Yale Center on Climate Change and Health Annual Report

July 1, 2021 to June 30, 2022

Executive Summary

During the period July 1, 2021 to June 30, 2022, the Yale Center on Climate Change and Health (YCCCH) at Yale School of Public Health (YSPH) successfully implemented all major 2021-22 planned activities and planned a full set of activities for 2022-23. In summary, our 2021-22 accomplishments included:

- **Recruitment of a new core faculty member to serve as YCCCH Director of Education**. Dr. Daniel Carrión began January 1, 2022
- ***Conference on Climate Change and Health in Small Island Developing States: Focus on the Caribbean*, held October 5-8, 2021**. We organized the conference in partnership with more than 25 international, U.S., and Caribbean organizations.
- **Expansion of the core research program team** to three faculty, two postdoctoral researchers, four doctoral students, two visiting doctoral students, two master's students, and two undergraduate students
- **Research publications in high-impact journals**, including *The Lancet*, *Nature Communications*, and *The BMJ*
- Completion of the second annual Yale University sustainability in healthcare symposium, entitled ***Care Without Carbon – The Road to Net Zero Healthcare: Measure, Manage, Lead***
- **Continued membership in *The Lancet Countdown on Health and Climate Change*,** with authorship of two indicators in the 2021 Report
- **Major new grants and donations secured.**
- **Growth of our monthly YCCCH newsletter** to reach 3,500 recipients
- **Expanded enrollment in our Climate Change and Health Concentration** for Yale MPH students, from three in the inaugural class to 13 in the class of 2023
- **Continued offering of climate and health courses for Yale students**, including Climate Change and Public Health; Methods in Climate Change and Health Research; Clinic in Climate Justice, Law, and Public Health; and Seminar in Climate Change and Health
- **Continuation of the two-semester Clinic in Climate Justice, Law, and Public Health**, a joint course between Yale School of Public Health, Yale School of the Environment, and Vermont Law School, with evidence of its real-world impact on policy actions in Connecticut, California, and Philadelphia
- **Continued offering of the YCCCH Student Associates Program, Climate Change and Health Internship Program, and Mentorship Program**
- **Two offerings of our 18-week online Climate Change and Health Certificate program**
- **Build out of the Policy Impact Unit: Focus on Connecticut** by publishing issue briefs on extreme events and vector-borne diseases and partnering with the Connecticut Department of Public Health to secure a CDC grant to launch the DPH Office of Climate and Public Health
- **Identified three topic areas for focused work on maximizing YCCCH's real-world policy impact:** (1) Sustainable and equitable cooling, (2) Equitable building electrification, and (3) Healthcare environmental sustainability

YCCCH Structure and Administration

Since January 2020 we have operated as a University Center, as reflected in our updated name: the Yale Center on Climate Change and Health. To support our expanded mandate, we developed a four-year strategic plan (2020-24), expanded our staff, and created an Advisory Board. In 2021-22, we continued to build out our work as a University Center by securing additional funds, welcoming our new faculty hire, and expanding our research projects, among other activities.

YCCCH Core Team

- **Dr. Robert Dubrow**, Faculty Director; Professor of Epidemiology (Environmental Health Sciences)
- **Dr. Martin Klein**, Executive Director; Senior Advisor, YSPH Dean's Office, Lecturer (Health Policy and Management)
- **Dr. Kai Chen**, Director of Research; Assistant Professor of Epidemiology (Environmental Health Sciences)
- **Dr. Laura Bozzi**, Director of Programs; Lecturer (Environmental Health Sciences)
- **Dr. Jodi Sherman**, Director of Program on Healthcare Environmental Sustainability; Associate Professor of Anesthesiology
- **Dr. Daniel Carrión,** Director of Education; Assistant Professor of Epidemiology (Environmental Health Sciences)
- **Mr. Mauro Diaz-Hernandez**, Program Administrator

New hire: Assistant Professor of Epidemiology (Environmental Health Sciences) & Director of Education

In January 2022, as the result of an international search, YCCCH welcomed Dr. Daniel Carrión as a new assistant professor and inaugural YCCCH Director of Education. Dr. Carrión is an environmental health scientist focused on the intersection of climate, energy, and health (in)equity. He conducts exposure science and environmental epidemiology research focused on ambient temperature and air pollution in the United States and internationally. The goal of this research is to understand the relationship between structural forms of inequality and exposure and health disparities to inform interventions. Dr. Carrión received his BA from Ithaca College, an MPH from New York Medical College, a PhD from Columbia University, and postdoctoral training at the Icahn School of Medicine at Mount Sinai. As YCCCH Director of Education, Dr. Carrión directs the Climate Change and Health Concentration for MPH students, serves as faculty in the Clinic in Climate Justice, Law, and Public Health, directs the online Climate Change and Health Certificate Program for working professionals, and is developing his research agenda.

Advisory Board

The YCCCH Advisory Board includes students, faculty from other universities, and representatives from government and non-profit organizations. The Advisory Board met March 10, 2022 via Zoom; the agenda focused on how YCCCH can best maximize its real-world impact.

The following constitutes the Advisory Board membership:

- **Paul Anastas, PhD**, Teresa and H. John Heinz III Professor in the Practice of Chemistry for the Environment, Yale School of the Environment
- **Michelle Bell, PhD,** Mary E. Pinchot Professor of Environmental Health, Yale School of the Environment
- **Tekisha Dwan Everette, PhD, MPA**, Executive Director, Health Equity Solutions; Assistant Clinical Professor in Social and Behavioral Sciences, Yale School of Public Health
- **Paulette Frank**, Chief Sustainability Officer at Johnson & Johnson
- **Rebecca French, PhD**, Director, Office of Climate Planning, Connecticut Department of Energy and Environmental Protection
- **Howard Frumkin, MD, DrPH**, Senior Vice President, The Trust for Public Land; Professor Emeritus, Environmental and Occupational Health Sciences, University of Washington School of Public Health
- **Shelley Geballe, JD, MPH**, Assistant Professor of Public Health Practice (Health Policy), Yale School of Public Health; Clinical Lecturer, Yale Law School; Distinguished Senior Fellow, Connecticut Voices for Children
- **Emily Goddard**, MPH Candidate, Yale School of Public Health
- **Rachel Hennein,** MD/PhD Candidate, Yale School of Medicine
- **Tara Houska, JD,** Zhaabowekwe (Couchiching First Nation) tribal attorney, land defender and climate justice activist
- **Mark Mitchell, MD, MPH, FACPM**, Associate Professor of Climate Change, Energy, & Environmental Health Equity, George Mason University; Co-chair, Commission on Environmental Health, National Medical Association
- **Michael Pascucilla, MPH, REHS,** Chief Executive Officer/Director of Health**,** East Shore District Health Department, Branford, Connecticut
- **Surili Patel, MS,** Vice President, The Metropolitan Group
- **Peggy Shepard,** Co-founder and Executive Director, WE ACT for Environmental Justice
- **Vasilis Vasiliou, PhD,** Department Chair and Susan Dwight Bliss Professor of Epidemiology (Environmental Health Sciences), Yale School of Public Health
- **Nick Watts, MD,** Chief Sustainability Officer, National Health Service, United Kingdom
- **Daniel Weinberger, PhD,** Associate Professor of Epidemiology (Microbial Diseases)**,** Yale School of Public Health
- **Sacoby Wilson, PhD,** Professor, the Maryland Institute for Applied Environmental Health and Department of Epidemiology and Biostatistics, School of Public Health, University of Maryland-College Park
- **Elizabeth Yeampierre, JD,** Executive Director, UPROSE

Affiliated Faculty

On June 30, 2022, we had 51 Affiliated Faculty, 29 with primary appointments at YSPH and 22 with primary appointments in other schools or departments.

Student Assistants

- Lily Johnston, a first-year MPH student, served as a Research Assistant for the YCCCH Program on Healthcare Environmental Sustainability.

- Weixi Wu, a second-year MPH student and first-year Master of Environmental Science student at the Yale School of Environment, served as the YCCCH Student Associate Program Student Coordinator.
- Emily Goddard, a first-year MPH student, served as a Research Assistant for the YCCCH Policy Impact Unit.
- Sophia Ptáček, a first-year joint MPH/Master of Environmental Management student, served as a Research Assistant for the YCCCH Policy Impact Unit.
- Natalie Henning, a second-year MPH student, served as the YSPH Sustainability Committee Student Coordinator.
- Claire Latendresse, a first-year MPH student, served as the YCCCH Communications and Social Media Assistant.

