

Impacts of transitioning to clean household energy

Evidence from policy reform in peri-urban Beijing

Sam Harper

2024-11-21



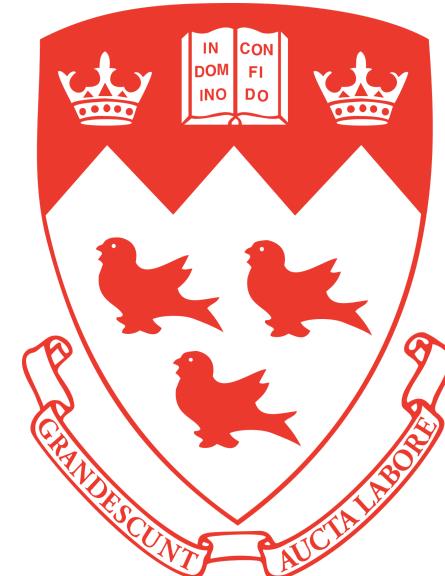
McGill

Department of
Epidemiology, Biostatistics
and Occupational Health

Background

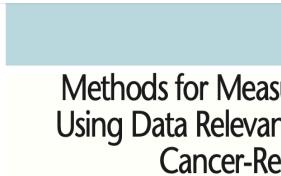
Prior work

- Measuring and monitoring health inequalities
- Analysis and decomposition of life expectancy gaps
- Evaluating the impact of policy interventions



Measurement and analysis of health inequalities

- Methodological development, software, applied analysis

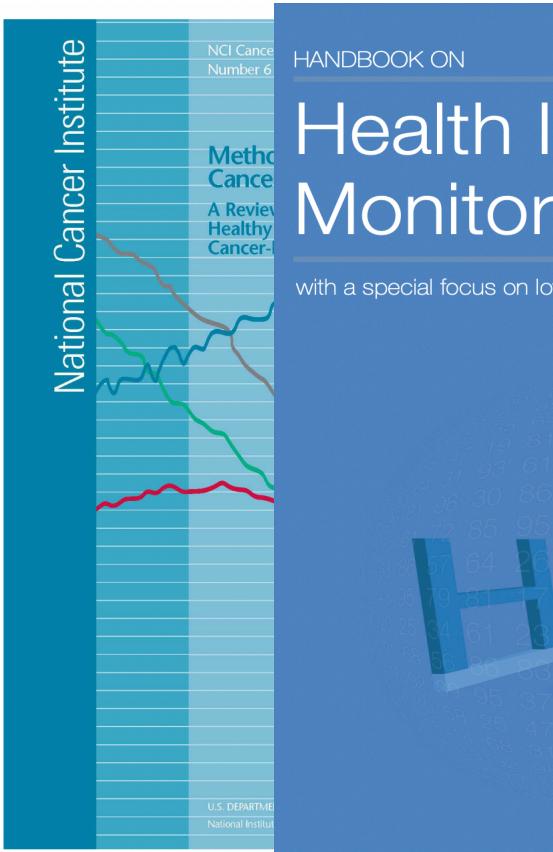


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This report was written under contract from the
Research Program (ARP) of the Division of Cancer
Control and Prevention, National Institutes of Health. Additional support was provided by the Director at the National Institutes of Health.
Health disparities related to cancer, quantitative
interventions to remove them. NCI Project Officer:
Bryce Reeve, Ph.D. (ARP), and Nancy Breen, Ph.D.



McGill University; Case Western Reserve University; Institute, University of South Australia

Context: Quantitative estimates of health inequalities play a crucial role in eliminating the disparity between different populations. It is generally assumed that this process is value-neutral, providing unbiased results.

Methods: We discuss five examples of the measurement process itself, the strategy to exclude others, and the weight assigned to the variables being measured.

Findings: Overall, we find that most value judgments are important consequences for interpretation.

Conclusions: Because values implicitly measure health, we urge researchers to explicitly consider the underlying assumptions of other consumers of health inequality research when they base their assessments.

Keywords: Health inequalities, measurement, social determinants of health.

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Milbank Quarterly, March 2010.

Variance Estimation Intervals for 11 Common Disparity Measures

There is increased interest in broadly defined, health disparities according to ethnicity, socioeconomic status, and geographic location. To make informed health decisions, it is important to estimate the magnitude of disparities and assess new statistical software that provides corresponding 95% confidence intervals. We have also conducted cancer incidence and mortality analyses to indicate the health disparity measures when used in clinical practice.

Clin Cancer Inform. © 2010 by American Society of Clinical Oncology.

USER Health Equity Assessment BUILT-IN DATA



INTRODUCTION

In recent years, there has been increasing interest in eliminating health disparities expressed by US government agencies and by worldwide institutions, such as the World Bank. Broadly, health disparities refer to preventable inequalities in health, such as cancer prevalence or mortality rates, access to health care services, and quality of health care received, across defined by ethnicity, socioeconomic status, gender identity, education, and geographic locations. It is important for health-related policymakers and researchers to have precise estimates of the magnitude of health disparities and correct for over time. With proper evaluation and monitoring of the effects of current health-related policies, researchers can help improve health outcomes so as to lead to the elimination of health disparities, as well as to improve the health of all groups to the greatest extent possible.

To measure health disparities across different groups, it is necessary to define groups across different social categories.



CHAPTER FIVE

HEALTH INEQUALITIES: MEASUREMENT AND DECOMPOSITION

Sam Harper and John Lynch

Since the prior edition of this chapter (Harper and Lynch 2006), the literature on measuring and monitoring health inequalities has exploded. The combination of new data sources, particularly in low- and middle-income countries (e.g., Hosseinpour 2013; de Walque and Filmer 2013), and widespread international concern regarding social determinants of health (WHO Commission on Social Determinants of Health 2008) has led to a wealth of new studies providing quantitative estimates of social inequalities in health. The raft of new studies suggests continued research and policy interest in understanding and reducing health inequalities. We maintain the basic premise of our earlier chapter that reliable and valid measurement of progress toward reducing health inequalities, if it is to be of value in research and policy-making, requires a framework for conceptualizing and measuring inequalities in health (Sen 2002; Asada 2007).

In this chapter we focus on reviewing ways of measuring health inequalities—that is, observable differences in health among individuals of different social groups. We also show that measures of inequality inherently reflect, to a greater or lesser extent, different ethical and value judgments about what aspects of health inequality are important to capture. Thus it is worthwhile to restate that any choice of health inequality statistic implicitly or explicitly reflects a choice about what is important to measure (Sen and Foster 1997; Asada 2007), the consequences of which can strongly affect conclusions.

Social inequalities in life expectancy

- Social group differences, time trends, decomposition

ORIGINAL CONTRIBUTION

DISPARITIES

RESEARCH LETTER

Trends in the Black-White Life Expectancy, 2003-2008

To the Editor: Understanding the causes of black-white differences in mortality has important consequences to reduce health inequities in the United States. A previous report found a nearly 2-year decline in the white life expectancy gap among men and a 1-year among women between 1993 and 2003.¹ We investigate whether these changes have continued in recent years.

Trends in the Black-Gap in the United States

Sam Harper, PhD
John Lynch, PhD
Scott Burris, JD
George Davey Smith, MD

LIFE EXPECTANCY AT BIRTH (THE average number of years an individual can expect to live under current age-specific mortality rates)² has generally been increasing in the United States since at least the late 19th century.³ Additionally, for as long as data have been given by race/ethnicity, life expectancy of blacks has been lower than that of whites.^{3,4} However, overall trends tend to obscure the fact that the gap in life expectancy between blacks and whites has varied considerably during the 20th century. The near elimination of typhoid and other waterborne communicable diseases improved black life expectancy in both absolute and relative terms compared with whites in the period 1900-1940, but black-white differences stabilized during the 1960s.

Blacks again made absolute and relative progress compared with whites during the 1970s and early 1980s, but the study by Kochanek et al⁵ found that the black-white gap in life expectancy at birth increased between 1984 and 1989, primarily due to slower declines in heart disease among blacks relative to whites and faster increases in homicide and human immunodeficiency virus (HIV)-related mortality among young blacks. The gap continued to widen until the early 1990s, but

Table 1. Causes of Death Contributing to the Gap in Life Expectancy

Cause of Death	2003	2008
Cardiovascular	1.94 (29.7)	1.75
Hypertension	1.35 (20.7)	1.19
Stroke	0.15 (2.2)	0.16
Other ^a	0.41 (6.2)	0.37
Cancers	0.03 (0.5)	0.03
Colorectal	0.99 (15.1)	0.89
Uterine	0.12 (1.9)	0.14
Breast	0.07 (1.0)	0.07
Prostate	0.27 (4.1)	0.26
Other ^b	0.30 (4.6)	0.27
Communicable	0.93 (14.2)	0.73
Influenza/pneumonia	0.10 (1.6)	0.08
Septicemia	0.19 (2.9)	0.18
HIV	0.57 (8.8)	0.41
Other ^c	0.07 (1.0)	0.06
Chronic disease	0.54 (8.3)	0.42
Acute heart disease	0.02 (0.3)	0.03
CLRD	0.03 (0.4)	0.01
Diabetes	0.21 (2.8)	0.30
Nephritis	0.25 (3.9)	0.26
Coronitis	0.02 (0.3)	0.02
Injuries	0.91 (14.0)	0.61
Homicide	1.08 (16.6)	1.03
Suicide	-0.21 (-3.3)	-0.27
Unintentional injuries	0.04 (0.7)	-0.15
Poisoning	0.01 (0.2)	-0.14
Transportation-related	0.01 (0.2)	-0.07
Other	0.03 (0.3)	0.01
Infant mortality	0.51 (7.7)	0.45
Congenital anomalies	0.05 (0.8)	0.04
Perinatal death	0.45 (6.9)	0.41
Residual ^d	0.72 (11.0)	0.59
Total	6.53 (100)	5.44

Abbreviations: CLRD, chronic lower respiratory disease; HIV, human immunodeficiency virus; CLRD and HIV are reported separately on the death certificate and do not sum to 100 due to rounding.

^aValue in parentheses represents each cause's percentage contribution to the total.

^bIncludes all other listed causes of death.

^cIncludes other causes of chronic disease and HIV.

^dIncludes all other categories.

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Impact of interventions and policies

THE CHANGING FACE OF EPIDEMIOLOGY

Editors' note: This series addresses topics of interest to epidemiologists across a range of specialties. Commentaries start as invited talks at symposia organized by the Editors. This paper was presented at the Third North American Congress of Epidemiology held in Montreal in June 2011.

Social Epidemiology

Questionable Answers and Answerable Questions

Sam Harper^a and Erin C. Strumpf^{a,b}

Social epidemiology encompasses the study of relationships between health and a broad range of social factors such as race, social class, gender, social policies, and so on. One could broadly partition the work of social epidemiology into surveillance (ie, descriptive relationships between social factors and health, tracking of health inequalities over time) and etiology (ie, causal effects of social exposures on health).¹ Many social epidemiologists believe these twin pursuits should ultimately serve to structure interventions aimed at reducing health-damaging social exposures or increasing exposure to social factors that enhance health.

Impact of interventions and policies

- Substance use, maternal / child health, social and economic policies



Do Medical Marijuana Laws Extend?

SAM HARPER, PhD, ERIN C. S.

PURPOSE: To replicate past medical marijuana laws and extend state characteristics and methods. We obtained a survey on Drug Use and Health prevalence in the United States (MMJ) on marijuana use, and results. We replicated past difference-in-differences estimates by 0.53 percentage points, the perceived riskiness of marijuana use, and extended linear effects.

RESULTS: We replicated past difference-in-differences estimates by 0.53 percentage points, the perceived riskiness of marijuana use, and extended linear effects.

CONCLUSIONS: Our error had an important effect on evidence of causal effects of MMJ. *J Am Epidemiol* 2012;22:207–1.

KEY WORDS: Adolescents, Marijuana, Health, Quasi-Experiments.

INTRODUCTION

The potential impact of legalizing medical and recreational marijuana has much popular and legislative attention (1). In a recent issue of the *Annals*, I used this literature to analyze the impact of marijuana use among adolescents in US states and have not passed a law legalizing marijuana purposes (2). They reported evidence that use was higher in states that had passed laws (MMJs) compared with states that had concluded that the causal mechanism determined. In this paper, we replicate Wall et al. and, using the same data, we evaluate the effect of passing MMJs on measures of m

METHODS

Wall et al. were transparent with respect and methods, which greatly facilitated our analysis.

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The Annals

Sam Harper, PhD

Additional material is [published online](http://dx.doi.org/10.1136/injuryprev-2018-043606) via the journal online (<http://dx.doi.org/10.1136/injuryprev-2018-043606>).

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The Effect of Mandatory Seat Belt Laws on Socioeconomic Position

Abstract

We investigated the differential effect of socioeconomic subgroups. We found that higher versus lower education is associated with greater seat belt use. Results: Better educated individuals with an income in the bottom quartile had a higher rate of seat belt use than those in the top quartile. Our results imply that existing research may be biased if all states upgrade their mandatory seat belt laws uniformly.

Conclusions: The population-wide effect on the number of drivers

INTRODUCTION

Mandatory seat belt laws, starting in the 1980s, increase seat belt use across the United States (1, 2). Shultz, Nichols, and unbelted drivers to increase belt use and reduce fatal crashes, for which they drive belts alone (Cohen & Einav, 2006a, 2006b).

As a consequence, US rates, roughly 20 percent in the mid-1990s, increased to nearly 90% by 2008 (Nelson et al., 1992; Nelson et al., 1998; Sullivan, 1988). However, studies have shown that the use of seat belts is not universal (Beck et al., 2004; F & Comstock, 1977; Hersch, 1998; Kresnow, 1998; Robertson, Williams, & Farmer, 2002). For example, the proportion of drivers who always wear seat belts is less than a high school completion rate.

A population-level risk factor suggested that the approximate degree of importance of seat belt use is greater than the quality of the vehicle. Cohen and Einav (2006a) found that the use of seat belts is more likely to occur among younger people, more likely to occur among drivers who drink and alcohol more frequently, and less likely to occur among drivers who drink and alcohol more frequently.

However, the proportion of drivers who always wear seat belts is less than a high school completion rate.

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Current projects

Early Childhood Education Policies and Examining the role of discrimination in Beijing Household Energy Transitions [BHET]

labor force participation in India



Photo: <http://policynote.ca>

(with [Arijit Nandi](#), [Emis Akbari](#), [Jody Heymann](#), and [Linda White](#))

This project aims to investigate how Early Childhood Education and over time in the United States and how these policies affect children's health, and well-being.



Photo: India Express

(with [Arijit Nandi](#), [Anoushaka Chandrashekhar](#), [Rosa Abraham](#), [Nick K](#) Photo: The Straits Times

The project's main objectives are to:

1. Create a free and publicly-available longitudinal database of state hiring behavior in India. The objective of this project in the longer term is to estimate the impact of specific state ECEC reforms on the hiring behavior in India. Using an experimental "correspondence study" design, we will send applications from fictitious candidates for positions advertised in India from 1995 to present; the magnitude of gender discrimination, measured by the gender difference in callbacks varies based on the characteristics of the applicant (e.g., age, occupation, race/ethnicity, and socioeconomic position; and time vs. full-time work, industry, number of employees). Additionally, stipulated by the 2017 Amendment to the Indian Maternity Benefit Act.
2. Estimate the impact of specific state ECEC reforms on the degree of gender discrimination in callbacks is greater for women of child-bearing age.
3. Estimate the effect of children's participation in ECEC on the degree of gender discrimination in callbacks is greater for women of child-bearing age.

