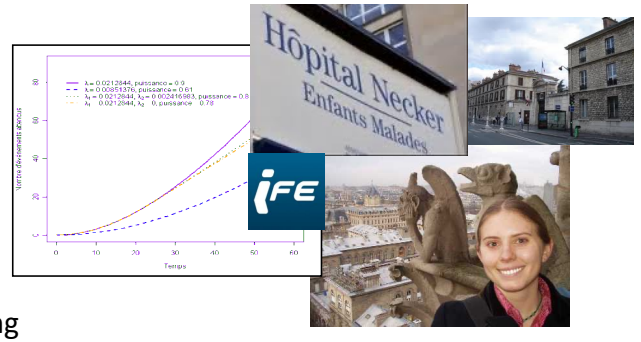
Health co-benefits and disparities in the transition to electric vehicles in California

LA's BeST data analysis project
Summer 2024


Erika Garcia, PhD – Environmental Health
Sandy Eckel, PhD – Biostatistics

LA's BeST @USC

Sandy Eckel - Background



- Academic journey
  - Vassar College math/French double major
    - Junior year abroad in Paris, biostats intern
    - First learned R in 2003, installed via CD (!)
  - JHSPH Biostatistics PhD
    - Mentor: Tom Louis, and worked with: Francesca Domenici, Roger Peng
    - Dissertation included work on NMMAPS: multi-site time-series study of air pollution health effects
  - USC postdoc, mentor: Kiros Berhane
  - USC faculty since 2011 & Director PhD Program in Biostatistics
- I ❤️ teaching data analysis: PM511a (9 years) and PM511c (currently)
- General research area: stats methods and applications for air pollution health effects
- Current research related to climate change and health:
  - Drought: Salton sea (Johnston, Farzan)
  - Decarbonizing medicine (McConnell, Hu, Sharma)
  - EV transition co-benefits (Garcia)
- Future directions of interest
  - Climate change mitigation co-benefits to provide evidence of benefit to public health
  - Methods for intervention studies, large administrative time-series datasets

Erika Garcia – Background

- Assistant Professor of Population and Public Health Sciences (Environmental Health) at the Keck School of Medicine
- PhD in Environmental Health Sciences from UC Berkeley
  - Trained as in Occupational Epidemiology but now work more broadly in Environmental Epidemiology
- Also teach PM617:
  Introduction to Causal Inference in Epidemiology

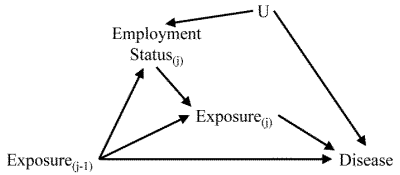
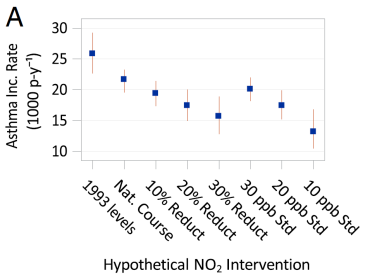


Figure 1. Directed acyclic graph depicting the data structure underlying the healthy worker survivor effect.



Class: Data Science **Methods** for Climate Change **Health** Research

PM599/GEOL499

Goal: provide the framework and tools to empower the next generation of data scientists to improve the future of human health in a changing climate.