Affiliations

YCCCH has affiliated with the following organizations:

- Global Consortium on Climate and Health Education
- Planetary Health Alliance
- US Climate and Health Alliance
- Lancet Countdown: Tracking Progress on Health and Climate Change
- Connecticut Governor's Council on Climate Change

Communications

We maintain a YCCCH website within the YSPH website, and we continue to expand the site to reflect the Center's extensive work. We also have an active Twitter account (@cchyale) with over 1,000 followers and a new YouTube page. We have worked closely with the YSPH Communications Office to produce news articles and social media posts highlighting YCCCH efforts, including articles summarizing our faculty's research publications (e.g., "The climate implications of the health sector" on Dr. Sherman's paper published in The BMJ) and promoting YCCCH-hosted events (e.g., "Environmental justice conference explores a just recovery"). Our monthly newsletter reaches approximately 3,500 recipients and boasts an impressive open rate of approximately 45%.

Program Accomplishments

Research

Core Research Program

The core research program is led by Dr. Kai Chen, the YCCCH Director of Research. Through this program, we are building a vibrant community of doctoral students, postdoctoral researchers, and collaborating faculty who apply multidisciplinary approaches – including climate and air pollution sciences, exposure assessment, mathematical and statistical modeling, and environmental epidemiology – to investigate a) interactive effects on human health of ambient temperature, air pollution, extreme weather events, demographic factors, and social determinants; b) future climate change impacts as determined by modeling of alternative scenarios; c) health co-benefits of climate change mitigation and adaption measures and related policies; d) effects of mitigation and adaptation policies on reducing disparities in environmental exposures and their adverse health effects; and e) adaptation strategies, especially to extreme heat. The program aims to produce policy-relevant knowledge that can be used to advance climate change mitigation and adaptation in a manner that promotes health and protects vulnerable populations.

During the 2021-22 academic year, the core research program included Dr. Chen, Dr. Dubrow, Dr. Carrión, two postdoctoral researchers (Dr. Pin Wang and Dr. Nina Domingo), four doctoral students (Sappho Gilbert, Lingzhi Chu, Yiqun Ma, and Chengyi Lin), two visiting doctoral students (Evan de Schrijver and Riyang Liu), two master's students (Dieyi Chen and Mitchell Manware), and two undergraduate students (Zully Arias and Fiona O'Brien).

In 2021-22, the core faculty continued the following funded research projects:

- **Effect of air pollution reductions on mortality during the COVID-19 lockdown: A natural experiment study** (funded by Health Effects Institute). This study aims to evaluate whether changes in mortality are associated with changes in ambient NO_2 and $PM_{2.5}$ levels before, during, and after COVID-19 lockdowns and to disentangle the short-term effects of NO_2 versus $PM_{2.5}$ on mortality. The analysis is being conducted in four countries: China, Germany, Italy, and the United States.
- **Associations between extreme precipitation, floods, or drought and childhood diarrhea in low- and middle-Income countries** (funded by the Reckitt Benckiser Global Hygiene Institute). This study aims to quantify the relationship between extreme precipitation, floods, or drought, and risk of childhood diarrhea in children under age five years in low- and middle-income countries and to evaluate whether the effects of extreme precipitation, floods, and drought are modified by water, sanitation, and hygiene practices. The study's first paper was published in *Nature Communications* in June 2022.
- **Ethane cracker plants in the United States: emissions and community vulnerability** (funded by the High Tide Foundation). This study, led by Dr. Nicole Deziel, characterized emissions profiles of ethane cracker plants in the U.S., as well as sociodemographic characteristics of people living near the plants. Twenty-nine of the 32 plants are located in Texas and Louisiana. The chemicals emitted in the greatest quantities were (in decreasing order) ethylene, propylene, hydrochloric acid, benzene, n-hexane, 1,3-butadiene, ammonia, toluene, vinyl acetate, and methanol. In 2019, 68 million metric tons of CO_{2e} were emitted. Census block groups within 5 km of a facility have higher proportions of people who are Hispanic and Black, lower income, and lower educational attainment than block groups further away. Results from this study will be submitted for publication in 2022-23.

New donations, grants, & contracts to support research

Yale University awarded nearly $1.5 million to 21 proposals in its inaugural round of Planetary Solutions Project Seed Grants. These grants support the Yale community's work in addressing climate change, biodiversity loss, and climate-linked health and justice issues. YCCCH researchers received four of the 21 grants, in partnership with multi-disciplinary teams that include a number of YCCCH Affiliated Faculty (core and Affiliated Faculty are bolded below). Each grant was for the period July 1, 2022 to June 30, 2023:

- **Heat-related mortality, air conditioning and inequality in the US**. The project aims to estimate 1) nationwide U.S. county-level air conditioning use, 2) the extent to which air conditioning use reduces heat-related mortality, and 3) race/ethnicity and income disparities in heat-related mortality reduction.
    - Team: **Kai Chen, PhD**, **Narasimha D. Rao, PhD** (Yale School of the Environment), and **Robert Dubrow, MD, PhD**
    - Total costs for project period: $80,000
- **Healthcare organization greenhouse gas emissions accounting tool for strategic management**. The project aims to develop a carbon accounting tool to aid healthcare organizations in tracking and strategically managing their carbon emissions.
    - Team: **Jodi Sherman, MD**, Michael Oristaglio, PhD (Yale Department of Earth & Planetary Sciences), Robert Klee, PhD, JD (Yale School of the Environment), Matthew Eckelman, PhD (Northeastern University – College of Engineering)
    - Total costs for project period: $80,000
- **Activating tenants to advocate for energy justice: barriers and solutions**. Using community based, participatory methods, and partnering with local organizations, the project will learn from low-income renters in New Haven about barriers to tenant engagement around energy efficiency, and what could motivate them to engage and advocate, both for upgrades for their own homes and for the larger community.
    - Team: **Annie Harper, PhD** (Yale School of Medicine); **Laura Bozzi, PhD**; **Krystal Pollitt, PhD** (Yale School of Public Health); **Narasimha D. Rao, PhD** (Yale School of the Environment)
    - Total costs for project period: $71,675
- **Building a digital repository to strengthen the structure for community-engaged research on people and the environment in New Haven**. The project will create a digital repository of research conducted by Yale faculty and students involving people and the environment in New Haven over the last 10 years and will strengthen the structures for Yale faculty and students to carry out the principles of community-engaged research and measure its impact.
    - Team: Kristin Barendregt-Ludwig, M.Ed (Yale Center for Environmental Justice); **Laura Bozzi, PhD**; **Gerald Torres, JD** (Yale Center for Environmental Justice); Paul Sabin, PhD (Yale Department of History); Colleen Murphy-Dunning, M.S. (Yale's Hixon Center for Urban Ecology; Urban Resources Initiative)
    - Total costs for project period: $29,500

Other grants and contracts

- **Yale-China Training Program in Climate Change and Health**. This program is a partnership with the China National Institute of Environmental Health (NIEH) at the Chinese Centers for Disease Control and Prevention. YCCCH will train one researcher (either a postdoctoral fellow or senior visiting scientist) per year from NIEH. The first Li Foundation Climate Change Fellow will be Dr. Jie Ban, who will join YCCCH in November 2022.
    - Principal Investigators: Kai Chen, PhD; Robert Dubrow, MD, PhD
    - Funder: Li Foundation

    - Project period: 10/01/2021-09/30/2024, with the possibility of extension to 09/30/2026
    - Total costs for project period: $208,067, with the possibility of an additional $150,323
- **Environmental justice: tools, processes and protocols supporting credible measurement**. This project is a partnership with Resources for the Future, New York City Environmental Justice Alliance, Northeastern University, and the University of California at Davis Institute of Transportation Studies. The project is assessing the environmental justice implications with regard to air quality of New York State climate policy proposals under the Climate Leadership and Community Protection Act.
    - Yale Team: Kai Chen, PhD (Principal Investigator); Robert Dubrow, MD, PhD; Michelle Bell, PhD
    - Funder: Environmental Defense Fund via sub-contract from Resources for the Future
    - Project period: 07/01/2021-04/30/2022
    - Total costs for project period: $100,000