Air pollution is a leading public health problem. Over 400 million Chinese homes burn coal to meet their indoor space heating needs, leading to high levels of air pollution and health impacts in adults and children. Coal burning in China also contributes to poor air quality and mercury contamination in Canada. This project will assess how transitioning away from coal and introducing new clean heating technology in China will impact the health and environment of people who live in homes impacted by policy changes.

Funding: Canadian Institutes for Health Research

A photograph showing the impacts of a clean energy transition policy. In the foreground, a man in dark clothing is using a long-handled shovel to move a large pile of dark coal onto the back of a bright green three-wheeled motorized cart. The cart has two front wheels and one large rear wheel, with a small headlight and a simple suspension system. To the right of the cart, a woman wearing a yellow jacket and a pink headscarf sits on another green three-wheeled vehicle, which appears to be a moped or a small motorcycle. She is looking towards the camera. The background features a large, dark, single-story building with a brick chimney and a brick wall. There are several bags of coal stacked near the entrance. Bare trees stand behind the building under a hazy sky.

Impacts of a Clean Energy Transition Policy

Interdisciplinary Team

McGill University

- Sam Harper (Epidemiology)
- Jill Baumgartner (Epidemiology)
- Brian Robinson (Geography)
- Chris Barrington-Leigh (Economics)
- Koren Mann (Toxicology)
- Arijit Nandi (Epidemiology)
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- Zhongjie Fan (Cardiology)

Peking University

- Shu Tao (Environmental Science)
- Yaojie Li (project coordinator)

China National Center for Cardiovascular Disease

- Liancheng Zhao (CVD epidemiology)

Knowledge Users

- Barry Jessiman (Health Canada)
- Alison Dickson (Environ & Climate Change Canada)
- Iris Jin, Asia Pacific Foundation of Canada
- Richard Fuller, Pure Earth Foundation

Funders

- Canadian Institutes of Health Research
- Health Effects Institute

Why Did We Start?

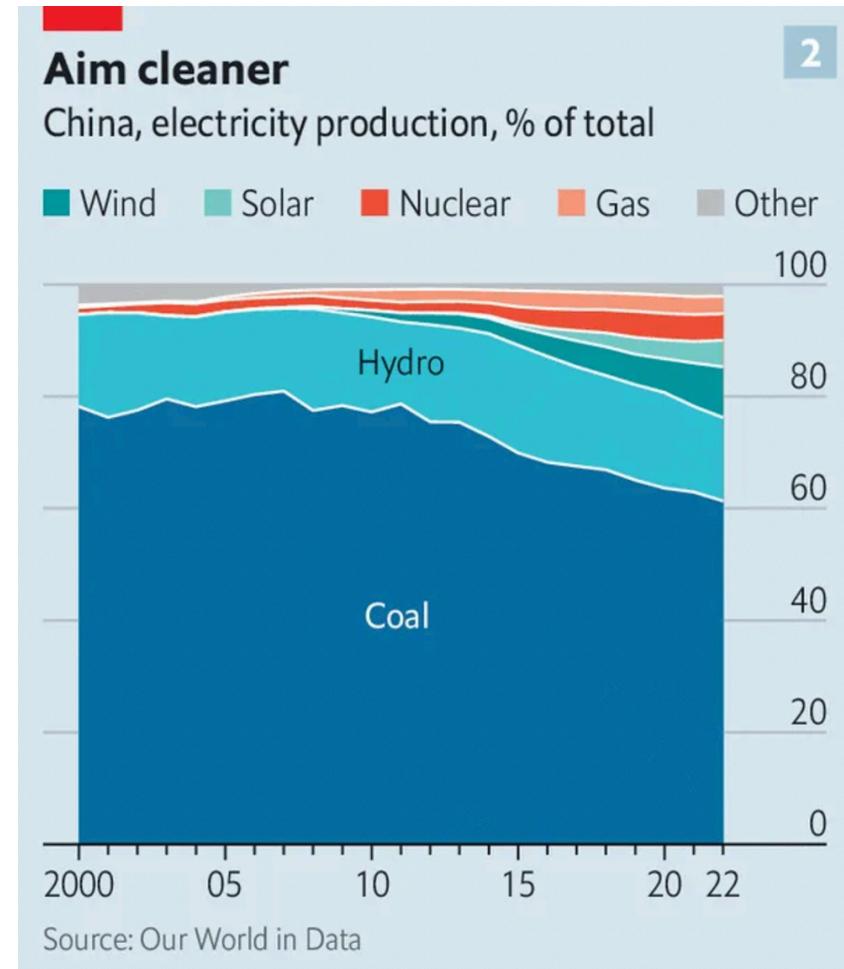
The role of coal in China

~ 30% of global emissions

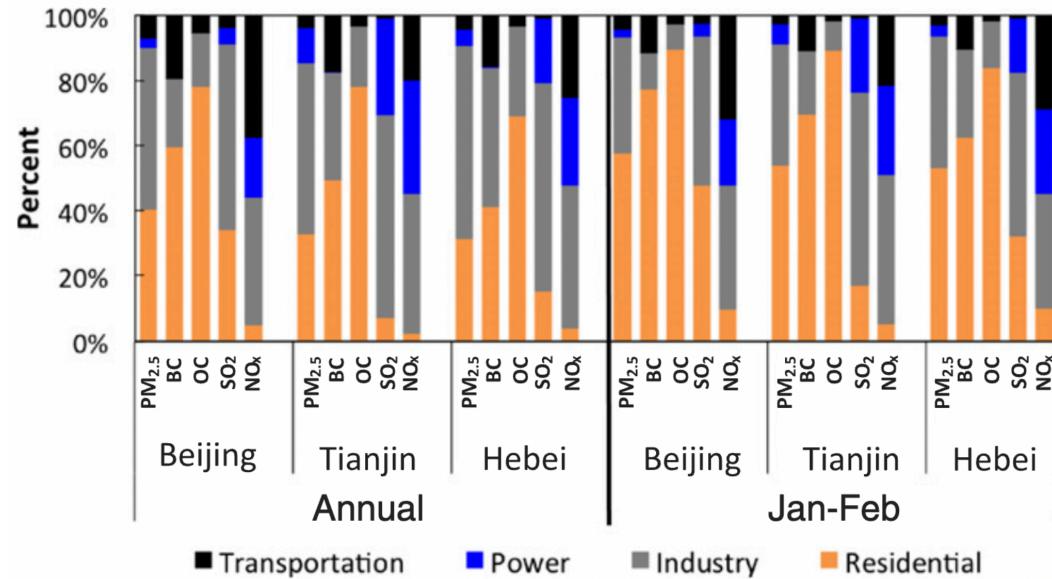


Image credits: [The Economist](#)

Still dominated by coal



Residential coal burning in China



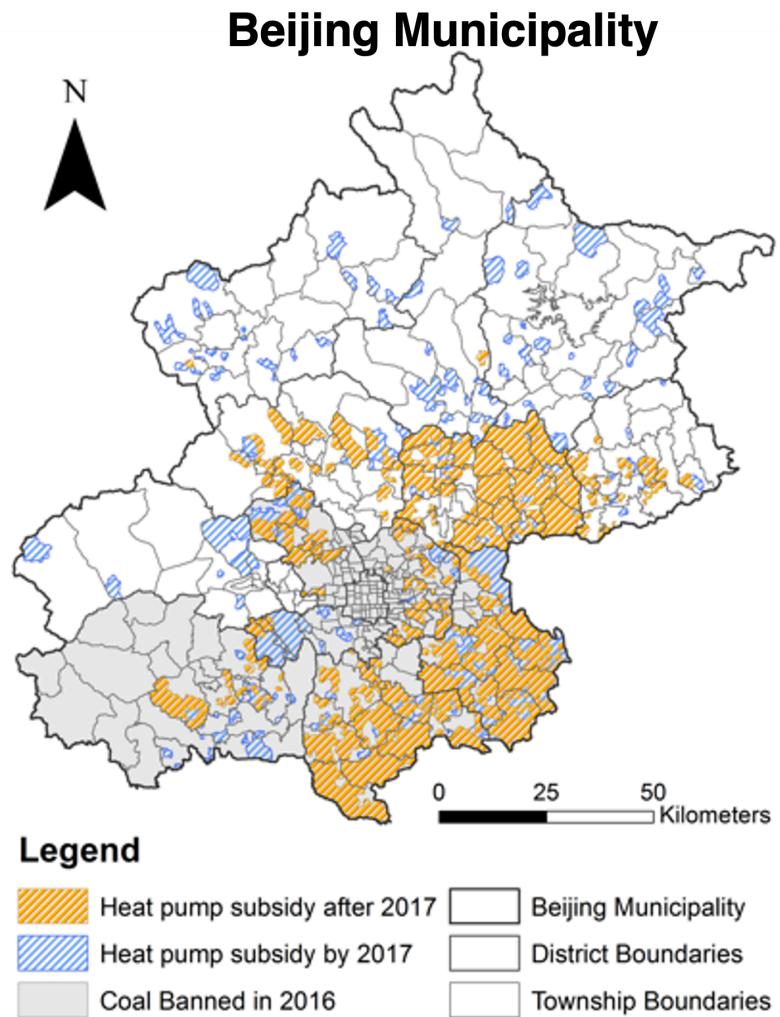
- Coal contains fluorine, arsenic, lead, selenium and mercury, which are not destroyed by combustion;
- Technical constraints make it difficult to burn coal cleanly in households;



- Residential coal burning makes a substantial contribution to emissions
- Particularly in winter months

Policy Context

- Beijing designated “coal restricted areas”
- Government subsidized electric or gas-powered heat pumps (80% of \$4,500 cost)
- 2017: required 1.5 million people to halt coal use (scaled to >2 million by ambitious local officials)
- Stepped implementation from 2017-2021 in Beijing and northern China (63 million homes)



“Coal to Clean Energy Program”

- Village-level intervention.
- Subsidized purchase of heat pump; electricity subsidized regionally.
- Remove coal stoves.
- Retrofit existing homes or build new homes in the village.



In China's Coal Country, a Ban Brings Blue Skies and Cold Homes

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By STEVEN LEE MYERS FEB. 10, 2018



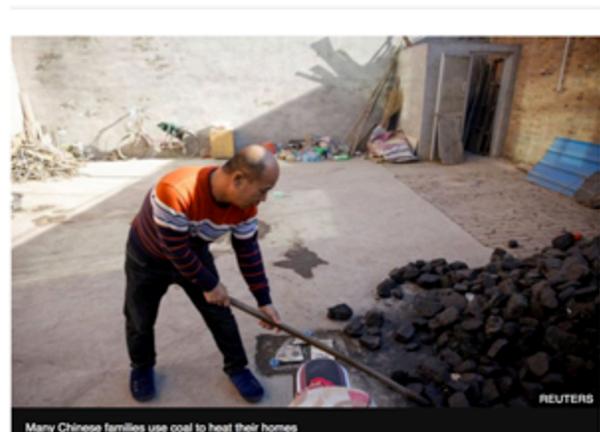
A woman farmer ties a bunch of firewood as her son watches outside their home in Hutou village on Pingtan island. (GOH CHAI HIN/AP/ Getty Images)

Coal Ban Forces Chinese Living in Frigid North to Burn Furniture to Keep Warm

China does U-turn on coal ban to avert heating crisis

HES
November 22, 2018

Share f t w g ... A



Many Chinese families use coal to heat their homes

China's government has allowed some northern cities to burn coal in a

China eases northern home coal ban to offset gas shortage

Push for use of cleaner fuel set back by cold weather and rising prices



Coal powder briquettes have been identified as a particular hazard to health © AFP

Lucy Hornby in Beijing DECEMBER 7, 2017...



China Backtracks on Local Coal Ban

An analysis by Michael Lelyveld
2018-12-10

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Workers sort coal on a conveyor belt near a coal mine in Datong, northern China's Shanxi province, Nov. 20, 2015. (AP Photo)

Poor bear brunt of Beijing coal cleanup with no heating at -6C

Switch from coal to gas has left residents of towns around Beijing without heating after gas supply falters, reports Climate Home News



pipeline construction on the outskirts of Beijing. There is a demand-supply gap for gas after coal sites are demolished. (Photograph: Jason Lee/Reuters)

middle class Beijingers breathe the cleanest air in recent winters, in Zhou, a small city 20 minutes by train from Beijing's downtown, residents shivering through cold nights without heating. The reason: a five-year anti-pollution drive has forced rural areas in northern China to switch from dirty c



The Good News (And Not So Good News) About China's Smoggy Air

December 18, 2018 - 11:36 AM ET

China plans to cut coal heating again, but can it avoid another crisis?

Attempts to cut back on coal use have improved air quality, but reportedly left millions without proper heating

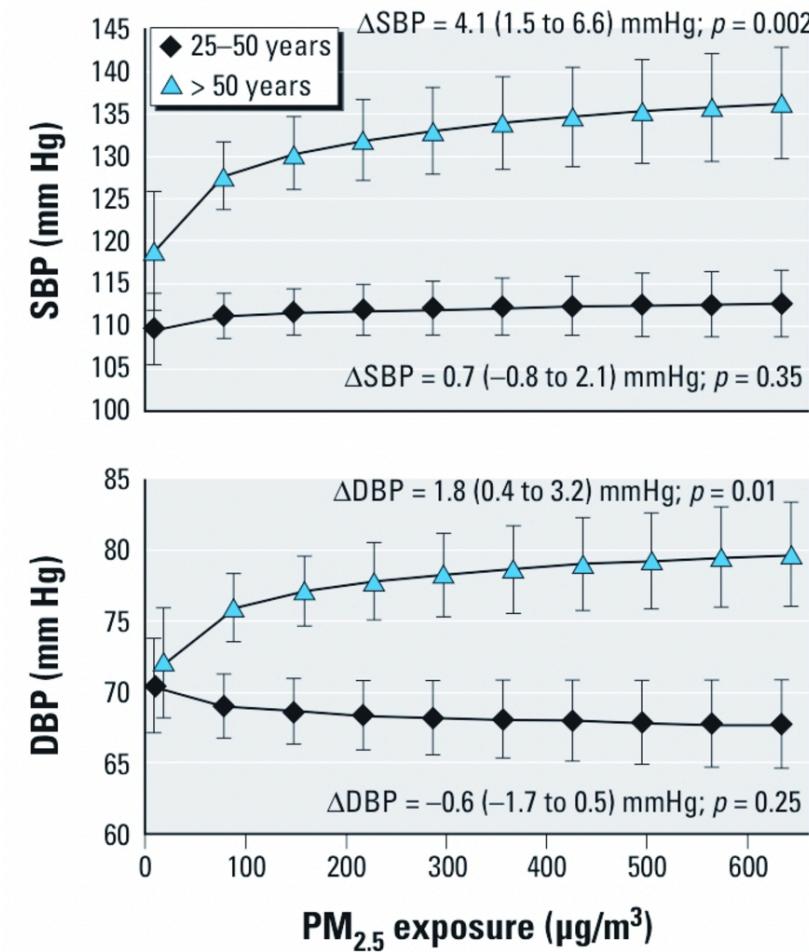
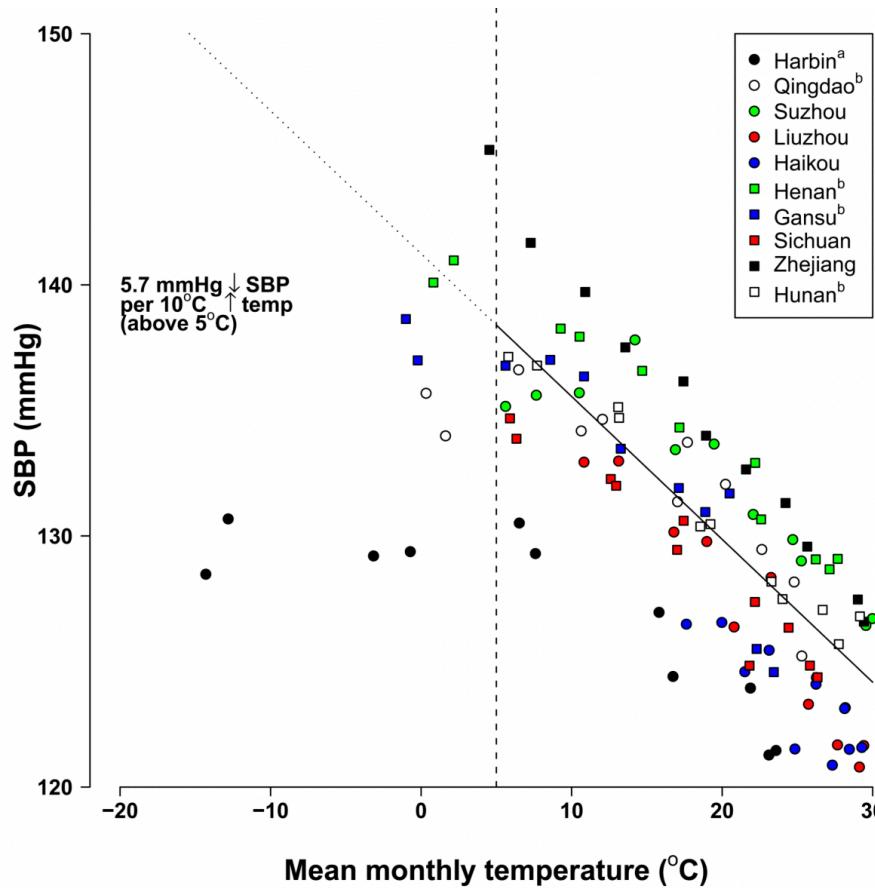
© 10.01.2018 by Lauri Myllyvirta and Xinyi Shen