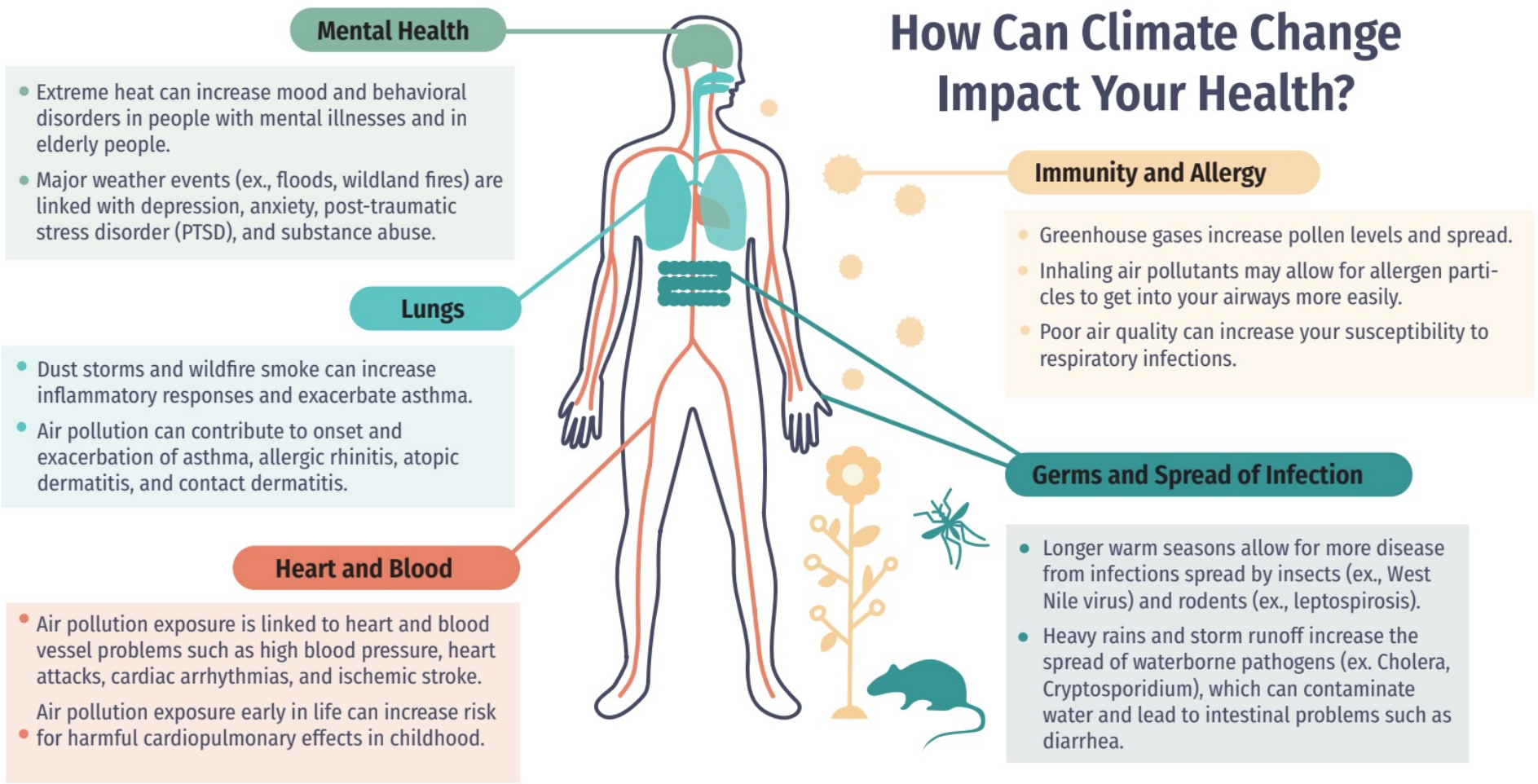
- Introduce data science methods to study the impacts of climate related events on human health.
- Study methods to evaluate evidence for adaptation, co-benefits of mitigation, vulnerability, and attribution.