Publications

The following relevant articles were published by core program faculty during the period of this annual report:

- Yoo EH, Eum Y, Gao Q, **Chen K.** Effect of extreme temperatures on daily emergency room visits for mental disorders. Environ Sci Pollut Res Int. 2021 Aug;28(29):39243-39256
- Sun Z, Wang Q, Chen C, Yang Y, Yan M, Du H, **Chen K,** Ji JS, Li T. Projection of temperature-related excess mortality by integrating population adaptability under changing climate - China, 2050s and 2080s. China CDC Wkly. 2021 Aug 13;3(33):697-701.
- Phung DT, Warren JL, Chu CM, **Dubrow R**. Relationship between flood severity and risk of hospitalisation in the Mekong River Delta of Vietnam. Occup Environ Med. 2021 Sep;78(9):676-678.
- Braneon C, Field R, Seto E, **Chen K,** McConnell K, Robinson L, Richardson S. Towards disentangling lockdown-driven air quality changes in the Northeastern U.S. J Extreme Events. 2021 Sep;08(02):2150017
- Wang Y, Hu J, Zhu J, Li J, Qin M, Liao H, **Chen K,** Wang M. Health burden and economic impacts attributed to PM2.5 and O3 in China from 2010 to 2050 under different representative concentration pathway scenarios. Resour Conserv Recycl. 2021 Oct;173:105731.
- Chu L, Du H, Li T, Lu F, Guo M, **Dubrow R, Chen K**. Short-term associations between particulate matter air pollution and hospital admissions through the emergency room for urinary system disease in Beijing, China: A time-series study. Environ Pollut. 2021 Nov 15;289:117858.
- Li J, Huang L, Han B, van der Kuijp TJ, Xia Y, **Chen K**. Exposure and perception of PM2.5 pollution on the mental stress of pregnant women. Environ Int. 2021 Nov;156:106686.
- Romanello M, McGushin A, Di Napoli C, Drummond P, Hughes N, Jamart L, Kennard H, Lampard P, Solano Rodriguez B, Arnell N, Ayeb-Karlsson S, Belesova K, Cai W, Campbell-Lendrum D, Capstick S, Chambers J, Chu L, Ciampi L, Dalin C, Dasandi N, Dasgupta S, Davies M, Dominguez-Salas P, **Dubrow R,** Ebi KL, Eckelman M, Ekins P, Escobar LE, Georgeson L, Grace D, Graham H, Gunther SH, Hartinger S, He K, Heaviside C, Hess J, Hsu SC, Jankin S, Jimenez MP, Kelman I, Kiesewetter G, Kinney PL, Kjellstrom T, Kniveton D, Lee JKW, Lemke B, Liu Y, Liu Z, Lott M, Lowe R, Martinez-Urtaza J, Maslin M, McAllister L, McMichael C, Mi Z, Milner J, Minor K, Mohajeri N, Moradi-Lakeh M, Morrissey K, Munzert S, Murray KA, Neville T, Nilsson M, Obradovich N, Sewe MO, Oreszczyn T, Otto M, Owfi F, Pearman O, Pencheon D, Rabbaniha M, Robinson E, Rocklöv J, Salas RN, Semenza JC, **Sherman J**, Shi L, Springmann M, Tabatabaei M, Taylor J, Trinanes J, Shumake-Guillemot

J, Vu B, Wagner F, Wilkinson P, Winning M, Yglesias M, Zhang S, Gong P, Montgomery H, Costello A, Hamilton I. The 2021 report of the Lancet Countdown on health and climate change: code red for a healthy future. Lancet. 2021 Oct 30;398(10311):1619-1662. Erratum in: Lancet. 2021 Dec 11;398(10317):2148.

- **Bozzi L, Dubrow R.** 2021. Climate change and health in Connecticut: 2020 report. *Connecticut Medicine*, 85(2), 49-54.
- **Carrión D,** Belcourt A, Fuller CH. Heading upstream: Strategies to shift environmental justice research from disparities to equity. Am J Public Health. 2022 Jan;112(1):59-62.
- Chong KC, Chen Y, Chan EYY, Lau SYF, Lam HCY, **Wang P,** Goggins WB, Ran J, Zhao S, Mohammad KN, Wei Y. Association of weather, air pollutants, and seasonal influenza with chronic obstructive pulmonary disease hospitalization risks. Environ Pollut. 2022 Jan 15;293:118480.
- Gao Q, Zang E, Bi J, **Dubrow R,** Lowe SR, Chen H, Zeng Y, Shi L, **Chen K.** Long-term ozone exposure and cognitive impairment among Chinese older adults: A cohort study. Environ Int. 2022 Feb;160:107072.
- Jin Z, Ma Y, Chu L, Liu Y, **Dubrow R, Chen K.** Predicting spatiotemporally-resolved mean air temperature over Sweden from satellite data using an ensemble model. Environ Res. 2022 Mar;204(Pt A):111960.
- Yoo E-H, Roberts JE, Eum Y, Li X, Chu L, Wang P**, Chen K**. Short-term exposure to air pollution and mental disorders: a case-crossover study in New York City. Environ Res: Health. 2022 April.
- Chu L, Phung D, Crowley S, **Dubrow R**. Relationships between short-term ambient temperature exposure and kidney disease hospitalizations in the warm season in Vietnam: A case-crossover study. Environ Res. 2022 Jun;209:112776.
- Ni W, Schneider A, Wolf K, Zhang S, **Chen K,** Koenig W, Peters A, Breitner S. Short-term effects of cold spells on plasma viscosity: Results from the KORA cohort study in Augsburg, Germany. Environ Pollut. 2022 Jun 1;302:119071.
- Alahmad B, Vicedo-Cabrera AM, **Chen K,** Garshick E, Bernstein AS, Schwartz J, Koutrakis P. Climate change and health in Kuwait: Temperature and mortality projections under different climatic scenarios. Environ Res Lett. 2022 Jun 14;17(7):074001.
- Wu Y, Zhang T, Ye Z, **Chen K**, Kuijp Jvd, Sun X, Han G, Zhao Y, Liu Y, Huang L. Public anxiety through various stages of COVID-19 coping: Evidence from China. PLOS ONE. 2022 Jun 16;17(6):e0270229.
- **Wang P**, Asare E, Pitzer VE, **Dubrow R, Chen K.** Associations between long-term drought and diarrhea among children under five in low- and middle-income countries. Nat Commun. 2022 Jun 30;13(1):3661.

Other Research Highlights

- *Lancet Countdown on Health and Climate Change*

The Lancet Countdown is an international collaboration that produces an annual report, published in *The Lancet*, that tracks indicators of global progress (or lack of progress) on climate change and health. Since 2018, Yale, represented by YCCCH, has been a member of the collaboration. Drs. Dubrow and Sherman were among the co-authors of the 2021 report, contributing indicators on (1) mitigation in the healthcare sector and (2) air conditioning: benefits and harms. Drs. Sherman and Bozzi served as reviewers for the ancillary 2021 Lancet Countdown on Health and Climate Change Policy Brief for the United States of America. YCCCH also hosted the Yale Launch Event for the 2021 Report of the Lancet Countdown on November 18, 2021, with virtual and in-person participation.

- *Conference on* Climate Change and Health in Small Island Developing States: Focus on the Caribbean, held virtually October 5-8, 2021

Although the Caribbean islands have made negligible contributions to the world's greenhouse gas emissions, due to their propensity to be hit by hurricanes, which are becoming more intense due to climate change, and accelerating sea level rise, also caused by climate change, these mostly underdeveloped islands, with very limited resources, are among the most vulnerable countries/territories in the world to the adverse effects of climate change, posing monumental public health challenges. Consequently, and because the Caribbean is in our "backyard," YCCCH has made the Caribbean our top global priority, with this conference being our first significant activity. YCCCH served as a lead organizer for the conference, in partnership with more than 25 international, U.S., and Caribbean organizations. More than 1,200 attendees from 84 different countries registered for the conference. A primary output from the conference will be an action-oriented research agenda for climate change and health in the Caribbean. This agenda is being finalized by an entity that emerged from the conference organizing: the Research for Action on Climate Change and Health in the Caribbean Project, which includes YCCCH, Earth Medic / Earth Nurse (a non-governmental organization based in Trinidad), the Pan American Health Organization, The University of the West Indies, and Emory University. The process of finalizing the agenda, which is scheduled to be completed in March 2023, has included consultations with non-governmental and governmental organizations in the Caribbean. Once completed, the agenda will be disseminated in a report for the general public and policymakers and in a peer-reviewed publication.