@laurimyllyvirta



Photo: Kevin Frayer/Getty Images

Low indoor temps and higher PM_{2.5} increase BP



Images: Lewington et al. (2012), Baumgartner et al. (2011). Also see Sternbach et al. (2022)

Research Gaps

- Most prior work only on cookstoves
- Several RCTs
- Mixed evidence on air pollution
- Challenges with uptake
- Multiple sources (e.g., stove-stacking)
- Unclear whether possible to scale-up
- Weaker and mixed evidence on health impacts, even when HAP reduced

AMERICAN THORACIC SOCIETY DOCUMENTS

Household Air Pollution Interventions to Improve Health in Low- and Middle-Income Countries

An Official American Thoracic Society Research Statement

Peggy S. Lai*, Nicholas L. Lam*, Bill Gallery, Alison G. Lee, Heather Adair-Rohani, Donee Alexander, Kalpana Balakrishnan, Iwona Bisaga, Zoe A. Chafe, Thomas Clasen, Anaíte Díaz-Artiga, Andrew Grieshop, Kat Harrison, Stella M. Hartinger, Darby Jack, Seyram Kaali, Melissa Lydston, Kevin M. Mortimer, Laura Nicolaou, Esther Obonyo, Gabriel Okello, Christopher Olopade, Ajay Pillarisetti, Alisha Noella Pinto, Joshua P. Rosenthal†, Neil Schlugger, Xiaoming Shi, Claudia Thompson‡, Lisa M. Thompson, John Volckens, Kendra N. Williams, John Balmes§, William Checkley§, and Obianuju B. Ozoh§; on behalf of the American Thoracic Society Assembly on Environmental, Occupational, and Population Health

THIS OFFICIAL RESEARCH STATEMENT OF THE AMERICAN THORACIC SOCIETY WAS APPROVED FEBRUARY 2024

Household energy solutions need to go beyond cooking interventions alone; there are multiple sources that contribute to HAP

Overall Study Objectives

Aim 1. 

Estimate the total effect of the intervention.

Aim 2. 

Estimate the contribution of changes in the chemical composition of $PM_{2.5}$ to the overall effect on health outcomes.

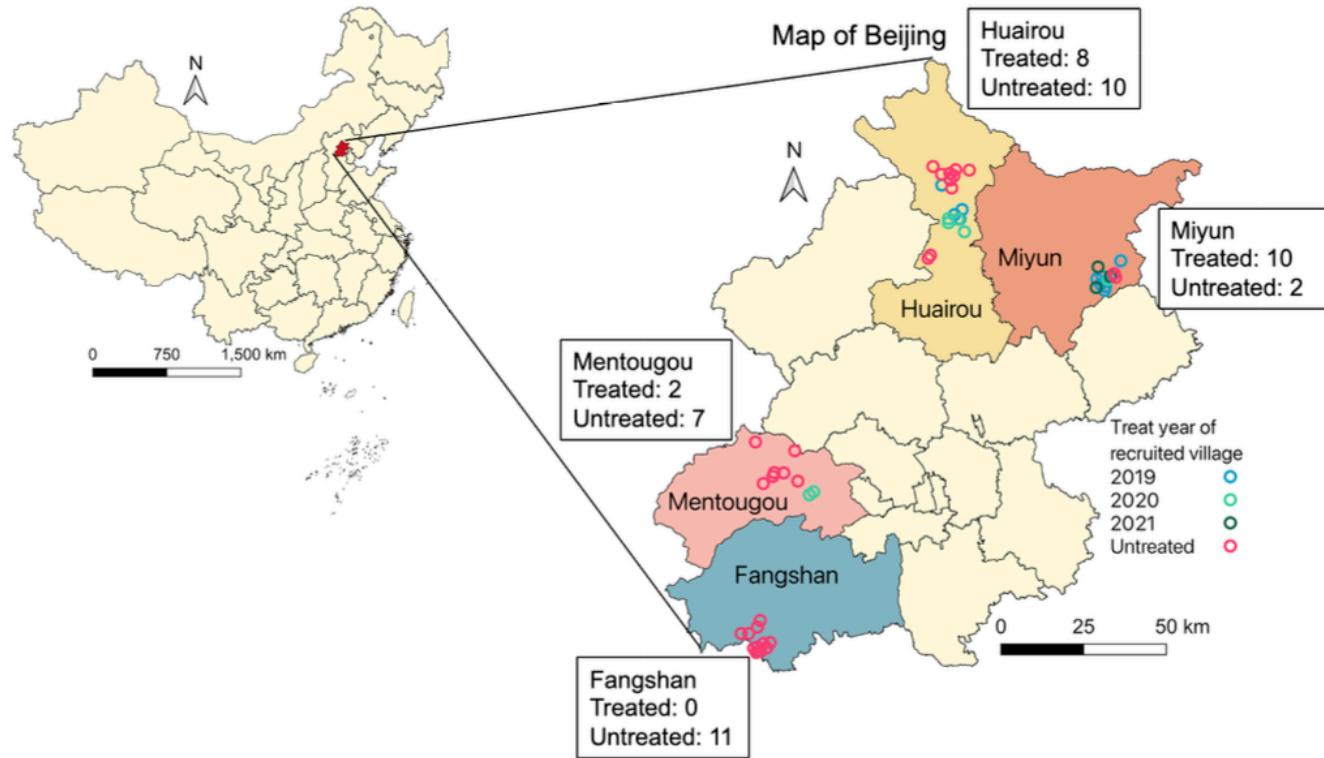
Aim 3. 

Examine alternative **pathways and mechanisms** that may contribute to the intervention's impact.

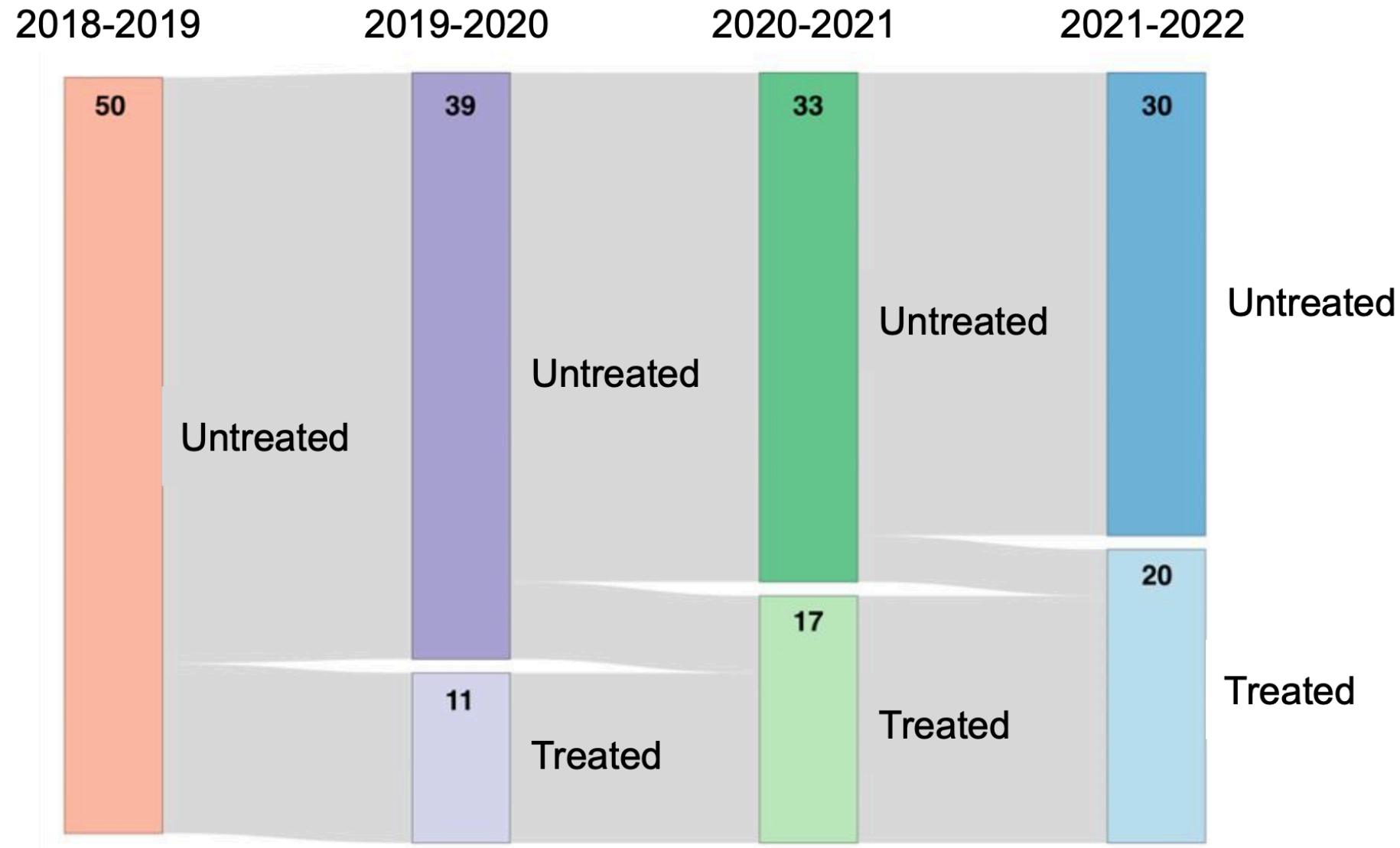
What Did We Do?

Village sampling

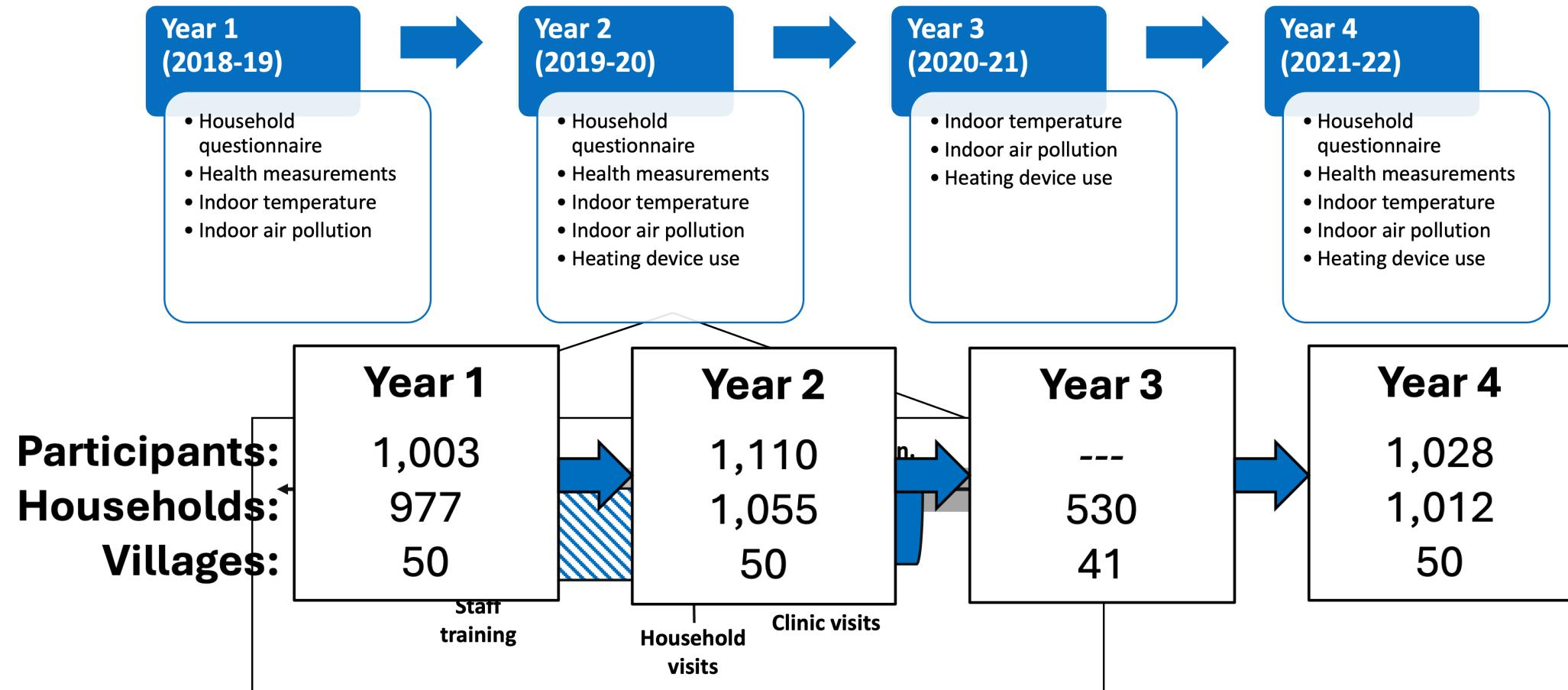
- Identified 50 villages not yet exposed to policy
- Randomly selected ~20 homes in each village
- Enrolled 1 individual per home



Timing of study village treatment by the policy



Data Collection Overview



Measurements

Village

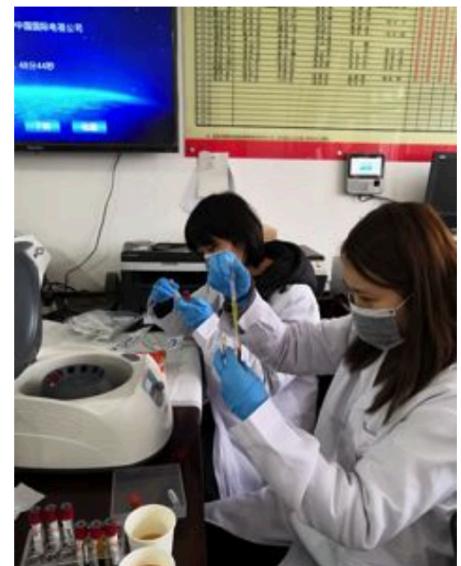
- Outdoor air pollution (1-2 months per season)
- Information on village policies/programs

Household

- Questionnaire to assess energy patterns and related expenditures
- Indoor air temperature (~75% of homes for 2+ winter months)
- Electricity use based on meters

Individual

- Questionnaires on health status, behaviors, conditions, and medication use
- Exposures to PM_{2.5} and black carbon (50% of participants)
- Health measurements (BP, self-reported respiratory symptoms, blood inflammatory and oxidative stress markers (~75%), grip strength (~75%), airway inflammation via exhaled NO (~25%)



Blood pressure measurement

- Automated oscillometric device.
- Calibrated by manufacturer before Years 1 and 4.



