, and children's health disparities in their own communities. They will be challenged to develop ways of reducing climate change and its effects on vulnerable children. By stimulating their interest, cultivating their talents and skills, and mining their creativity to explore ideas that address climate change inequities, these young people will play a part in changing their world for the better and become our future leaders.

This program will be modeled on our *Break the Cycle of Children's Environmental Health Disparities* program and oriented to climate change as seen in figure 2.<sup>38</sup> Each student will develop a project on how to address the existential threats of climate change from the perspective of their own communities and define ideas and strategies on how to break the cycle of climate-driven health disparities. The program will focus on physical, emotional, and mental health of children and encourage a variety of unique approaches. Each student, working with a mentor, will have freedom to explore ideas that center on the complex interactions of climate effects, children's exposures, health outcomes, and the ways to counter the ubiquitous and structural effects of poverty, discrimination, and racism as social determinants of health. The confluence of three big ideas (climate change, environmental justice, and children's health) offers a program that is unprecedented and rich with multidisciplinary solutions. Students will be provided with the foundations to study, research, discuss, and publish, and may choose to explore the fields of science, chemistry, toxicology, medicine, law, public policy, sociology, construction, or urban planning, as well as literature, poetry, art, – or any other field of study – for all lend themselves to creative application.

Students who complete the program will move on to advanced education or to careers, taking with them the experience and lessons this program provides. For example, when they next see or smell or read about a wildfire, they will know that exposure to the particulate matter in smoke is worse for children. And it is worse still for children in communities not able to plan and prepare clean air spaces and for children in childcare and schools without adequate ventilation and filtration systems. Students from this program will be equipped for life to help their communities through floods, heat waves, and vector-borne disease outbreaks, because they will be grounded in the basics of exposure, and they will learn about bringing communities together to build resilience. They will have had a taste of problem solving and critical thinking in environmental health; they will have a community of experts to rely on in times of need, and they will be able to care for children in their communities by preventing harmful everyday environmental exposures, preventing short and long-term illness, as well as providing the support and care in disaster situations. In short, this program will prepare the young eager and bright minds to understand and address environmental health, environmental justice, and climate change in their careers and in their communities. In the process, they will make

valuable contributions to society with their cumulative knowledge and practical strategies to Break the Cycle of Climate Change and become our future leaders in promoting a cooler, greener, and healthier planet, with health equity for all children.

## Conclusion

Children of color from low-income families and communities are more likely to be exposed to adverse environmental factors and are more physically, physiologically, and psychologically vulnerable to these adverse environmental factors. The consequences of cumulative adverse environmental factors on these vulnerable children have far-reaching effects on their physical health, mental health, and functioning potential as adults, resulting in an intergenerational cycle of health disparities. Although the phenomenon of climate change is universal, there are indisputably disproportionate consequences on different communities. Climate change is a real and present threat to the health and well-being of all children, but potentially profoundly devastating to Black, Brown, and Indigenous children who are also poor and living in Environmental Justice Communities. Our proposed program will tap into the lived experience of University and College students in vulnerable communities and inspire them to come up with ideas to Break the Cycle Climate Change in their own communities and support them in their efforts to do so. Through these strategies we aim to cultivate a set of skills in the participating students to enable them to tap into their intellect, talents, passions and potential, and prepare them for the leadership responsibility to address the challenges of children's health disparities, in the context of environmental justice, and climate change to forge a brighter, healthier future.

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