The conference sessions were recorded and are available on the YCCCH YouTube page (links: Day 1; Day 2; Day 3; Day 4).

The following funders made the conference possible: The Edward J. and Dorothy Clarke Kempf Memorial Fund, the Council on Latin American & Iberian Studies at The Whitney and Betty MacMillan Center for International and Area Studies at Yale, the Burroughs Wellcome Fund, the European Union, the University of Pittsburgh Graduate School of Public Health, Emory University Rollins School of Public Health, the Yale Institute for Global Health, the Inter-American Development Bank, and the Guardian Group Charitable Foundation.

- Yiqun Ma, YCCCH Pre-doctoral Fellow, awarded the *2021 American Geophysical Union Fall Meeting Outstanding Student Presentation Award*

Ms. Ma's presentation was on the *Nature Communications* paper, "Role of meteorological factors in the transmission of SARS-CoV-2 in the United States," co-authored with Drs. Kai Chen and Robert Dubrow of YCCCH, and Drs. Sen Pei and Jeffrey Shaman from the Mailman School of Public Health at Columbia University.

- Dr. Chen awarded the *YSPH Research Award: Early Career Investigative Award*

In May 2022, Dr. Chen received this award for the paper in *Nature Communications* entitled "Role of meteorological factors in the transmission of SARS-COV-2 in the United States," which set the standard for research examining the relationship between meteorological variables and SARS-CoV-2 transmission. The findings indicated that cold and dry weather and low levels of UV radiation are moderately associated with increased SARS-CoV-2 transmission in the U.S., with specific humidity playing the greatest role. This article has received considerable attention. According to Almetric, it is in the 99th percentile of articles of a similar age in all journals.

- Dr. Chen appointed to the Wai Tsi Institute at Yale

In June 2022, Dr. Chen was appointed a member of the Wai Tsi Institute at Yale. The institute includes researchers from natural, social, computational, and engineering sciences. Dr. Chen's work on "understanding the potential independent and joint effects of climate-related exposures, such as extreme heat and increased levels of air pollution, on cognitive functions" aligns well with the institute's interdisciplinary study of human cognition. Dr. Chen notes that he hopes "to connect and collaborate with Yale experts on neuroscience and cognition and work together...to better understand the biological and socio-behavioral processes related to climate change, extreme weather, and air pollution that affect brain health."

- Dr. Carrión featured in the National Institute of Environmental Health Sciences *Global Environmental Health Newsletter*

Dr. Carrión's research on "the stove use discontinuance framework" in Ghana was highlighted. The article, "For insight into cookstove use, researchers turn to behavioral science," was published in the February 2022 issue.

- Yale news outlets featured YCCCH research

YCCCH faculty and their research were featured periodically in Yale news outlets. For instance, YSPH reported on a study published in *Nature Communications* by Drs. Wang, Chen, Dubrow, and others in a news article, "Drought linked to higher diarrhea risk in children," and the Yale Daily News featured a study by Drs. Chen, Dubrow, and others on an association between long term ozone exposure and cognitive decline in a cohort of older Chinese adults in the article, "Yale study links ozone exposure to cognitive decline in older adults."

Yale Program on Healthcare Environmental Sustainability

The Yale Program on Healthcare Environmental Sustainability (Y-PHES), led by Dr. Jodi Sherman, is housed within YCCCH. The health sector is a leading emitter of greenhouse gas and non-greenhouse gas pollution. Y-PHES seeks to improve the environmental performance of the healthcare sector by a) quantifying its environmental impacts to aid decision-making and b) designing and testing interventions to reduce unnecessary resource consumption, waste, and greenhouse gas emissions. The program is a partnership among the Schools of Public Health, Nursing, and Medicine, working in close collaboration with Yale-New Haven Health System.

The following articles were published by program faculty during the period of this annual report:

- Andersen M, Nielsen OJ. **Sherman JD**. The global warming potentials for anesthetic gas sevoflurane need significant corrections. Environ. Sci. Technol. 2021 July 55(15):10189–10191.
- Wang EY, Zafar JE, Lawrence CM, Gavin LF, Mishra S, Boateng A, Thiel CL, **Dubrow R**, **Sherman JD**. Environmental emissions reduction of a preoperative evaluation center utilizing telehealth screening and standardized preoperative testing guidelines. Resources, Conservation and Recycling 2021 Aug;171:105652.
- **Sherman JD**, McGain F, Lem M, Mortimer F, Jonas WB, MacNeill AJ. Net zero healthcare: a call for clinician action. BMJ 2021 Sep;374:n1323.
- Gordon IO, **Sherman JD,** Leapman M, Overcash M, Thiel CL. Life cycle greenhouse gas emissions of gastrointestinal biopsies in a surgical pathology laboratory. Am J Clin Pathol. 2021 Sep 8;156(4):540-549.
- Senay E, Bernstein A, Shephard P, Salas R, Rizzo A, **Sherman JD,** Richardson L, Butts G, Marwah H, Solomon C, Galvez M, Thanik E, Pezeshki G, Zajac L, Lee A, Sheffield P, Wright R. Improving patient outcomes in the dual crises of climate change and COVID-19:

Proceedings of the Third Annual Clinical Climate Change Meeting, January 8, 2021. J Occup Environ Med. 2021 Nov 1;63(11):e813-e818.

- White SM, Shelton CL., Gelb AW, Lawson C, McGain F, Muret J, **Sherman JD**, representing the World Federation of Societies of Anaesthesiologists Global Working Group on Environmental Sustainability in Anaesthesia. Principles of environmentally-sustainable anaesthesia: a global consensus statement from the World Federation of Societies of Anaesthesiologists. Anaesthesia. 2021 Nov; 77(2):201–212.
- Senay E, Cort T, Perkison W, Laestadius JG, & **Sherman JD.** What can hospitals learn from The Coca-Cola Company? Health care sustainability reporting. NEJM Catalyst. 2022 Mar;3(3).
- Devlin-Hegedus JA, McGain F, Harris, RD, **Sherman JD**. Action guidance for addressing pollution from inhalational anaesthetics. Anaesthesia. 2022 June;77(9):1023-1029.
- **Sherman JD**, Chesebro BB. Inhaled anaesthesia and analgesia contribute to climate change. BMJ 2022 June;377:o1301.

Y-PHES Events & Research Highlights

- *Care Without Carbon – The Road to Net Zero Healthcare: Measure, Manage, Lead*

The second annual Yale University sustainability in healthcare symposium was co-hosted by Y-PHES and Yale Center for Business and the Environment (CBEY) on March 18, 2022. There were 502 registrants. Recording of the symposium is available here. Topics included:

- Materiality and risk
- Reporting standards and metrics development
- Emerging disclosure regulations and standards
- ESG: the financial implications of sustainability in healthcare delivery
- Governance and management of sustainability: case study examples
- Quality and safety of care, health equity, and carbon mitigation – data-driven solutions and change management

- *Lancet Planetary Health Commission on Sustainable Healthcare (LPHCSH)*

The LPHCSH is a global commission dedicated to facilitating a rapid transition to low-carbon, sustainable, resilient health systems. It is led by a partnership between Dr. Sherman, Lancet Planetary Health, and Andrea MacNeill, MD (Clinical Associate Professor of Surgery, University of British Columbia; Director, UBC Planetary Healthcare Lab).

Climate Change and Health Pilot Research Grant

In January 2022, YCCCH held a meeting with its Affiliated Faculty members and facilitated discussions about how YCCCH could better support their collaborative research on climate change and health. Informed by that feedback, we revised the YCCCH pilot research grant program to make available more seeds grants (up to $10,000 per project, with a total funding pool of up to $50,000 in 2022) and to simplify the administrative burden on applicants.