- Home BP measurement by trained staff.
- Measured blood pressure 3 to 5 times on participants supported right arm, after 5 mins of quiet, seated rest.
- Mean of final 2 measurements used in analysis.



Indoor temperature

- Measured indoor temperature in the 5-min before BP.
 - Long-term measurement in a subsample of households with sensor taped to household wall.
 - Thermochron iButton or LabJack Digit-THL sensors.
 - Interior wall of most commonly used room.
 - 1.5m height (~ participant height).
 - Measured 5-12 months
 - 125-min sampling interval.



Indoor air pollution (PM_{2.5})

1. Long-term measurement with real-time sensors.

- 6 households per village.
- Run with standard measurements (BAM/TOEM) pre- and post-data collection, each year.
- Measured 5-mo., 1-min sampling interval



2. 24h measurement with filter-based instrument.

- 3 households per village.
- Accepted (gold-standard) measurement.
- Used to calibrate real-time measurements.



Basic idea for mediation study

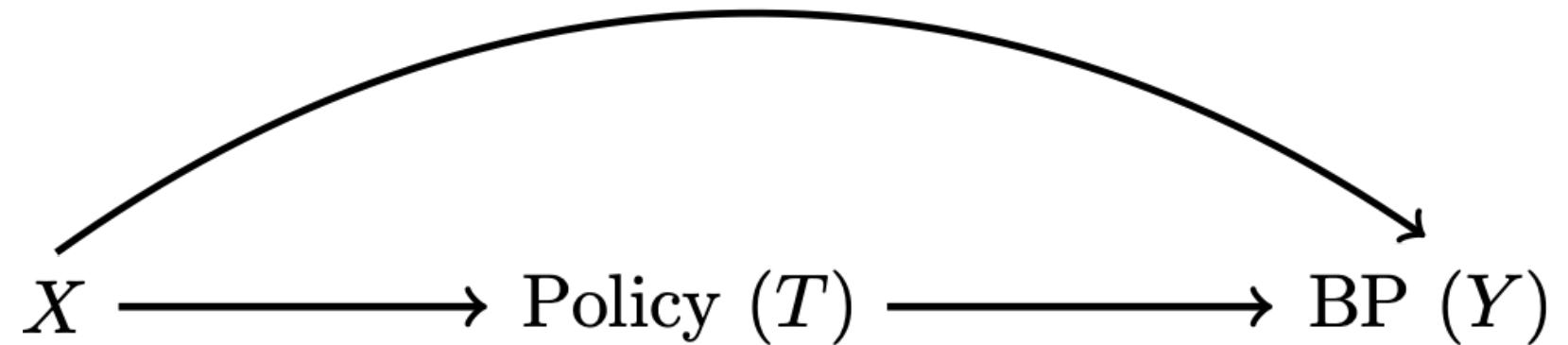
To understand the pathways, mechanisms, and intermediates through which a treatment affects an outcome.

How much of the policy effect is through:

- Reduced exposure to PM_{2.5}
- Other pathways (indoor temperature, behavioral changes)
- Consider multiple mediators

First part of mediation: total effect

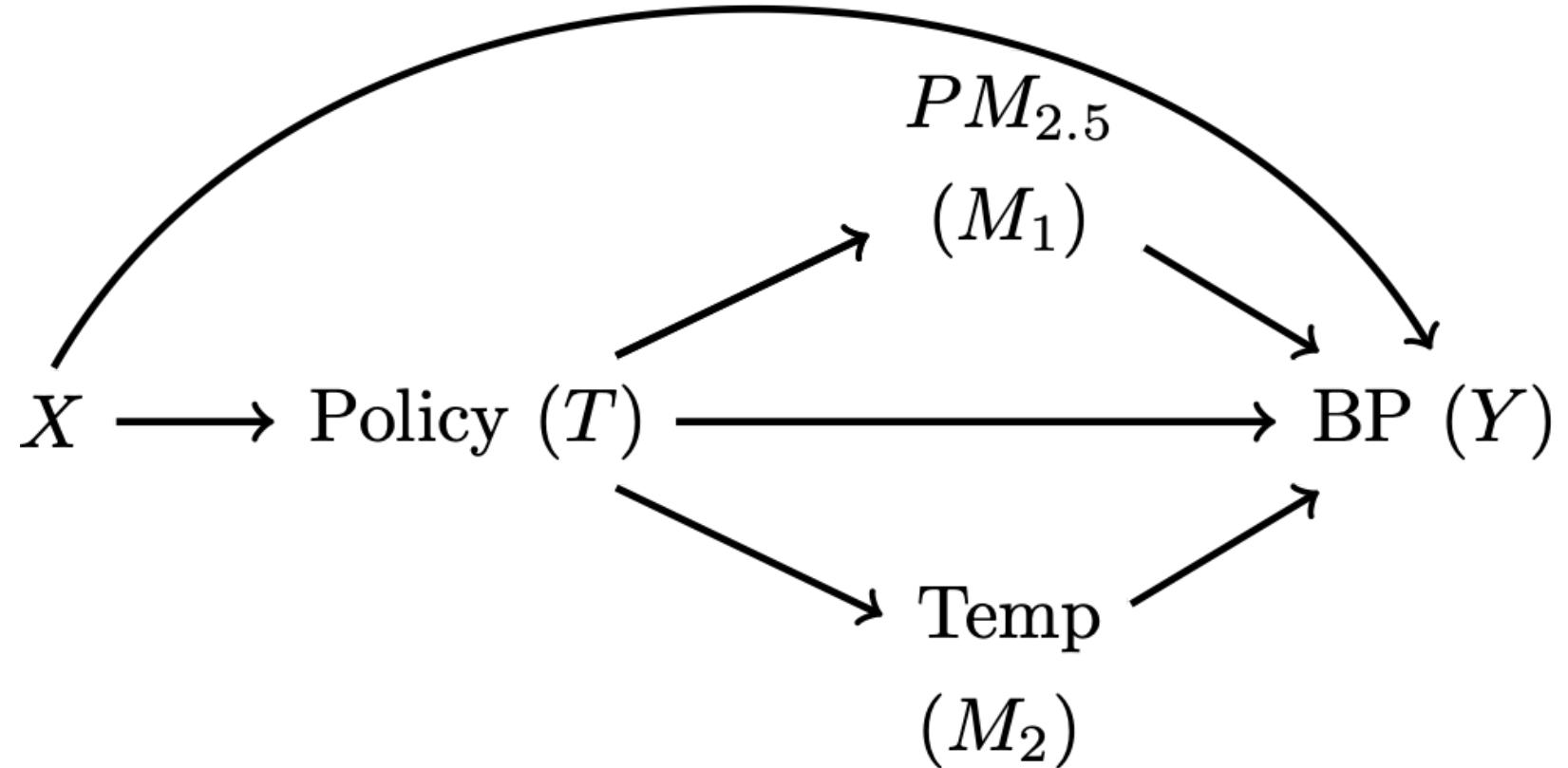
Step 1: Estimate the total effect of T .



Second part of mediation: decomposition

Basic idea: understand pathways of effects

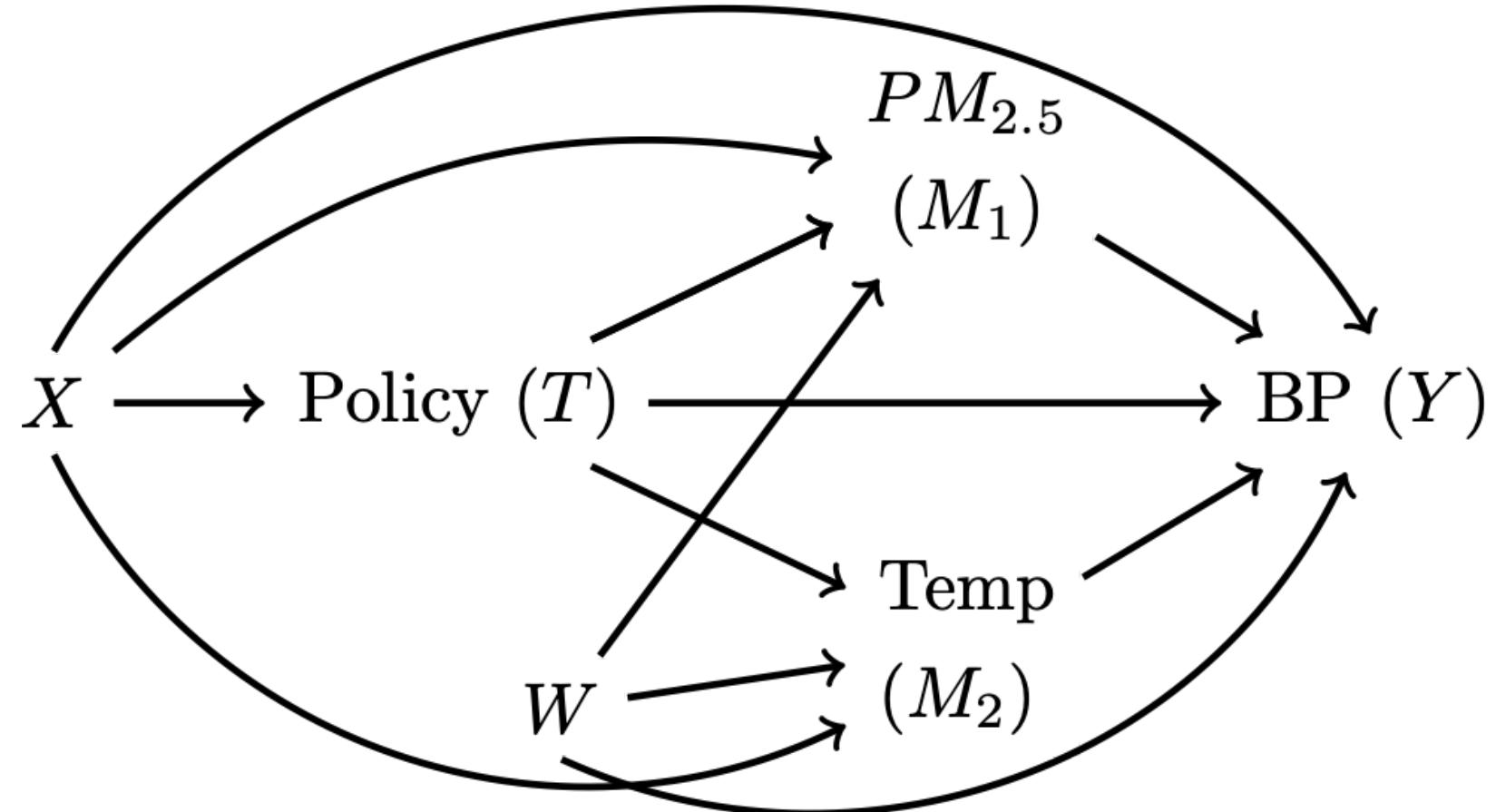
Step 2: Estimate how
much of the total
effect is due to
 $PM_{2.5}$ vs. other
pathways?



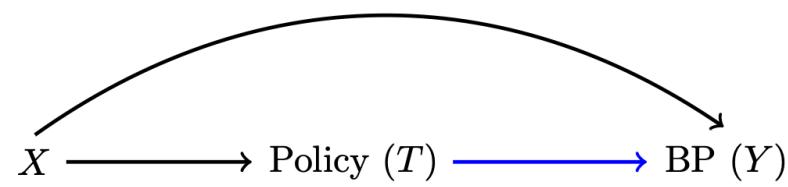
Second part of mediation: decomposition

Basic idea: understand pathways of effects

Step 2: Estimate how much of the total effect is due to $PM_{2.5}$ vs. other pathways?



Quantities of interest



Total effect:

$$E[Y|T, X] = \beta_0 + \beta_1 T + \beta_2 X$$

This equation estimates the total effect of the ban:

$$\text{TE} = \beta_1(T^* - T)$$

where T^* is exposure to ban and T is no exposure.

Mediation model

Estimate two regressions:

1. Treatment on mediator:

$$E[M|T, X] = \beta_0 + \beta_1 T + \beta_2 X$$

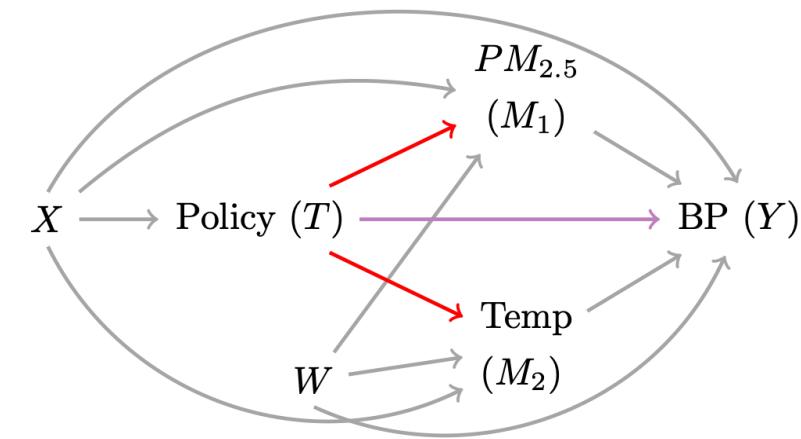
2. Treatment and mediator on outcome:

$$E[Y|T, X, M] = \theta_0 + \theta_1 T + \theta_2 M + \theta_3 TM + \theta_4 X + \theta_5 W$$

Second equation estimates the “Controlled Direct Effect”:

$$CDE = \theta_1 + \theta_3 TM$$

See VanderWeele (2015). Other quantities include the “Natural Direct Effect” ($\theta_1 + \theta_3(\beta_0 + \beta_1 + \beta_2)$) and the “Natural Indirect Effect” ($\theta_2\beta_1 + \theta_3\beta_1$)



What the hell is the CDE?