2023 Sustainability Across the Curriculum New Course Award

2023 DPPHS Chair's Citation on Pedagogical Excellence Award

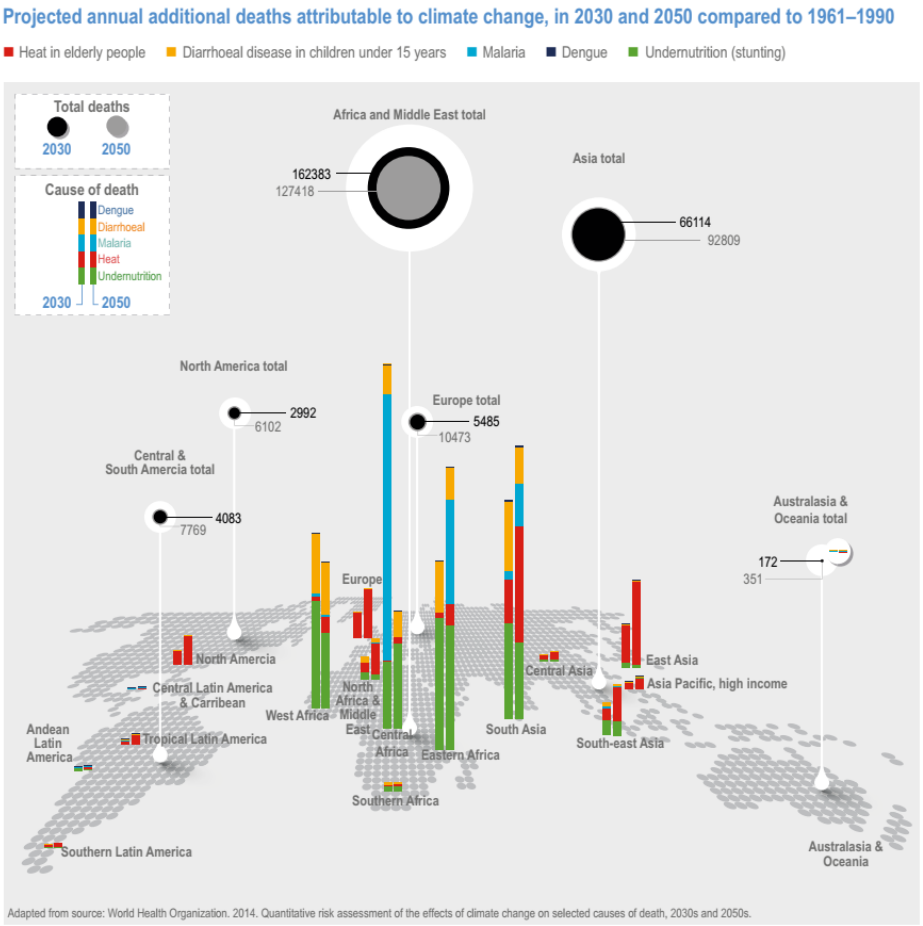
Climate Change and Health

Broad context for this project



Chinthrajah S, Garcia E, Hasan Z, Hy A, Wong L. Climate Change Health Effects and What You Can Do. American Journal of Respiratory and Critical Care Medicine. 2022 Jan 1;205(1):P1-2.

Climate change acts like a stress multiplier



2015 Lancet Commission: "Climate change is the **greatest global health threat** facing the world in the 21st century…"

https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_Chapter07.pdf

"…tackling climate change could be the **greatest global health opportunity** of the 21st century"

"Many **mitigation** and **adaptation** responses to climate change are "no-regret" options, which lead to direct reductions in the burden of ill-health, enhance community resilience, alleviate poverty, and address global inequity. Benefits are realised by ensuring that countries are unconstrained by climate change, enabling them to achieve better health and wellbeing for their populations. These strategies will also reduce pressures on national health budgets, delivering potentially large cost savings, and enable investments in stronger, more resilient health systems."

Watts N, Adger WN, Agnolucci P, Blackstock J, Byass P, Cai W, Chaytor S, Colbourn T, Collins M, Cooper A, Cox PM. Health and climate change: policy responses to protect public health. The Lancet. 2015 Nov 7;386(10006):1861-914.

Climate change mitigation through ***Electrification of transportation***

- Transition to electric vehicles (EVs) is **projected** to have considerable co-benefits for public health
  - Tailpipe-related emissions are key source of harmful ambient air pollutants

- **Question**:
  Are health and air quality co-benefits **detectable** at current relatively low levels of EV adoption?

Study location: California

- California is a leader in EV adoption in the US

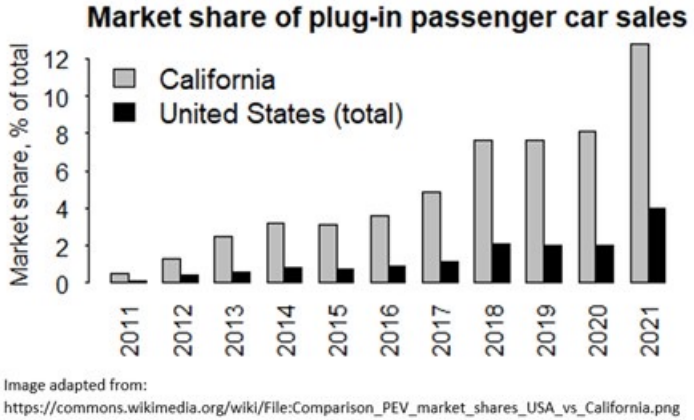
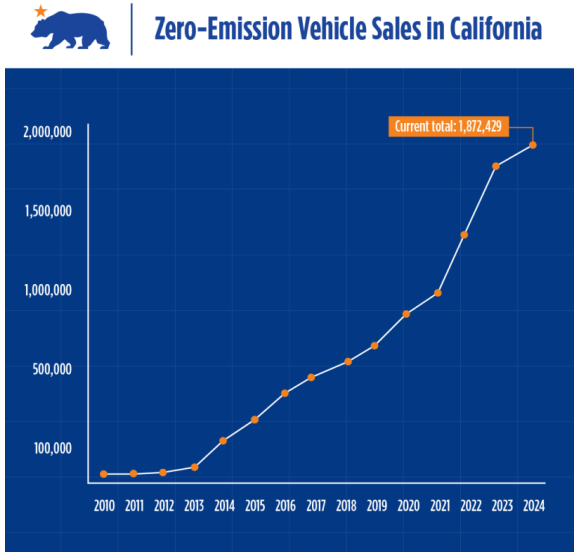