In 2022, one project was selected for a $10,000 grant:

- Title: Ambient temperature during pregnancy and risk of childhood leukemia
- Co-principal investigators: Tormod Rogne, MD, PhD, Assistant Professor (Chronic Disease Epidemiology), YSPH; Xiaomei Ma, PhD, Professor (Chronic Disease Epidemiology), YSPH; Nicole Deziel, PhD, Associate Professor (Environmental Health Sciences), YSPH
- Abstract: There is increasing awareness of how ambient temperatures during pregnancy affects the risk of adverse birth outcomes. However, very little is known about the longer-term consequences for the offspring due to prenatal exposure to extreme ambient

temperatures. We aim to conduct the first study to evaluate the association between ambient temperature during pregnancy and risk of childhood acute lymphoblastic leukemia (ALL). We propose to conduct a nested case-control study of childhood ALL (age 0-14 years) within a birth cohort from California. By linking cancer diagnoses reported to the California Cancer Registry from 1988-2015 and statewide birth records from 1978-2015, we have established a large, population-based California Linkage Study of Early-Onset Cancers. With 6,340 primary cases of childhood ALL and 50 times as many controls (n = 317,000), this study population is the largest of its kind, and offers a unique opportunity to evaluate whether ambient temperature in pregnancy is associated with offspring risk of childhood ALL. The pilot funding will be used to estimate ambient temperature exposure of the study population during pregnancy, using geocoded maternal address at the time of the child's birth. Different sensitive windows during pregnancy will be explored, in addition to one month pre-conception (assumed to have no direct effect on ALL other than through correlation with temperature in early pregnancy). It is key to understand what factors contribute to the likelihood of developing childhood ALL so that appropriate mitigation strategies may be put in place.

In 2019, we issued a pilot research grant to Drs. Michelle Bell and Joshua Warren for a project entitled, "Exposure to greenspace and risk of hospital admissions under a changing climate." We are pleased to identify the following publication resulting from the pilot grant:

- Heo S, Chen C, Kim H, Sabath B, Dominici F, Warren JL, Di Q, Schwartz J, Bell ML. Temporal changes in associations between temperature and hospitalizations by greenspace: Analysis in the Medicare population in 40 U.S. northeast counties. Environment International 2021 Nov;156:1006737.

Education

In 2021-22, YCCCH enrolled the second cohort of MPH students into its Climate Change and Health Concentration. YCCCH continued to offer three climate change and health courses, with its clinic course offered in both semesters. Our courses are popular choices not only with MPH students from a range of departments, but also with students from Yale School of the Environment. We also continued to offer our online program for working professionals.

Climate Change and Health Concentration for MPH Students

Concentrations are cross-departmental programs, with specific requirements, that are open to all MPH students, regardless of department. Dr. Carrión has assumed the role of director of the Climate Change and Health Concentration. The course requirements are as follows:

- EHS 547, Climate Change and Public Health
- EHS 560, Methods in Climate Change and Health Research OR EMD 570 Ethical Issues in Global Public Health: Practice, Research and Policy
- EPH 555, Clinic in Climate Justice, Law, and Public Health
- EPH 570/571, Seminar in Climate Change and Health (must be taken twice)
- Two courses from an approved list of electives

It is also recommended that students complete a thesis with a substantive focus on climate change and health and a summer internship related to climate change and health.

In May 2022, our first cohort of three students from the Class of 2022 graduated from YSPH having completed the Climate Change and Health Concentration. The concentration expanded fourfold with the acceptance of 13 students into the concentration from the Class of 2023.

EHS 547: Climate Change and Public Health

This course is the foundational climate change and public health course offered at YSPH. Developed and taught by Dr. Dubrow, it is a required course for concentration students, as well as a course that is open to other students at YSPH and to students across the university. In Spring 2022, 21 students enrolled in the course.

The following is the course description:

> This course takes an interdisciplinary approach to examining relationships between climate change and public health. After placing climate change in the context of the Anthropocene, planetary boundaries, and planetary health, and exploring the fundamentals of climate change science, the course covers impacts of climate change on public health, including extreme heat, wildfires, hurricanes and flooding, vector-borne diseases, population displacement, and mental health effects. The course covers the public health strategies of adaptation (secondary prevention) and mitigation (primary prevention) to reduce adverse health impacts of climate change and discusses the substantial non-climate immediate health benefits of these strategies. Policy, vulnerability, and climate justice considerations are integrated into the course throughout. The course is reading-intensive and makes ample use of case studies. This course should be of interest to students across YSPH and the University.

See the course syllabus here.

EHS 560/ ENV 606: Methods in Climate Change and Health Research

This course, offered by Dr. Chen, is a required course for concentration students and an important component of the course sequence for doctoral students working with YCCCH faculty. In Fall 2021, 15 students took the course. The following is the course description:

Climate change is recognized as one of the greatest public health challenges of the twenty-first century. This course takes multidisciplinary approaches to identify, assess, quantify, and project public health impacts of climate change and of measures to address climate change. It first introduces the fundamental principles of health impact assessment and gives a brief overview of the public health approaches to address climate change. Then it applies advanced data analysis methodologies in environmental epidemiology, including time-series analysis, spatial epidemiology, and vulnerability assessment, to characterize the present climate-health (exposure-response) relationships and to identify vulnerable populations. The course discusses key concepts of scenario-based climate projections and their applications in projecting future health impacts, evaluating health co-benefits of climate mitigation polices, and assessing climate change adaptation measures. Emphasis is placed on hands-on computer lab exercises with real-data examples and R scripts.

See the course syllabus here.

EPH 555/ ENV 959: Clinic in Climate Justice, Law, and Public Health

As in 2020-21, we offered this course jointly with Vermont Law School (VLS), with Yale students participating in person and VLS students participating remotely. Dr. Bozzi co-taught the course, which is required for concentration students, with Ms. Amy Laura Cahn, a VLS visiting professor and Director of the VLS Environmental Justice Clinic. Ms. Cahn brought both strong community lawyering and environmental justice experience.

The following is the course description:

> This course is an innovative collaboration between Yale School of Public Health and Vermont Law School and includes faculty and students from both Yale and Vermont Law School. In the course, interdisciplinary student teams carry out applied projects at the intersection of climate justice, law and public policy, and public health. Each team works with a partner organization (e.g., state agency, community organization, other nongovernmental organization) to study, design, and implement a project, typically through community-based participatory research practices. The course affords the opportunity to have a real-world impact by applying concepts and competencies learned in the classroom. Class sessions and team meetings are conducted using a hybrid approach that combines in-person, all-virtual, and virtually connected classroom arrangements. This course should be of interest to graduate and professional students across the University and is open to Yale College juniors and seniors. In addition, this course is one of the options available to students to fulfill the practice requirement for the M.P.H. degree at YSPH and the capstone requirement for the M.E.M. degree at YSE. Students who plan to enroll must complete an application, which will be used to match each student with a clinic project. Check the course's Canvas site or contact the Yale instructor at laura.bozzi@yale.edu for more information.

For the 2021-22 academic year, the faculty revised the course to center community-engaged research and lawyering, thanks to a 3-year $189,700 grant awarded by the *SNF Fund for the Integration of Theory and Practice* through the Yale Law School. The clinic was offered in both the fall and spring terms, with two academic-year-long projects with greater involvement than in previous years of the community partners and stakeholders.

Eleven students (six Yale students) took the course in the fall term and eleven students (seven Yale students) took the course in the spring term. The 2021-22 projects were:

Project Title	**Organizational Partner**
Energy Justice and Health in a Changing Climate (project descriptions: Fall, Spring)	Operation Fuel (Hartford, Connecticut)
Using Local Law to Protect Communities from Cumulative Impacts (project descriptions: Fall, Spring)	Public Interest Law Firm (Philadelphia, PA)

See the fall semester syllabus here and the spring semester syllabus here.