Interpretation

This effect is the contrast between the counterfactual outcome if the individual were exposed at $T = t$ and the counterfactual outcome if the same individual were exposed at $T = t^$, with the mediator set to a fixed level $M = m$.*

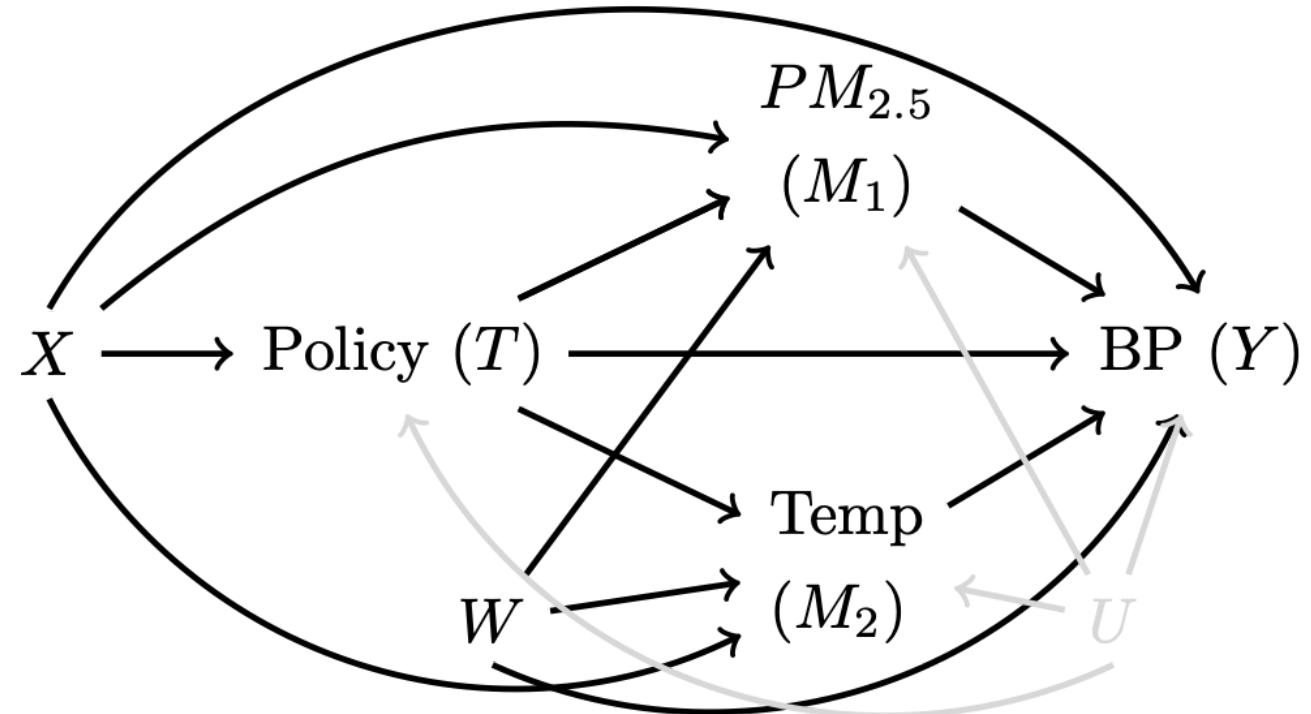
English:

“How much would blood pressure change if the policy were implemented and we held $PM_{2.5}$ fixed at m ?”

Key assumptions

Assumptions for valid CDE:

- No confounding of the total effect.
- No confounding of the mediator-outcome effect.

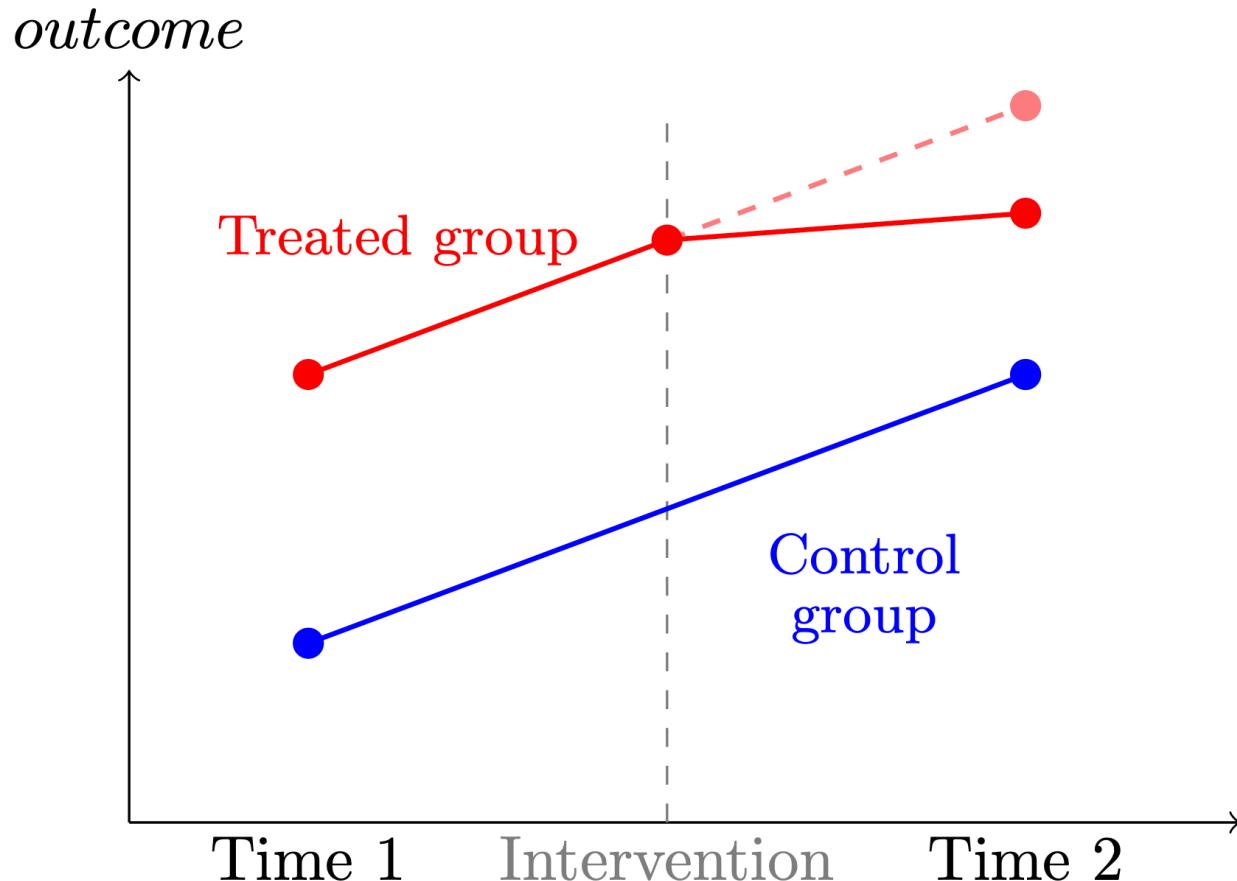


Basic Design: Difference-in-Differences

Need a *counterfactual* for treated group.

Challenges:

- Group differences
- Time trends
- Time-varying confounders
- **Staggered implementation**



Challenges with staggered adoption

- Using earlier treated groups as controls only ‘works’ under homogeneity.
- Early treatment effects get subtracted from the DD estimate.
- Generates poor summary estimate if there is heterogeneity.

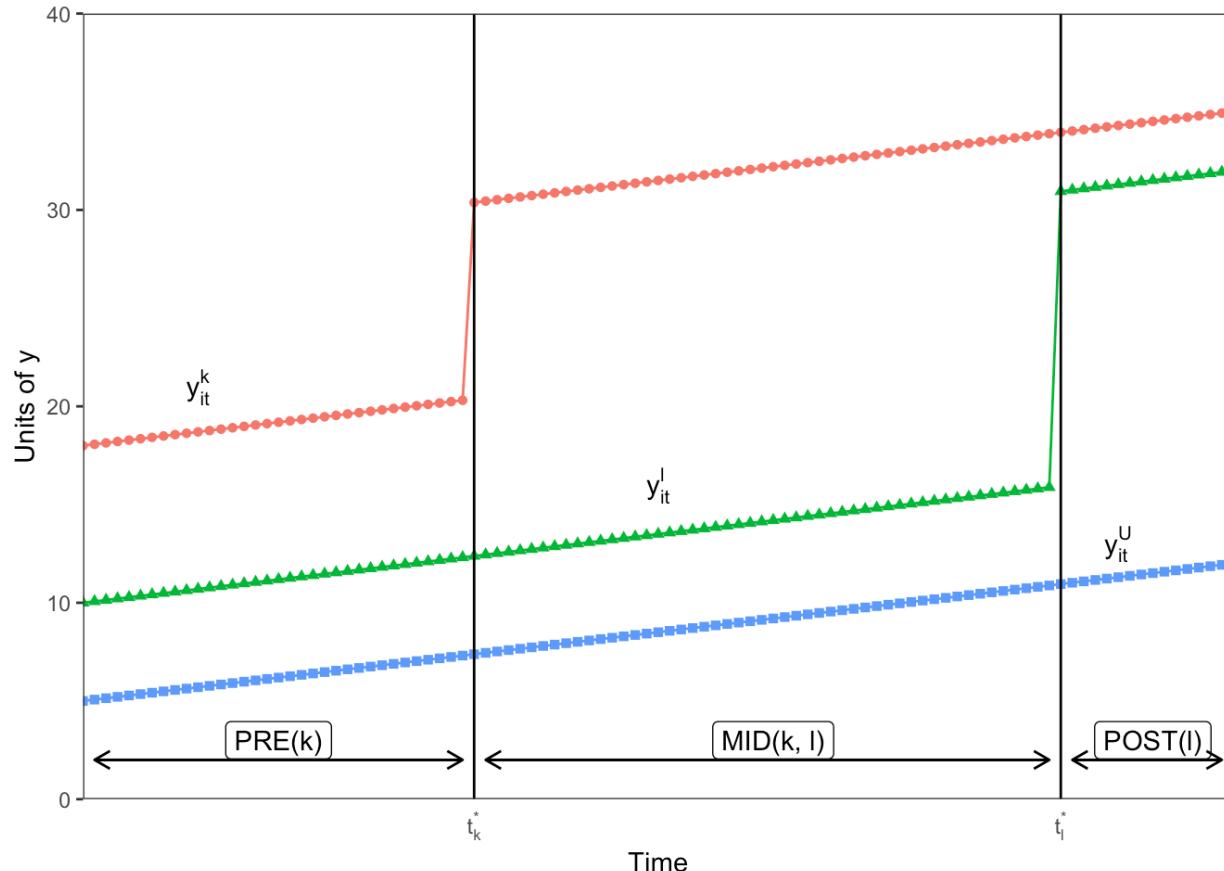
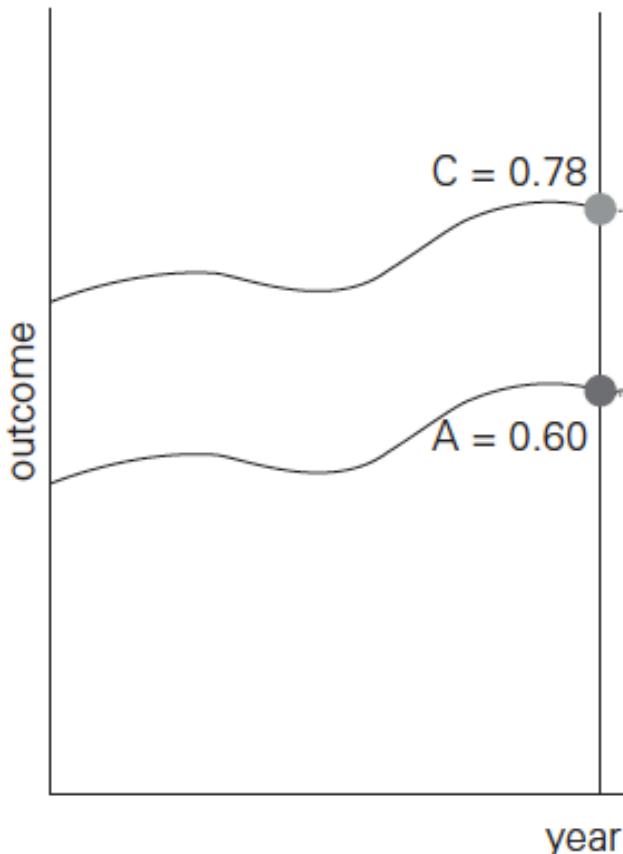


Image: [Andrew Baker](#). See also Goodman-Bacon (2021), Callaway and Sant'Anna (2021), Sun and Abraham (2021)

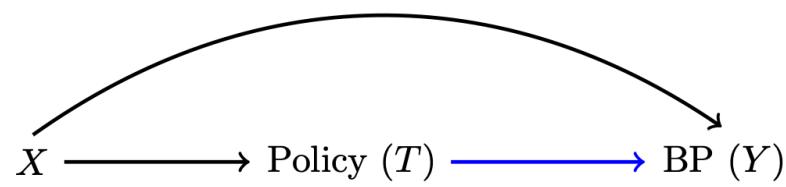
Key Assumption: Parallel Trends



- Basic DD controls for any time invariant characteristics of both treated and control groups.
- Does not control for any time-varying characteristics.
- If another policy/intervention occurs in the treated (or control) group at the same time as the intervention, we cannot cleanly identify the effect of the program.
- DD main assumption: in the absence of the intervention treated and control groups would have displayed similar trends.
- This is called the *parallel trends* assumption.

Impossible to verify, see Gertler et al. (2016).

Statistical model



Total effect via “extended” two-way fixed effects:

$$Y_{ijt} = \alpha + \sum_{r=q}^T \beta_r d_r + \sum_{s=r}^T \gamma_s fs_t + \sum_{r=q}^T \sum_{s=r}^T \tau_{rs} (d_r \times fs_t) + \mathbf{Z}_{ijt} + \varepsilon_{ijt}$$

X includes:

- d_r = treatment cohort fixed effects
- fs_t = time fixed effects
- \mathbf{Z}_{ijt} = time-varying covariates

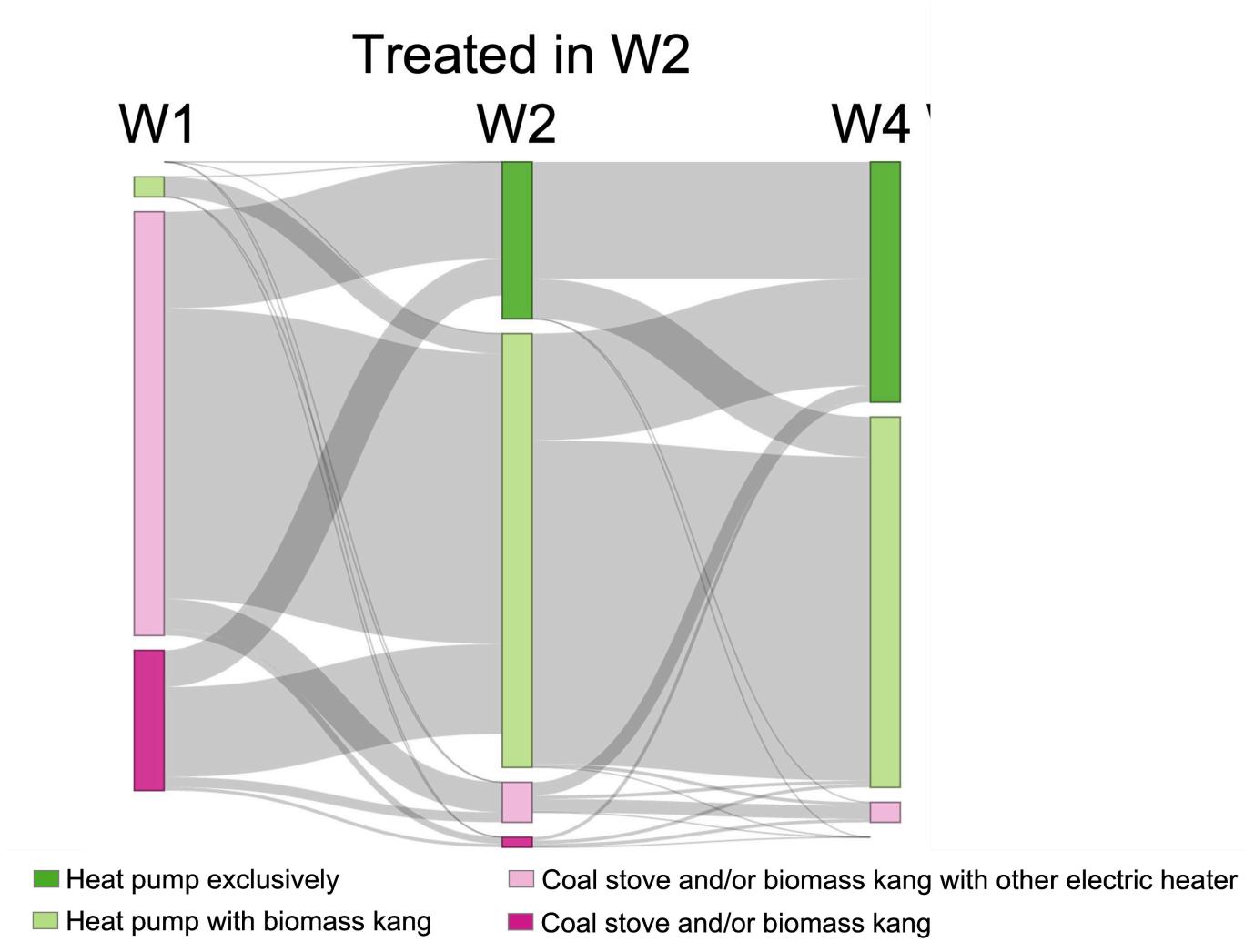
TE is average of marginal ATTs τ_{rs} , averaged over cohort and time.