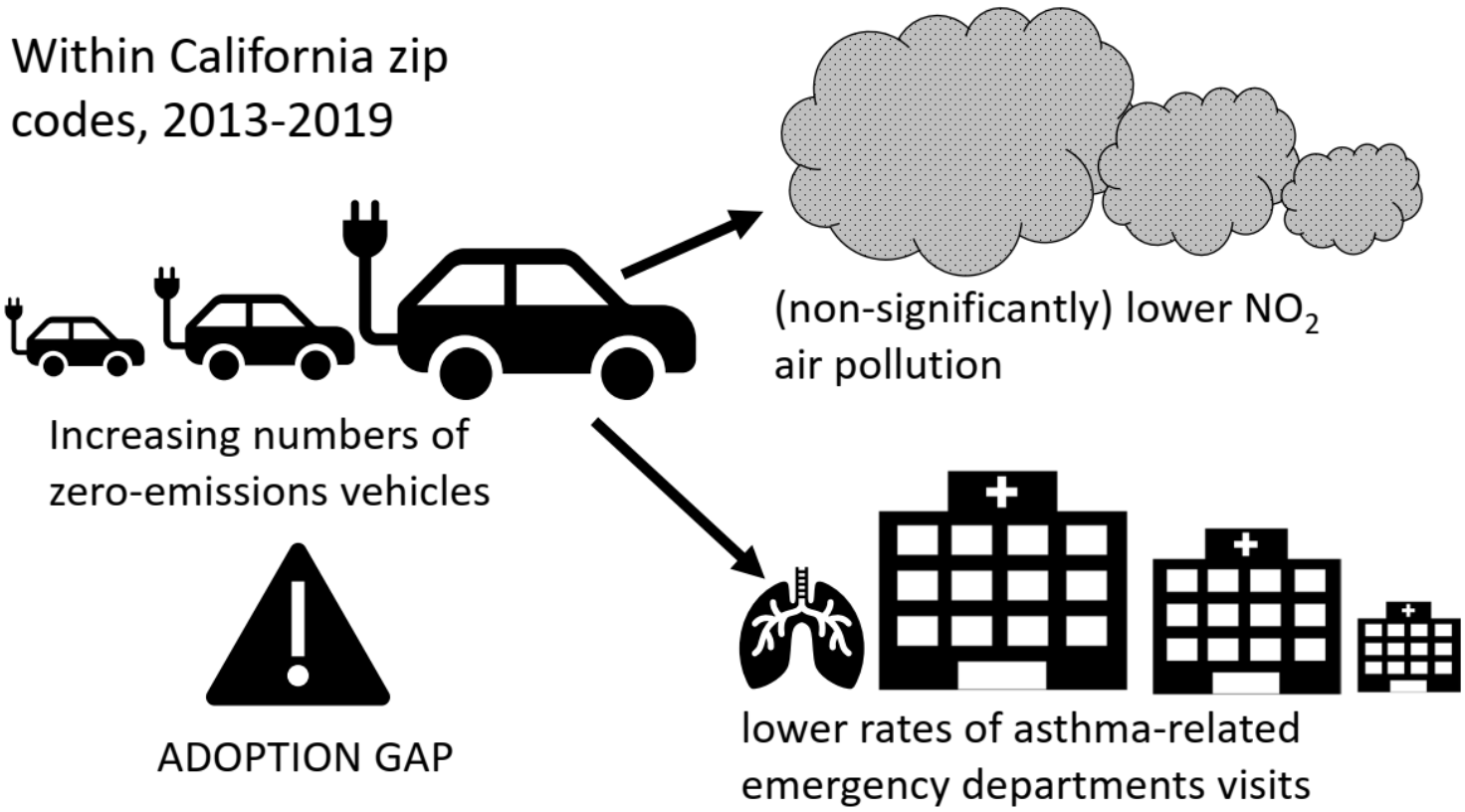
Image adapted from:
https://commons.wikimedia.org/wiki/File:Comparison_PEV_market_shares_USA_vs_California.png