YCCCH has set a goal of real-world impact from the clinic projects. We do this through developing trusted partnerships with non-profit or government partners; sharing clinic project findings with policymakers, study participants, residents, and researchers; and continuing project implementation even after the semester project has ended. The following are examples of real-world impact:

- A 2019-20 clinic project, "Scoping and recommendations for the development of a Connecticut Environmental Justice Mapping Tool," in partnership with the Connecticut Department of Energy and Environmental Protection, informed a Connecticut Governor's Council on Climate Change recommendation, and ultimately, the funding to launch the development of the Tool in October 2021.
- In October 2021, a coalition of environmental justice, animal rights, and community organizations delivered to the California Air Resources Board a petition first drafted by clinic students in spring 2021. The petition identifies how the state's Low Carbon Fuel Standard overstates the climate benefits of methane gas from factory farms and illegally disregards disproportionate impact of the dairy digesters on low-income communities and communities of color.
- In December 2021, we released "Community centered climate resilience in Connecticut: Summary for communities and policymakers," which summarized a Spring 2021 clinic project in collaboration with the Connecticut Governor's Council on Climate Change. The report was covered in a Yale School of the Environment news release and has since been cited in a Connecticut climate resilience policy guidance document.
- A Fall 2021 team worked with the Public Interest Law Center in Philadelphia to draft the proposed Community Health Act for the City of Philadelphia. The legislation would require the city government to conduct environmental justice mapping in the city, study the cumulative impact of pollutants and other hazards on communities, and incorporate an analysis of those impacts into permitting decisions. Councilmember Helen Gym announced the bill on February 2, 2022; the language reflects the public health and legal research conducted by the student team.
- In April 2022, Connecticut-based non-profit, Save the Sound, released "Climate Action Plan 2022: cut emissions and build a healthy Connecticut." The report originated from a 2020-21 clinic project and collaboration between Save the Sound and YCCCH. The New Haven Register covered the report with a story entitled, "Connecticut should seek zero greenhouse gas emissions by 2050, says study from Yale and Save the Sound."
- In May 2022, YCCCH and Operation Fuel co-hosted a virtual *Town Hall on Energy Insecurity in Connecticut*, in which the student team presented their interim findings on the health and well-being impacts of energy insecurity on low-income Connecticut residents.

Over 100 people attended, including state and municipal officials, utility representatives, community organizations, activists, and study participants; the event also was simulcast and recorded on CT-N TV.

EPH 570 and 571: Seminar in Climate Change and Health

During the 2021-22 academic year, we continued to offer our Climate Change and Health Seminar speaker series, which is a required course for concentration students. Students are required to attend the seminar in person, read articles by the seminar speaker, and submit questions in advance. The seminar also is open to the Yale community and the public, either in-person or via Zoom, allowing us to expand our reach to audiences beyond Yale. The speakers and their topics are listed below, and recordings of their seminars are available on our website and YouTube page:

- Dr. Benjamin Zaitchik, Professor, Department of Earth & Planetary Sciences, Johns Hopkins University. Tools for environmentally-informed malaria control in the Western Amazon. [109 virtual attendees]
- Dr. Ana M. Vicedo-Cabrera, Institute of Social and Preventive Medicine & Oeschger Center for Climate Change Research, University of Bern, Switzerland. Attribution of health impacts to climate change. [61 virtual attendees]
- Dr. Diana Hernández, Associate Professor of Sociomedical Sciences, Columbia University Mailman School of Public Health, and Visiting Scholar at the Russell Sage Foundation. Disconnected: Understanding chronic and acute energy insecurity, health impacts and policy options for energy justice. [44 virtual attendees]
- Dr. Narasimha Rao, Associate Professor of Energy Systems, Yale School of the Environment. Household contributions to and impacts from air pollution in India. [34 virtual attendees]
- Dr. Pablo Méndez-Lázaro, Associate Professor, Environmental Health Department, University of Puerto Rico - Medical Sciences Campus. Dust storms, socio-environmental factors, and COVID-19 in Puerto Rico. [47 virtual attendees]
- Dr. Kim Knowlton, Senior Scientist, Natural Resources Defense Council and Assistant Professor, Environmental Health Sciences, Columbia University Mailman School of Public Health. When data isn't enough: Health, science, and climate advocacy. [55 virtual attendees]
- Dr. Laura H. Kahn, Co-Founder, One Health Initiative and Lecturer, Princeton University. A One Health analysis of food safety & security, antimicrobial resistance, and climate change in the 21st Century. [48 virtual attendees]
- Dr. Joshua Warren, Associate Professor of Biostatistics, Yale School of Public Health. Critical window variable selection for mixtures: Estimating the impact of multiple air pollutants on stillbirth. [35 virtual attendees]

Yale Global Initiative on Climate Change and Public Health Ethics

Led by Affiliated Faculty member Dr. Laura Bothwell and sponsored by YCCCH, this seminar series discussed issues at the intersection of climate change and public health ethics, including geoengineering, displaced populations, and the concepts of liberty and rights under a rapidly changing climate and world. Our speakers were:

- Stephen Latham, JD, PhD, Director of the Yale Interdisciplinary Center for Bioethics, Yale University. Geoengineering for climate crisis mitigation: Accountability, transparency and democracy. [52 virtual attendees]
- Laura Bothwell, PhD, Associate Research Scientist in Epidemiology (Microbial Diseases), Yale School of Public Health. Climate change and public health ethics: Our duty to displaced global populations. [47 attendees]

- Bruce Jennings, MA, Adjunct Associate Professor in Health Policy, Vanderbilt University Center for Biomedical Ethics and Society. Rediscovering freedom and rights in a climate changed world. [25 virtual attendees]

YCCCH Student Associates

Student Associates serve one-year terms as ambassadors for YCCCH while engaging with a diverse community of like-minded students. Associates gain broad exposure to issues of climate change and health through small, seminar-style discussions with field experts whom they help to select. Associates also participate in additional programming such as workshops and skill-based training, film screenings, and student-led presentations/discussions. There were 32 Student Associates in the 2021-22 academic year, representing the Schools of Public Health, the Environment, Medicine, and Nursing, as well as Yale College.

The Student Associates program was managed by YCCCH Program Administrator, Mauro-Diaz-Hernandez, along with Student Associates Coordinator Weixi Wu, a second-year MPH student. Student Associates participated in student-led working groups on Film Discussions, Advocacy Workshop, and Social Events. Programming focused on developing key skills students identified as useful in their growth as public health professionals, including:

- A beach cleanup and community outreach event with Save The Sound
- A series of three climate data visualization ArcGIS workshops at the Watson Center
- Lunchtime networking events
- Film screenings and student-led discussions on the films *Kiss the Ground* and *Gather*
- A workshop entitled *Climate Change and Mental Health: A Discussion for Idea Generation and Action*
- Student and recent graduate-led sessions at the YCCCH-sponsored Advocacy Month, including:
    - Isabel Kirsch's "Advocacy in action: Connecting with your legislator for change"
    - Catherine Webb's "A conversation on environmental racism"
    - Irene Vázquez's "Climate storytelling"
- Social events, including local hikes and boba tea gatherings

Additionally, several Student Associates played key roles in assisting with organization and logistics planning for the *Conference on Climate Change and Health in Small Island Developing States: Focus on the Caribbean*. To support the Student Associates' academic and professional development in the field of climate change and health, our mentorship program paired 19 students with experts in the field that worked at local governments, the National Park Service, the Pan American Health Organization, and the American Lung Association, among others.

For 2022-23, we are planning to convert the Student Associates Program into the YCCCH Fellows program, which will engage Yale students in climate change and health- related research, public health practice, communications, and operations through paid fellowship opportunities during the academic year. Fellows will work closely with YCCCH faculty and staff, as well as participate in community-building and educational activities.

Summer Internships in Climate Change and Health

YCCCH continued the expansion of its summer internship program to meet the significant interest in the field of climate change and health. The 2022 program was open to MPH students, YCCCH Student Associates, and undergraduate students in the Environmental Studies major. Through the two-step process we developed, eligible students applied to be matched with one of the summer internship projects, and then the selected students applied for funding from

sources including – but not limited to – YCCCH. YCCCH provided stipends to six students, while all other students secured funding from other Yale sources, which allowed us to expand our program's reach.

To build community, we organized optional weekly lunchtime get-togethers (on Zoom and in-person) for the summer interns, which was particularly important for students interning remotely. As part of the program, all students are expected to participate in an internship colloquium the following fall to report back and reflect on their internship experiences. A recording of the 2021 colloquium is available, and the Fall 2022 colloquium recording will be available on our website and YouTube page in late September 2022. The Summer 2022 students, their host organizations, and internship projects are listed below.