What Did We Find?

Treatment groups were generally balanced

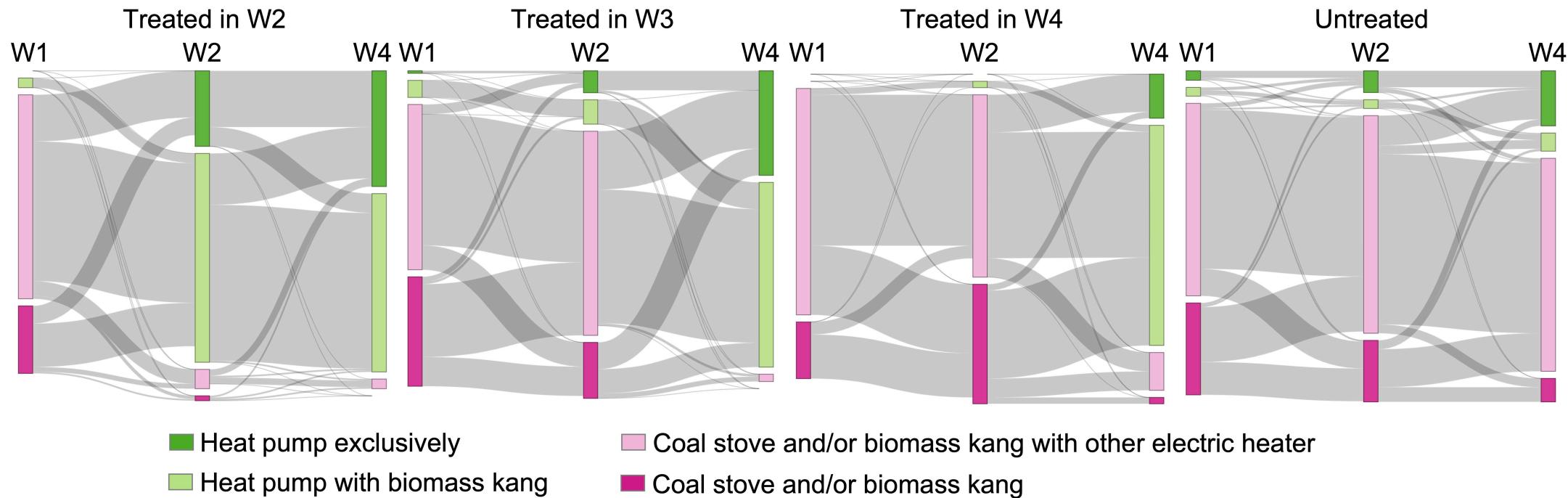
	Never treated (N=603)		Ever treated (N=400)		Diff	SE
	Mean	SD	Mean	SD		
Age (years)	59.9	9.4	60.4	9.2	0.5	0.6
Female (%)	59.5	49.1	60.0	49.1	0.5	3.2
Secondary+ education (%)	12.6	33.2	9.8	29.7	-2.9	2.0
Wealth index (bottom 25%)	26.9	44.4	22.3	41.7	-4.6	2.8
Current smoker (%)	26.2	44.0	25.4	43.6	-0.8	2.8
Daily drinker (%)	17.8	38.3	21.9	41.4	4.1	2.6
Systolic (mmHg)	131.4	16.8	128.7	14.3	-2.7	1.0
Diastolic (mmHg)	82.7	11.6	82.1	11.3	-0.6	0.8
Body mass index (kg/m2)	26.3	3.7	25.8	3.6	-0.5	0.3
Any respiratory problem (%)	50.6	50.0	54.3	49.9	3.7	3.2
Temperature (°C)	13.8	3.6	13.5	3.3	-0.3	0.2
Personal PM2.5 (ug/m3)	127.1	145.3	102.3	105.5	-24.7	11.9

Treated households adopted cleaner energy

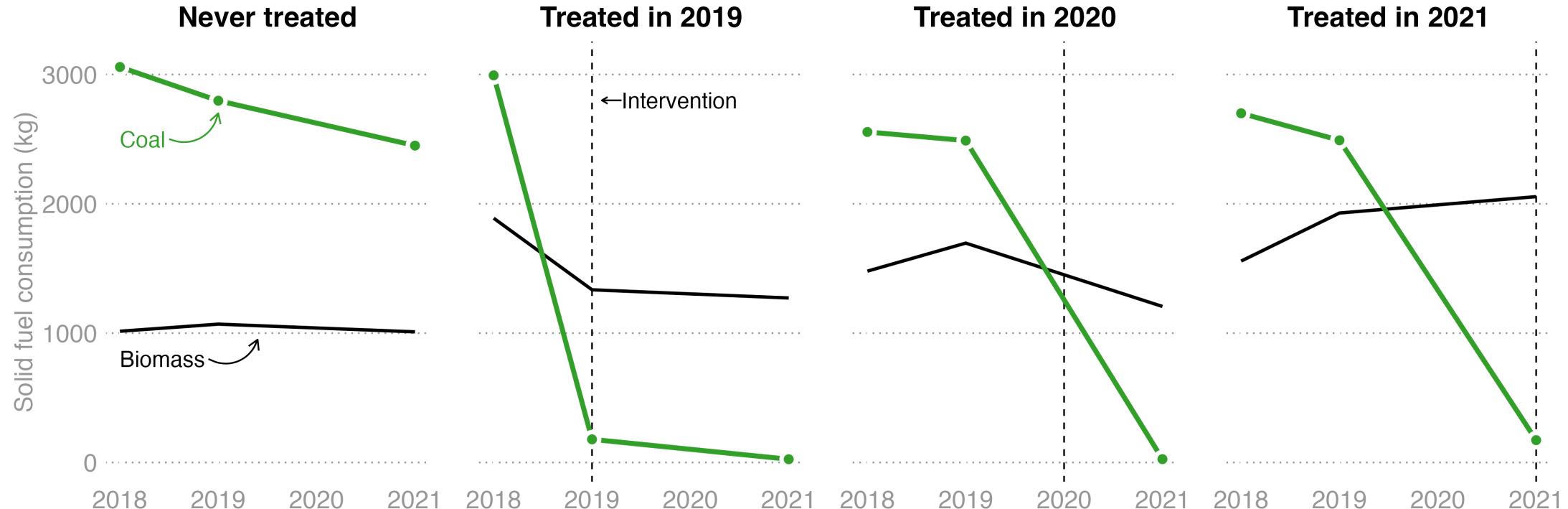


Treated households adopted cleaner energy

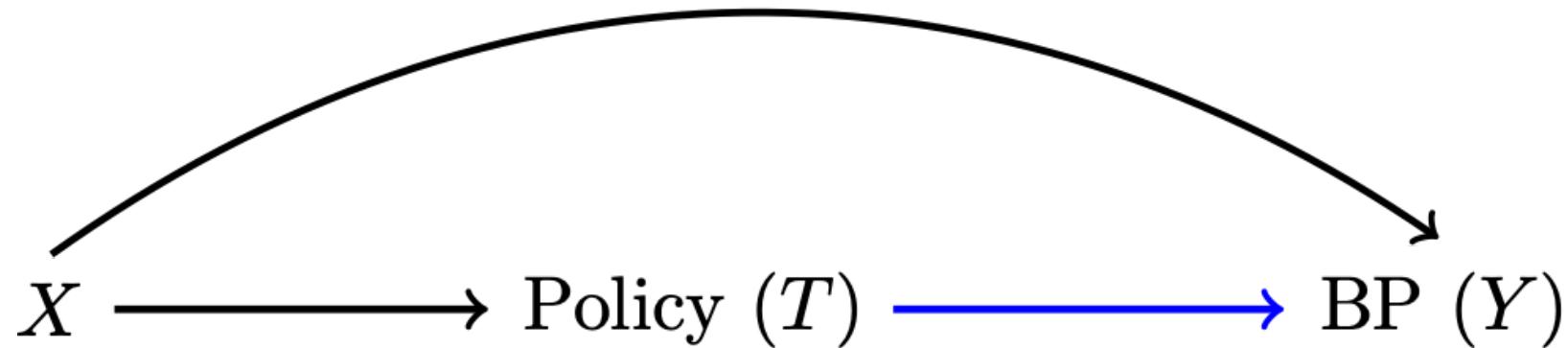
At the time of treatment



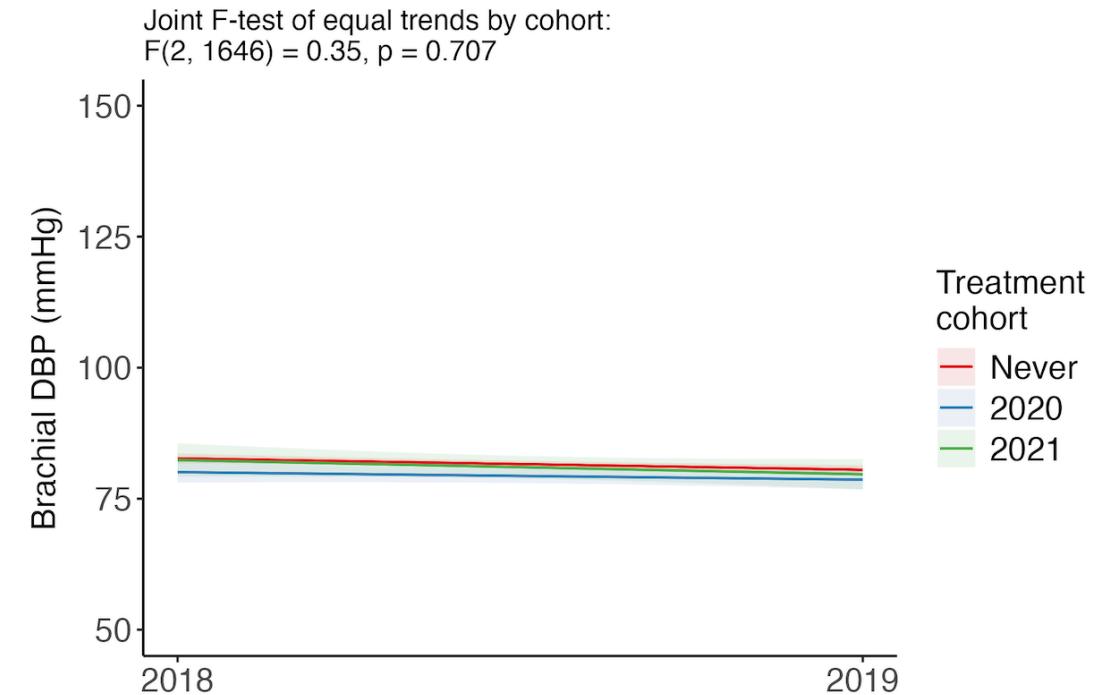
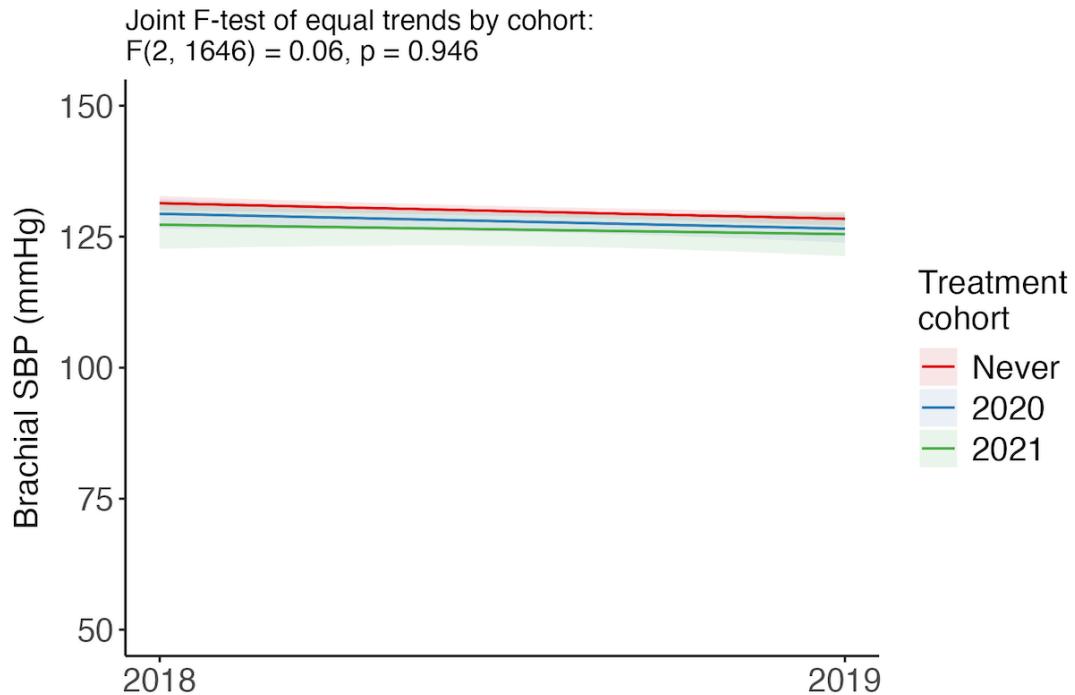
Treated households reported less coal use

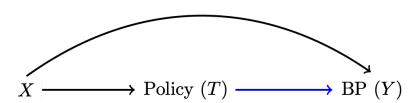


Did the policy affect outcomes?