All NEW cars sold in CA by 2035 must be zero-emission vehicles

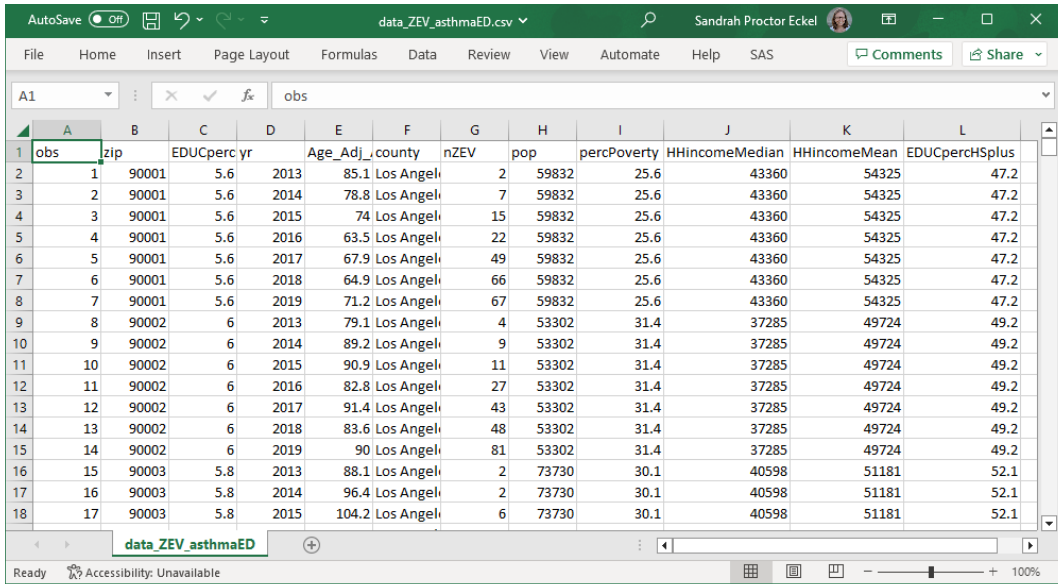
- Global context:
  - **China** largest number, e.g., 2022 sales: ~6 million in China vs 1 million in US
  - **Norway** furthest in transition: EVs 94% of new car registrations in January 2024

Study idea


Within California zip codes, 2013-2019
(non-significantly) lower NO_2 air pollution
Increasing numbers of zero-emissions vehicles
ADOPTION GAP
lower rates of asthma-related emergency departments visits

Data

- Zip code level annual summaries, from 2013-2109 in California
- **Zero Emissions Vehicle registration** data (annual counts) from the California Energy Commission: https://www.energy.ca.gov/zevstats
- **Asthma-related emergency department visits** (annual adjusted rate per 10,000) from California Health and Human Services: https://data.chhs.ca.gov/dataset/asthma-emergency-department-visit-rates
- **Population characteristics** from the American Community Survey (ACS) 5-Year Estimates