Host organization	**Project title**	**Student**	**Affiliation**
California Department of Public Health – Climate Change and Health Equity Unit	Management and expansion of climate change and health vulnerability indicators for California	Mitchell Manware	MPH, Social and Behavioral Sciences, Climate Change and Health Concentration
Connecticut Institute for Resilience and Climate Adaptation; YCCCH	Municipal tools for extreme heat	Adriana Ballinger	BA, Environmental Studies
Connecticut Department of Public Health	Food security and equity	Emily Goddard	MPH, Social and Behavioral Sciences, Climate Change and Health Concentration
	Private well survey	Maggie Hart	MPH, Social and Behavioral Sciences, Climate Change and Health Concentration
	Climate and health: vulnerable infrastructure	Fintan Mooney	MPH, Environmental Health Sciences
	Environmentally safe housing	Alix Rachman	MPH, Environmental Health Sciences, Climate Change and Health Concentration
	Air quality/extreme heat: educational curriculum	Julia Wang	MPH, Environmental Health Sciences, Climate Change and Health Concentration
Dejusticia	Climate change and human rights litigation research	Sebastian Duque	BA, Environmental Studies and Political Science
Minnesota Department of Public Health's Climate & Health Program	Communications and outreach internship	Matthew Di Vitto	MPH, Environmental Health Sciences
	Communications and outreach internship	Rose Hansen	BS, Environmental Studies
UNICEF	Maternal Newborn Adolescent Health Unit, Health Section, Programme Division	Caroline Helsen	MPH, Social and Behavioral Sciences, Climate Change and Health Concentration
Yale Center on Climate Change and Health	Policy Impact Unit: Building public health capacity to address climate impacts	Noelle Serino	MPH, Social and Behavioral Sciences
Yale Program on Healthcare Environmental Sustainability	Greenhouse gas emissions impacts of pandemic-related telehealth expansion	Ruihan Qin	MS, Biostatistics

Climate Change and Health Pre-Doctoral Fellowships

Our first pre-doctoral fellow, Alyssa Parpia, graduated in May 2022 from the YSPH doctoral program in the Department of Epidemiology of Microbial Diseases. She entered the program with an interest in mathematical modeling of infectious disease risks in relation to climate change. However, her interests broadened to infectious disease modeling in general. The title of her dissertation was "Applications of dynamic modeling and statistical analysis to infectious diseases." After completing her three years of funding by YCCCH, she was funded by other sources. Her dissertation advisor was Dr. Alison Galvani.

Sappho Gilbert, our second pre-doctoral fellow, completed her fifth year. She is interested in the effects of climate change on food security in indigenous Arctic communities, and her dissertation title is “Mapping and monitoring community nutrition in transition in Nunavut, Canada.” In 2021-22, she was supported by a National Institute of Environmental Health Sciences pre-doctoral fellowship award. Her dissertation advisor is Dr. Dubrow.

Lingzhi Chu completed her fourth year. Her dissertation title is “Ambient temperature, humidity, air pollution and renal disease risk.” In 2021-22, she received support from a Dan David Prize Scholarship. Her dissertation advisor is Dr. Dubrow.

Yiqun Ma completed her third year. In October 2021, her dissertation prospectus, entitled “Intersection of air pollution, meteorological factors, and the COVID-19 pandemic: sensitivity and accountability,” was approved with distinction. In 2021-22, she was supported by the China Scholarship Council and by a graduate research assistantship on Dr. Chen’s grant from the Health Effects Institute entitled “Effect of air pollution reductions on mortality during the COVID-19 lockdown: A natural experiment study.” Her dissertation advisor is Dr. Chen.

Chengyi Lin completed her second year. She is interested in the health effects of air pollution. In March 2022, her first-authored paper was published online by *Environmental Research*, entitled “Associations between short-term ambient ozone exposure and cause-specific mortality in rural and urban areas of Jiangsu, China.” Dr. Chen is her advisor.

Online Certificate Program in Climate Change and Health

YCCCH has continued to offer the well-regarded online Climate Change and Health Certificate program for working professionals. The program prepares public health professionals and those in related fields to address the health impacts of climate change and is open to any qualified person in the world. This 18-week program consists of three consecutive six-week courses: *Introduction to Climate Change and Health* (instructor: Robert Dubrow), *Climate Adaptation for Human Health* (instructor: Kathryn Conlon, Assistant Professor, Department of Public Health Sciences, School of Medicine, University of California at Davis), and *Communicating Climate Change and Health* (instructor: Kristin Timm, Research Associate, International Arctic Research Center, University of Alaska at Fairbanks). While focusing on distinct topics, all three courses interweave common themes of climate change health impacts, vulnerability and health equity, and the health co-benefits of mitigation and adaptation.

The curriculum includes video-recorded lectures that students can view at their convenience, readings, quizzes and short assignments, weekly live discussion sessions conducted via Zoom, each with 15 or fewer students, led by a discussion leader (typically a doctoral student), and a concluding assignment for each of the three courses.

We offered the program in September 2021 (Cohort 7) and in March 2022 (Cohort 8). Cohort 7 included 88 students representing 26 countries; Cohort 8 included 79 students representing 14 countries. In student evaluations from both cohorts, 98% would recommend the certificate program to others and 94% rated the program as excellent or very good.

We charged $2,000 for matriculation into the certificate program. Full scholarships, discounts for members of professional organizations, and financial aid were offered. YCCCH received a net income of $90,033 from the Cohort 7 session to support general YCCCH activities. We do not yet know the net income from Cohort 8 because income from this cohort will be applied toward completing a major revision of the program (see below).

The alumni network has continued with active participation. Interested alumni meet via Zoom and share resources via a listserv and a private LinkedIn group. We also have continued to integrate the Certificate alumni into YCCCH programming, including by inviting select alumni to serve as mentors for Student Associates. The impact of our alumni on the field of climate change and health continues to grow. Below is a selection of their professional accomplishments over the last year:

- Maggie Favretti (Cohort 2) – A forthcoming book to be published in Fall 2022, *Beyond Futurephobia: Teaching, Learning and Life in the Age of Climate Disasters*
- Rachel Hale (Cohort 2) – Developed and is now teaching a new online Climate Change and Public Health graduate course in Fall 2022/Spring 2023 at the University of Arkansas for Medical Science, College of Public Health, Department of Environmental Health Sciences
- Elizabeth Bechard (Cohort 1) – Published a book in September 2021 entitled *Parenting in a Changing Climate,* and in January 2022, started a full-time position as a Senior Policy Analyst with Moms Clean Air Force
- Mandi Beavers (Cohort 6) – Serving as the NASA Internships, Fellowships and Scholarships Project Lead for a Climate Change Project at NASA
- Patrice K. Nicholas (Cohort 1) – Director of the Massachusetts General Hospital (MGH) Institute of Health Professions Center for Climate Change, Climate Justice, and Health and a co-planner of MGH's annual Climate Change and Health Symposium
- Noorpreet Kaur (Cohort 2) – Started a new position at the University of Texas Health San Antonio's School of Dentistry as an Assistant Professor in Comprehensive Dentistry. "I look forward to using my new position to conduct research and build more awareness about the impact of climate change by using the research and skills I received through the Yale School of Public Health Climate Change and Health Program. As a dentist, I understand that our service delivery methods affect our environment. I will be focusing on vulnerable populations, socioeconomically disadvantaged groups and how dentistry contributes to climate change in South Texas."
- Pulin Modi (Cohort 6) – New job running campaigns with the nonprofit ParentsTogether. "We're always looking to amplify content and collaborate on ideas where parent and family voices can have an impact. We will definitely be looking into climate and health campaigns."
- Janelle Rosenfeld (Cohort 2) – Founding member of The Valley Fever Citizen's Alliance Group – a group that advocates on behalf of the Valley Fever Center of Excellence at the University of Arizona. "I am happy to announce the Arizona Board of Regents, as part of their 'New Economy Initiatives' program, has granted a two-year, $900,000 investment to the Valley Fever Center of Excellence for the development of precision medicine approaches, drug development, and environmental risk abatement to reduce the financial cost and human burden of Valley Fever. The disease incidence is increasing at an alarming rate and it is directly associated with climate change, rising temperatures, and dry climate in the Southwestern part of the United States."