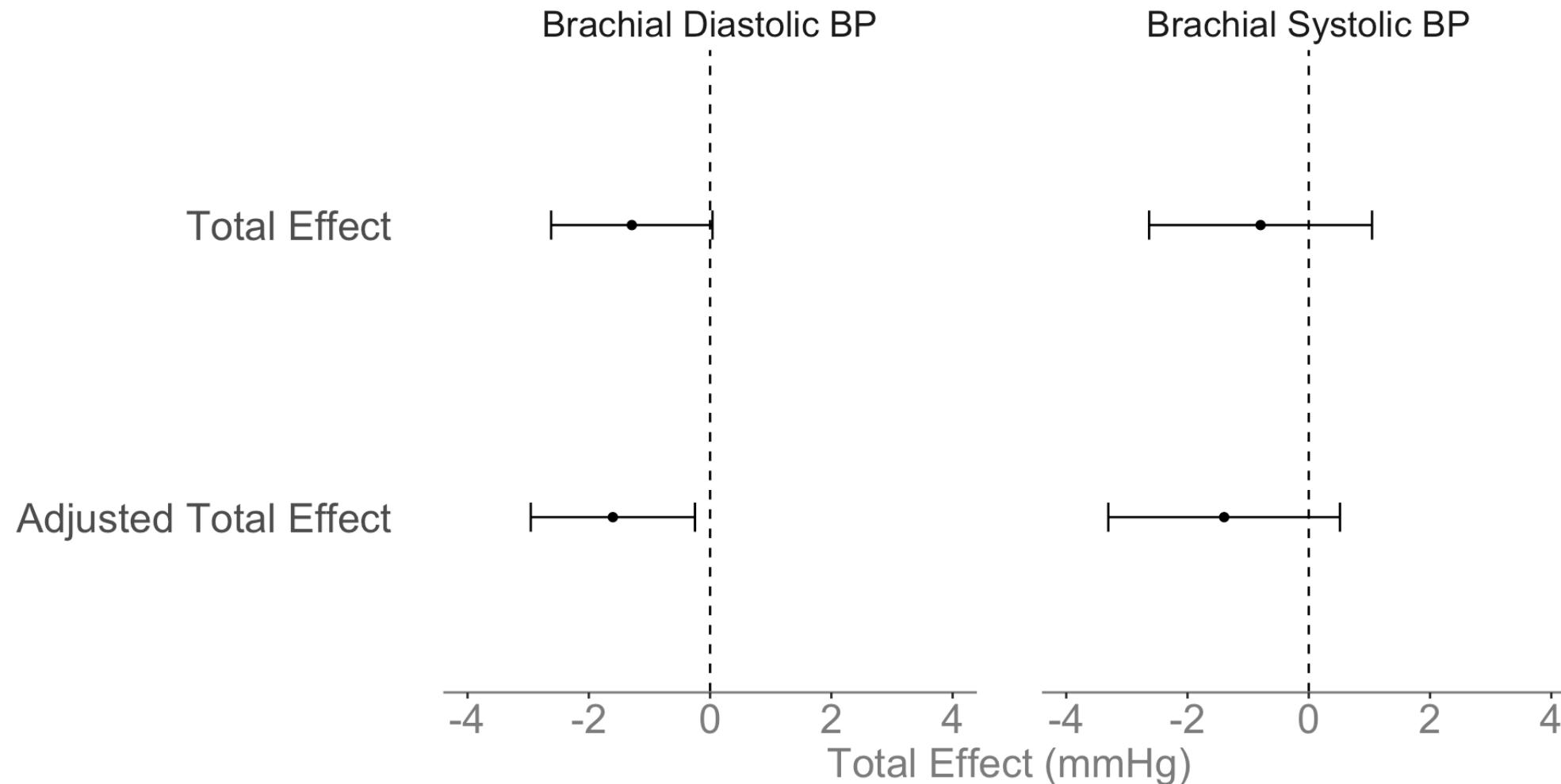


Evidence of parallel pre-trends for BP



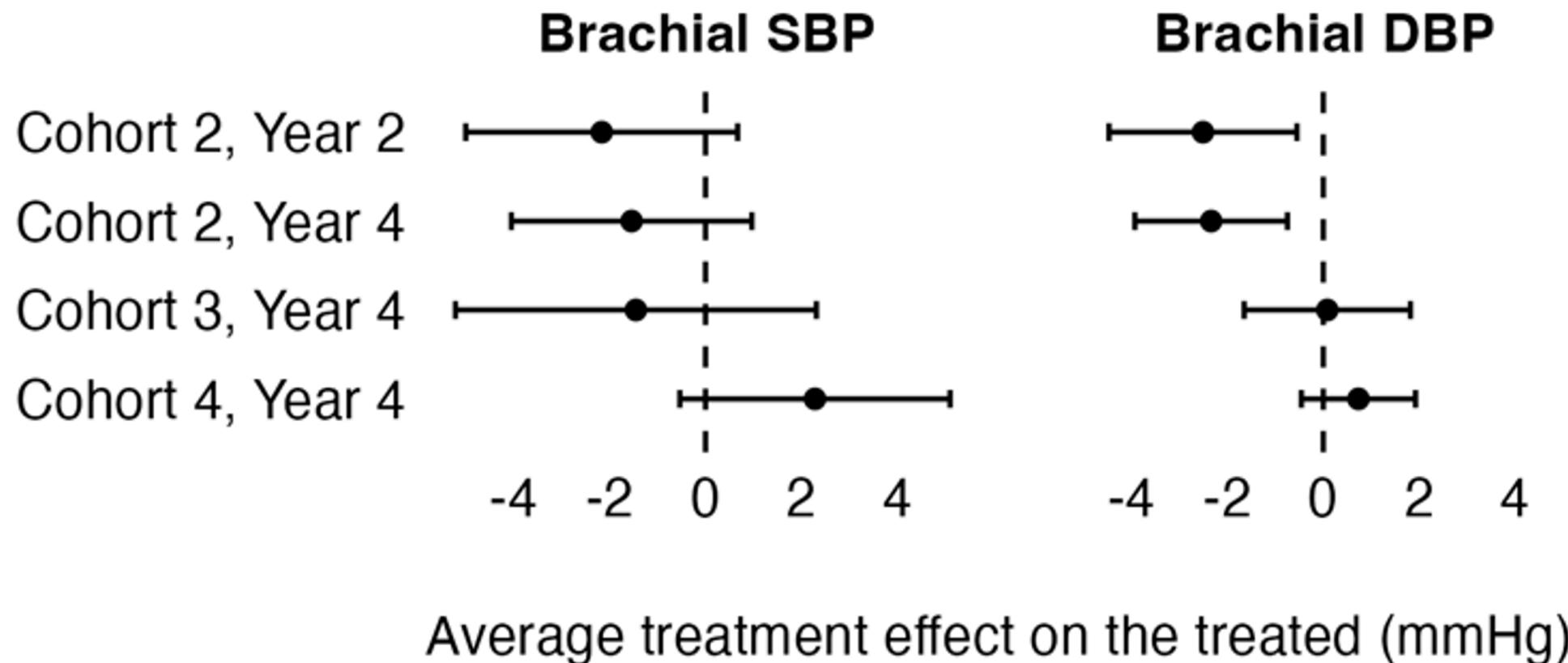


Impact on blood pressure



Time-varying covariates: age, sex, waist circumference, smoking, alcohol consumption, and use of blood pressure medication.

Some evidence of heterogeneity

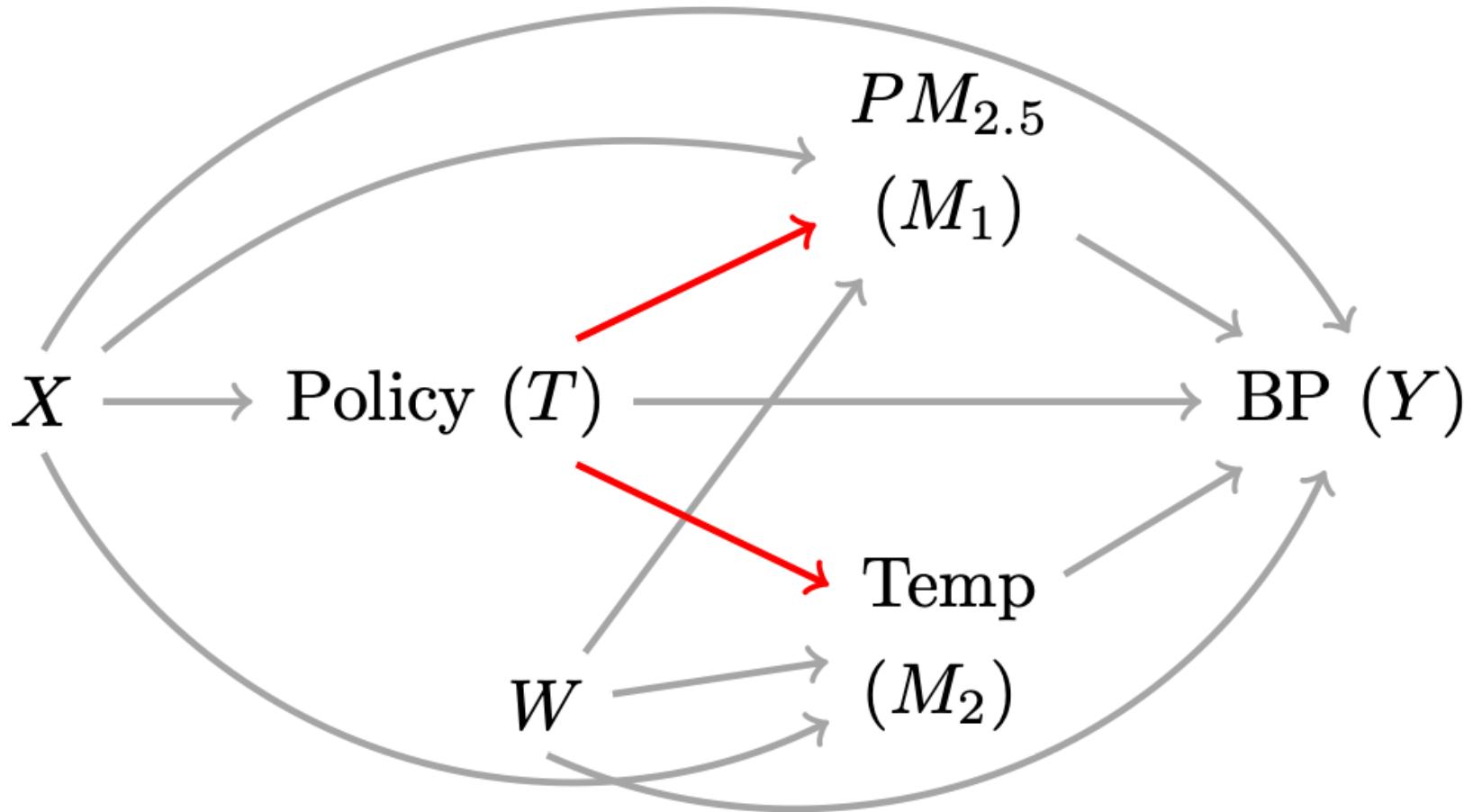


Reductions in some self-reported respiratory symptoms.

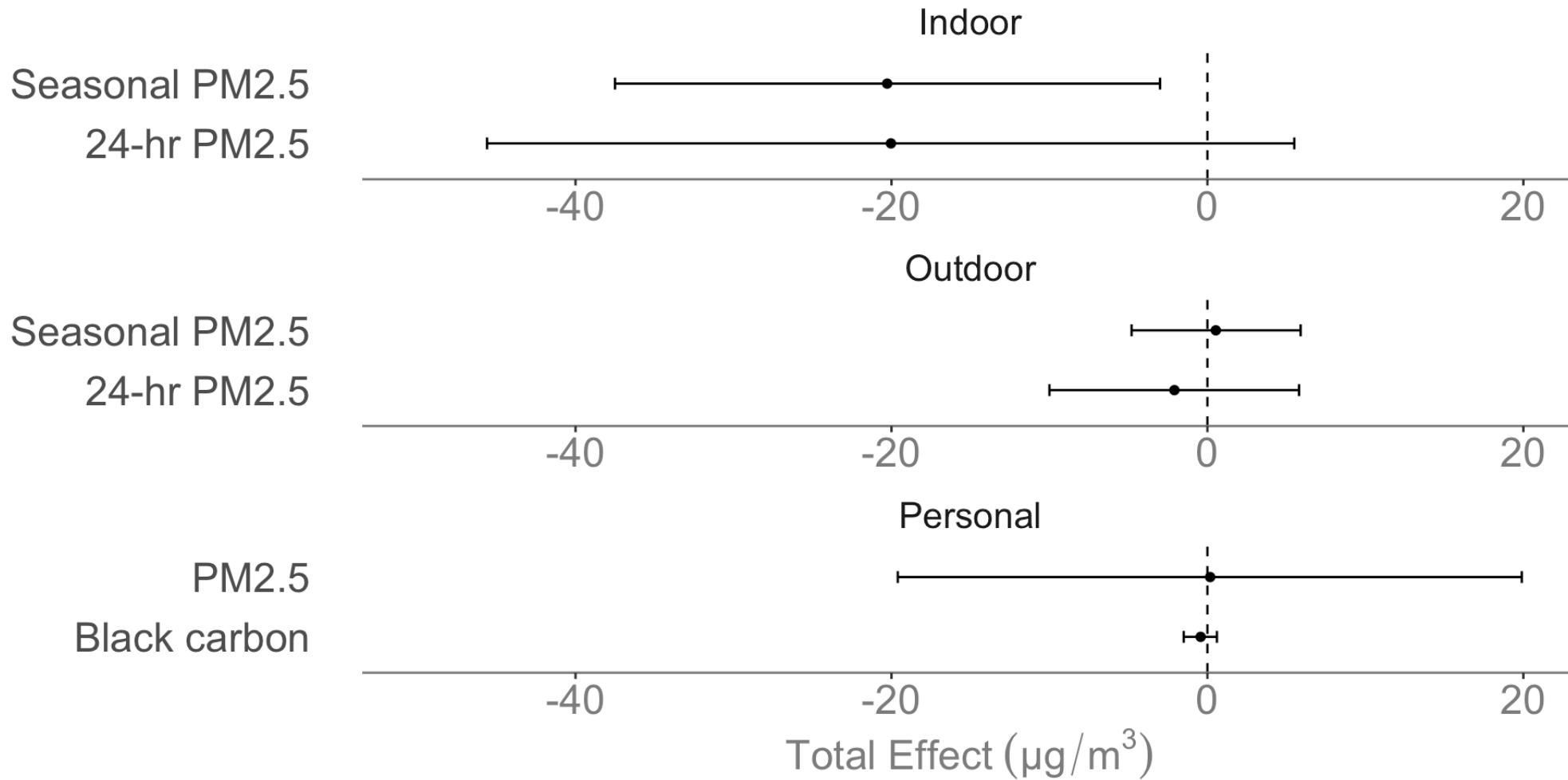
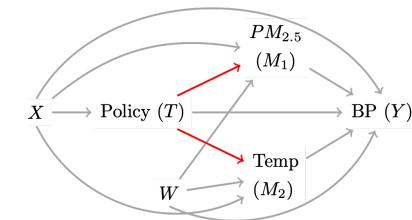
Little evidence of impact on inflammatory markers.

		Obs	ATT	(95% CI)
Respiratory outcomes				
Self-reported (pp)	Any symptom	3076	-7.5	(-12.7, -2.3)
	Coughing	3076	-2.7	(-7.1, 1.7)
	Phlegm	3076	-1.6	(-5.6, 2.4)
	Wheezing attacks	3076	1.0	(-1.9, 3.9)
	Trouble breathing	3076	-3.4	(-9.2, 2.4)
	Chest trouble	3076	-3.4	(-8.1, 1.3)
Measured	FeNO (ppb)	793	0.3	(-2.2, 2.8)
Inflammatory markers				
Measured	IL6 (pg/mL)	1603	0.8	(-0.3, 2.0)
	TNF-alpha (pg/mL)	1603	0.8	(-0.1, 1.7)
	CRP (mg/L)	1603	0.1	(-0.5, 0.6)
	MDA (μ M)	1603	0.2	(-0.2, 0.6)

Did the policy affect the mediators?