	A	B	C	D	E	F	G	H	I	J	K	L
1	obs	zip	EDUCperc	yr	Age_Adj_	county	nZEV	pop	percPoverty	HHincomeMedian	HHincomeMean	EDUCpercHSplus
2	1	90001	5.6	2013	85.1	Los Angel	2	59832	25.6	43360	54325	47.2
3	2	90001	5.6	2014	78.8	Los Angel	7	59832	25.6	43360	54325	47.2
4	3	90001	5.6	2015	74	Los Angel	15	59832	25.6	43360	54325	47.2
5	4	90001	5.6	2016	63.5	Los Angel	22	59832	25.6	43360	54325	47.2
6	5	90001	5.6	2017	67.9	Los Angel	49	59832	25.6	43360	54325	47.2
7	6	90001	5.6	2018	64.9	Los Angel	66	59832	25.6	43360	54325	47.2
8	7	90001	5.6	2019	71.2	Los Angel	67	59832	25.6	43360	54325	47.2
9	8	90002	6	2013	79.1	Los Angel	4	53302	31.4	37285	49724	49.2
10	9	90002	6	2014	89.2	Los Angel	9	53302	31.4	37285	49724	49.2
11	10	90002	6	2015	90.9	Los Angel	11	53302	31.4	37285	49724	49.2
12	11	90002	6	2016	82.8	Los Angel	27	53302	31.4	37285	49724	49.2
13	12	90002	6	2017	91.4	Los Angel	43	53302	31.4	37285	49724	49.2
14	13	90002	6	2018	83.6	Los Angel	48	53302	31.4	37285	49724	49.2
15	14	90002	6	2019	90	Los Angel	81	53302	31.4	37285	49724	49.2
16	15	90003	5.8	2013	88.1	Los Angel	2	73730	30.1	40598	51181	52.1
17	16	90003	5.8	2014	96.4	Los Angel	2	73730	30.1	40598	51181	52.1
18	17	90003	5.8	2015	104.2	Los Angel	6	73730	30.1	40598	51181	52.1

Main analysis goals

- Study trends, patterns, and disparities in ZEV adoption in CA zip codes from 2013-2019

- Relate zip-code level asthma-related emergency department visits to ZEV adoption, accounting for socioeconomic status and calendar year

- **Skills**: visualizations, longitudinal trends, linear regression, longitudinal data analysis, accounting for confounders, acknowledge strengths/limitations of data & study design

For more info

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Short communication

California's early transition to electric vehicles: Observed health and air quality co-benefits

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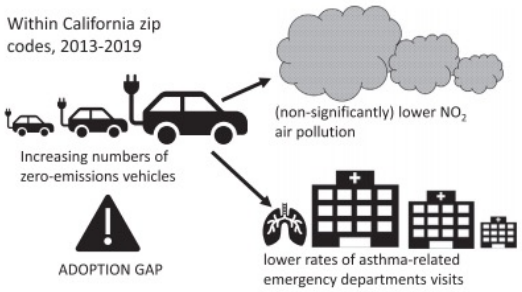
[b] University of Southern California, Suzanne Dworak Peck School of Social Work, Los Angeles, California, United States

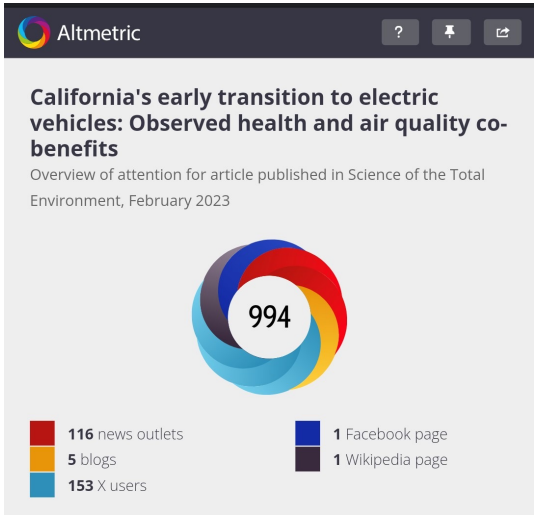
HIGHLIGHTS

- Real-world data use to quantify co-benefits of early electric vehicle transition
- More zero-emissions vehicles non-significantly associated with lower pollution
- Increases in zero-emissions vehicles linked with fewer asthma emergency room visits
- Zero-emissions vehicles adoption gap threatens equitable co-benefits distribution.

GRAPHICAL ABSTRACT



Considerable press coverage



American Lung Association June 2023 report: https://www.lung.org/clean-air/electric-vehicle-report/driving-to-clean-air

Researchers with the Keck School of Medicine of the University of Southern California recently published an analysis of early air quality and health improvements following zero-emission vehicle deployments between 2013 and 2019. The research team analyzed Zip Code level data on vehicle registrations, monitored air pollution concentration and health outcomes to observe changes associated with zero-emission vehicles. Even at relatively low levels of zero-emission technology deployments seen during the study period, researchers found that increased zero-emission vehicle registrations corresponded with reductions in in asthma-induced Emergency Department visits and a suggestive trend towards lower harmful air pollution. A key finding of this study was "adoption gap among populations with lower socioeconomic status," indicating the ongoing need to build equity into zero-emission transportation policy.[4]

Thank you!

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