We are planning a major overhaul of the certificate program in time for Cohort 9 in Spring 2023. The overhaul will update the asynchronous lectures to reflect the most recent science, (inter)governmental and non-governmental organization reports, and relevant climate events since the original recordings. In addition, the lectures and other course materials will have increased relevance to the growing number of global participants by incorporating more climate and health research and related events from across the world.

Coursera Specialization

In September 2019, we launched the three-course Coursera Specialization, *Climate Change and Health: From Science to Action*. Coursera is an online course platform with a large, global reach. The Specialization is an abridged version of the online certificate program that better fits the needs of learners who want an introductory learning experience with a smaller time commitment or who are looking to complete the courses at their own pace. The cost is substantially lower: a three-month Coursera subscription costs $147, and the courses also are free to audit (in this case, the learner does not receive a certificate of completion). In 2021-22, YCCCH's share of the revenue from the Coursera Specialization was $7,362.

Select cumulative statistics (since September 2019) for each of the three courses are as follows:

Course (Instructor)	**Enrollment Statistics**			
	Visitors	**Started course**	**Completed course**	**Average rating**
Introduction to Climate Change and Health (Robert Dubrow)	69,839	12,394	6,599	4.8/5 (based on 632 reviews)
Climate Adaptation for Human Health (Kathryn Conlon)	18,005	1,883	735	4.5/5 (based on 103 reviews)
Communicating Climate Change and Health (Connie Roser-Renouf)	20,662	1,734	705	4.7/5 (based on 92 reviews)

In April 2022, YCCCH discontinued the Coursera Specialization because the content was becoming out-of-date.

Public Health Practice

Policy Impact Unit: Focus on Connecticut

YCCCH continues to operate its Policy Impact Unit, launched in Fall 2020 to leverage YCCCH research and public health practice projects to inform climate policy. The initial focus of the unit, which is led by Dr. Laura Bozzi, YCCCH Director of Programs, is on Connecticut climate mitigation and adaptation policies. In September 2020, we issued *Climate change and health in Connecticut: 2020 report* (*2020 Report*), a first-of-its-kind comprehensive report on climate change and health in Connecticut. In 2021-22, we continued to build upon this report by completing an issue brief series that aligns with the *2020 Report*'s four domains, summarizing the key findings and extending them to include policy recommendations. The first two issue brief were released in 2020-21 followed by issue briefs on *Extreme events and health in Connecticut* and *Vector-borne diseases and health in Connecticut*, which were released in October 2021 and May 2022, respectively. Each issue brief was distributed widely to state legislators and other local and state decision-makers.

The *2020 Report* has become an important resource for the public and decision-makers in Connecticut; from January to July 2022, its webpage had been viewed over 600 times. YCCCH continues to share the report and issue briefs through engagement activities including public presentations, public comment on proposed policy, and media inquiries. For instance, building from the *2020 Report* and issue briefs, YCCCH submitted testimony in support of 2022 Connecticut legislation with important climate, health, and environmental justice benefits: HB 5039 (An Act Concerning Medium and Heavy-Duty Vehicle Emissions Standards), SB 292 (An Act Concerning Heating Efficiency in New Residential Construction and Major Alterations of Residential Buildings), and HB 5285 (An Act Concerning the Public School Curriculum).

In 2021, YCCCH collaborated with the Connecticut Department of Public Health (CT DPH) on a grant application to the Centers for Disease Control and Prevention's funding opportunity, *Building Resilience Against Climate Effects: Implementing and Evaluating Adaptation Strategies that Protect and Promote Human Health*. The application was successful, making Connecticut one of only 11 states and cities to be funded through this program. Over the 5-year grant period, YCCCH will work with CT DPH to launch and implement the state's first climate and health program. In December 2021, the program was expanded to an Office of Climate and Public Health by Governor Lamont's Executive Order 21-3.

YCCCH also works to engage health professionals in climate action. In January 2022, YCCCH co-hosted an online training event, *Climate Change & Our Health: From Education to Action*, with the Connecticut Nursing Association, American Lung Association, and Clean Water Action. There were 111 attendees.

Outreach

YCCCH faculty and staff are frequently asked to speak on climate change and health topics. Below is a selected list of public speaking events and media appearances we engaged in during 2021-22 to educate about climate change and health and propel policy action.

- Dr. Bozzi presented on climate change and health to Connecticut Public Health Association members, July 23, 2021
- Dr. Bozzi gave a guest lecture on climate change and health to all 1st year Quinnipiac University medical students, October 13, 2021
- Dr. Bozzi participated in a panel presentation at the *Climate Change and Insurance Conference*, October 13, 2021

- YCCCH co-sponsored the *Yale Global Environmental Justice Conference*. Dr. Bozzi organized and moderated the panel, "Pathways to a green and just recovery for energy systems, housing, and communities" on October 29, 2021
- Mr. Diaz-Hernandez delivered a presentation on climate change and health in a forum sponsored by the North Haven Clean Energy Task Force on November 8, 2021; the event was also broadcast on North Haven TV
- Dr. Dubrow spoke to third-year Yale medical students and graduating physician assistant students as part of Power Day, November 19, 2021, a day that addresses issues of power and control in healthcare relationships; the title of his talk was "Sustainability leadership in healthcare: Securing the health of current and future generations"
- Dr. Bozzi presented on the Connecticut Climate Crisis Mobilization (C3M)'s Forum on Climate Change and Health, January 16, 2022
- Dr. Bozzi was interviewed by Fox 61 meteorologist Ryan Breton on sea level rise impacts and projections in Connecticut, February 16, 2022
- Mr. Diaz-Hernandez authored a guest article for the Universal Health Care Foundation of Connecticut in April 2022, which connected the history of Earth Day to today's struggle for climate, environmental, and health justice
- YCCCH, with the Schwarzman Center and the Humanities, Arts, and Public Health Practice at Yale (HAPPY) Initiative, co-sponsored a film screening and discussion of *Containment* on April 13, 2022. The film explored the impact of radioactive waste in the United States, and brought filmmaker Peter Galison, nuclear contaminant researcher Dr. Tommy Rock, and research scientist Dr. Katlyn Turner together for a virtual discussion of this issue

Maximizing YCCCH's real-world policy impact

In May 2022, YCCCH held a half-day day internal retreat to identify strategies to maximize the real-world policy impact of our work. Collectively, we identified three topic areas for focused agenda-setting work: (1) Sustainable and equitable cooling, (2) Equitable building electrification, and (3) Healthcare environmental sustainability. Each topic builds on the Center's research strengths and is an area where we believe there is important potential for policy change to improve health and reduce greenhouse gas emissions. We plan to develop our strategic approach for each topic and begin implementation in the 2022-23 program year, including by securing additional funds.

Major 2022-23 Goals

2022-23 will focus on implementing the third year of our four-year strategic plan. Highlights include:

- **Expansion of the Yale MPH Concentration in Climate Change and Health**, with a goal to increase enrollment from 13 in the Class of 2023 to 20 in the Class of 2024
- **Major overhaul of the Online Certificate Program in Climate Change and Health** in time for Cohort 9 in Spring 2023, including updating the lectures with the most recent science and relevant reports and climate events, as well as incorporating a greater global focus into the lectures and other course materials
- **Conversion of the Student Associates Program into the YCCCH Fellows Program**, which will engage Yale students in climate change and health- related research, public health practice, communications, and operations through paid fellowship opportunities during the academic year. Fellows will work closely with YCCCH faculty and staff, as well as participate in community-building and educational activities.
- **Core research faculty will apply for major research grants**, including at least four National Institutes of Health R01 research grants, to support work on topics including health impacts of extreme heat, temperature and air pollution effects on dementia, and the health benefits of building electrification in low-income communities
- **Focused work across YCCCH faculty and staff to maximize our real-world policy impact in three areas: (1) Sustainable and equitable cooling, (2) Equitable building electrification,** and **(3) Healthcare environmental sustainability**. This will include engaging the YCCCH community (Affiliated Faculty, Advisory Board, certificate alumni, and others) in informing the strategy and building partnerships.
- **Fundraising to support our research-to-policy impact work**, including through strategic partnerships with non-governmental organizations
- **Fundraising to support core YCCCH operations and increase YCCCH's endowed funds** by securing major new grants or donations and by actively supporting efforts associated with Yale University's capital campaign