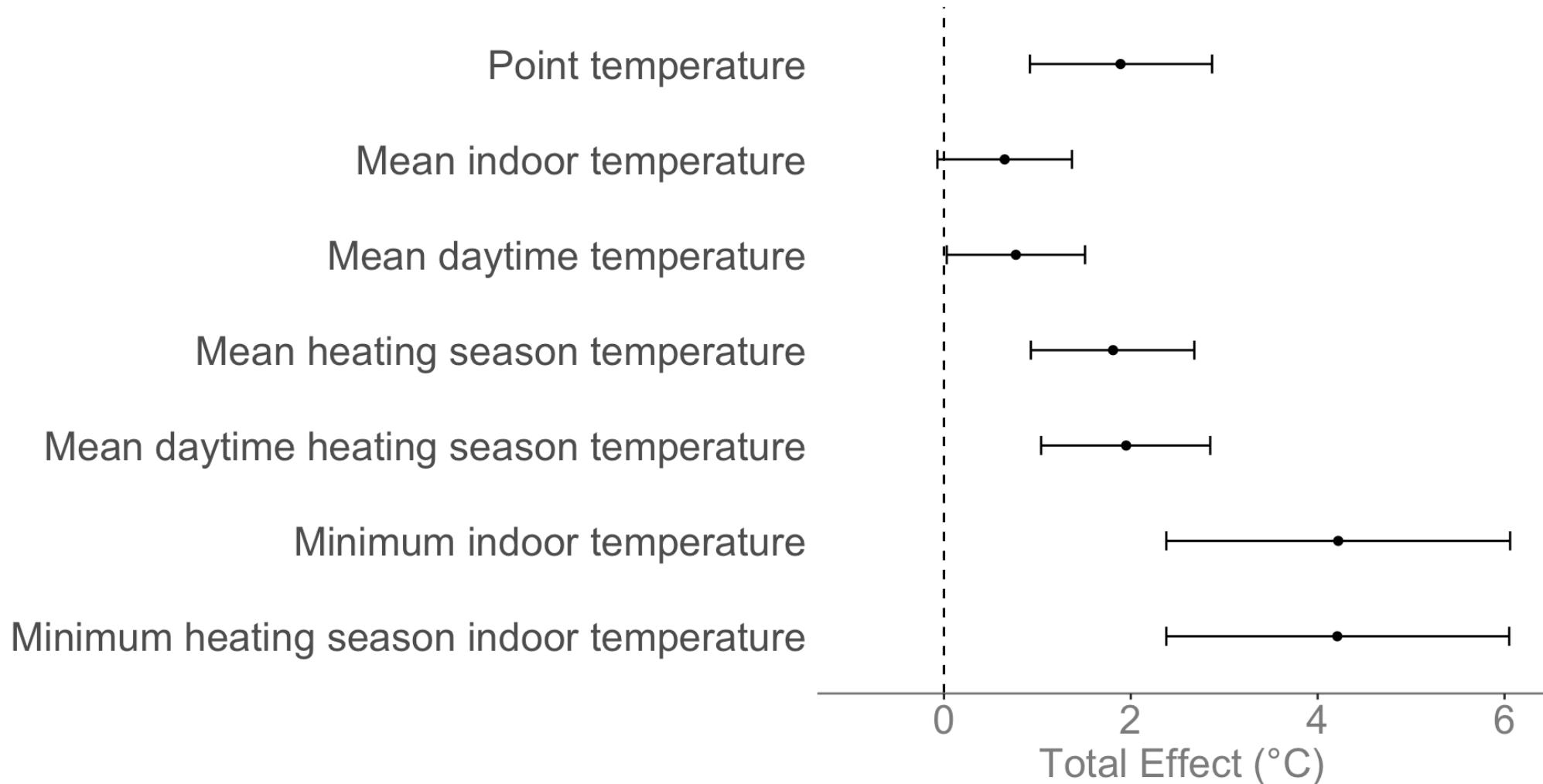
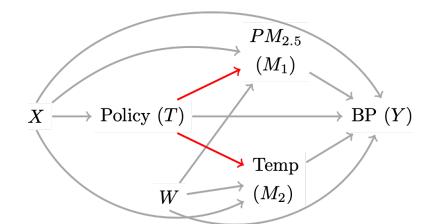


Policy reduced (only) indoor PM



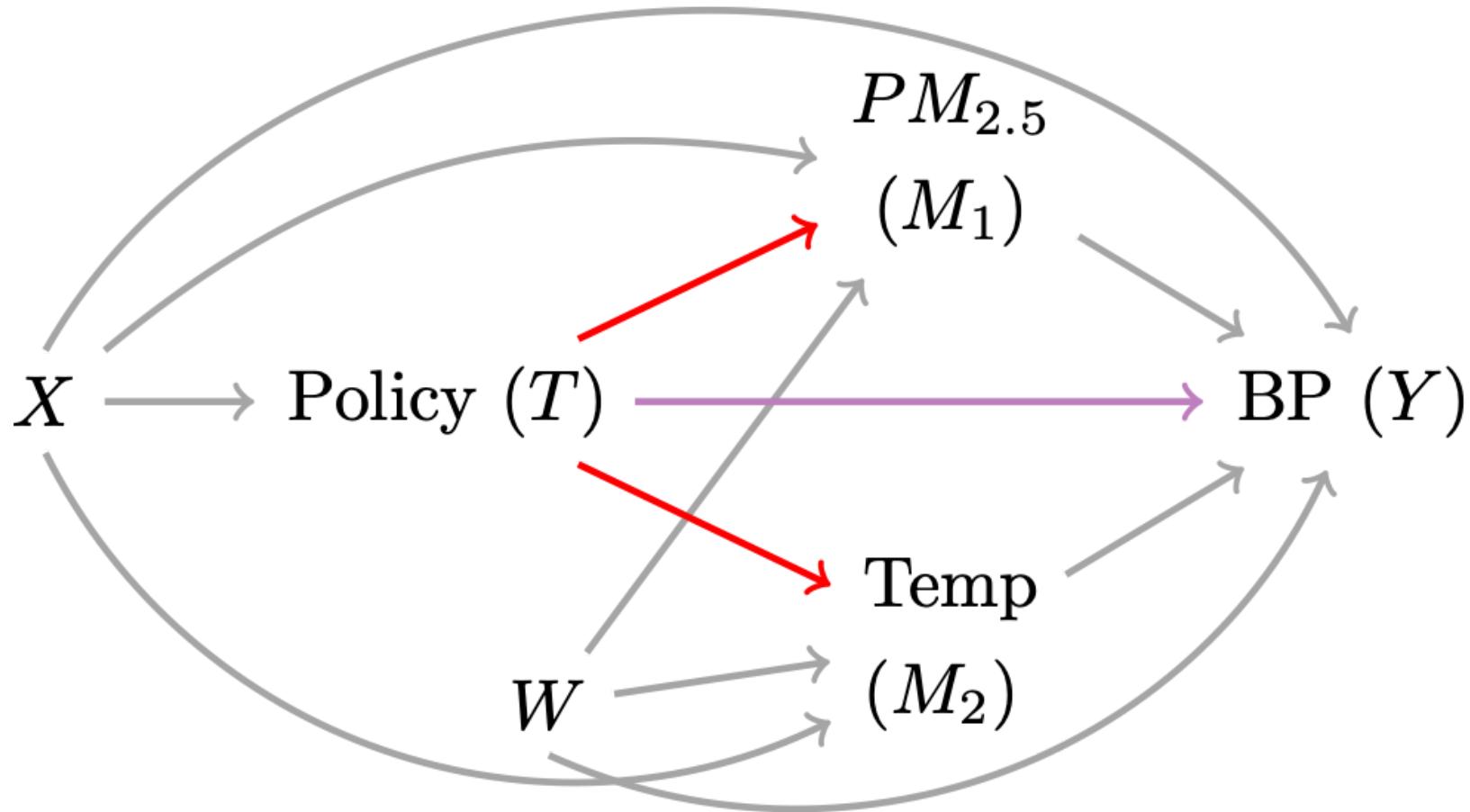
ETWFE models adjusted for household size, smoking, outdoor temperature, and outdoor dewpoint.

Policy increased indoor temperature

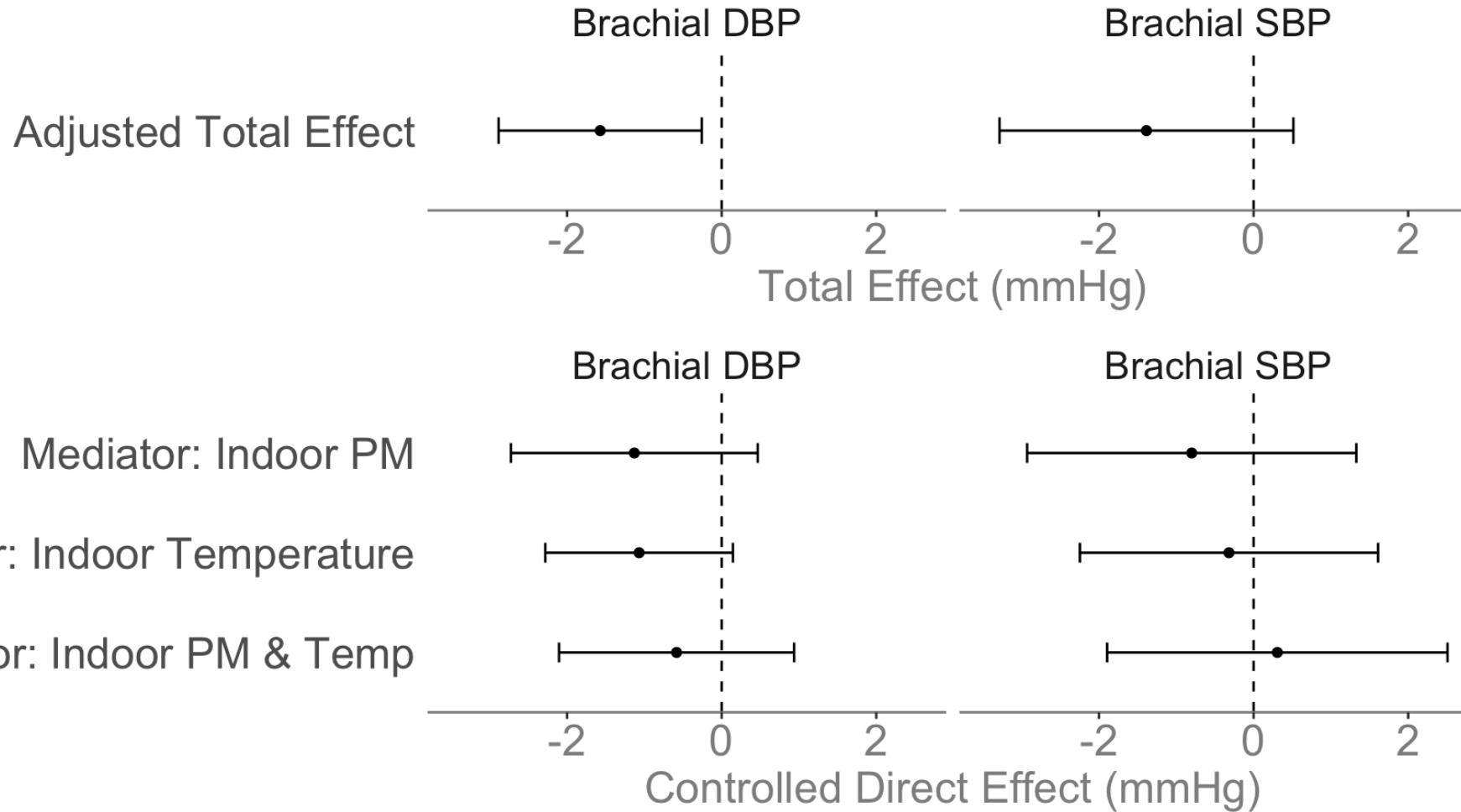
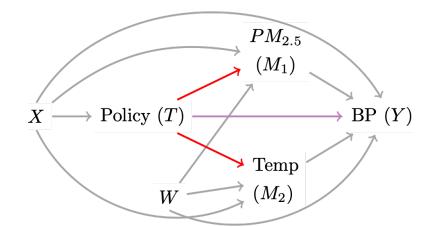


ETWFE models adjusted for the number of rooms and wintertime occupants in the household, age of the primary respondent, and wealth index.

Do $PM_{2.5}$ and temperature mediate the BP effect?

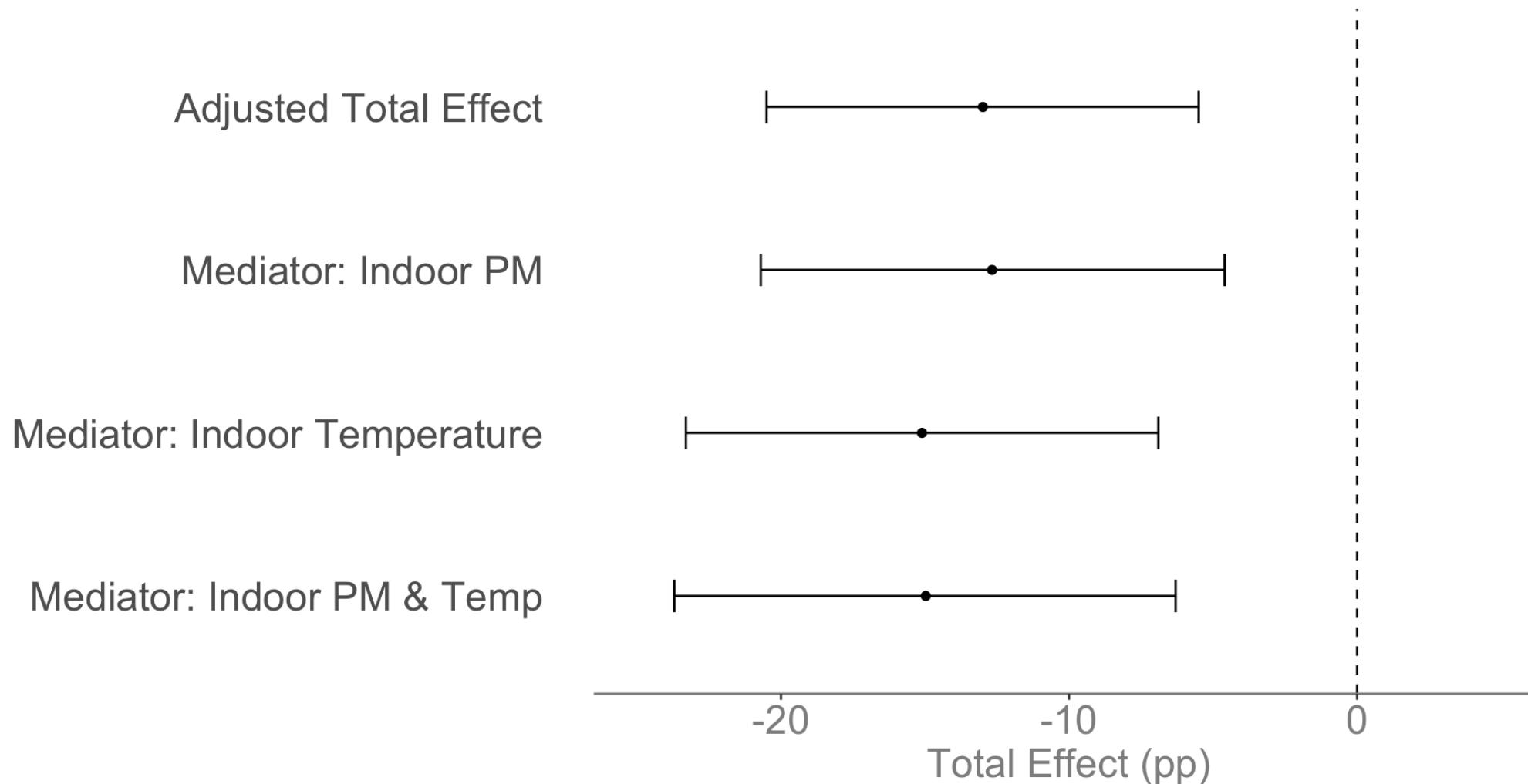


BP mostly mediated by PM_{2.5} and temp



ETWFE model with exposure-mediator interaction, adjusted for time-varying covariates.

Little mediation for respiratory symptoms



What Does It Mean?

Uptake

- High uptake and consistent use of the new heat pump technology.
- Persistent effects for early treated villages.
- Large reductions in coal use in treated villages.



Impacts

Air pollution

- Impacts on indoor PM_{2.5} but not personal exposures or outdoor PM_{2.5}
- Secular trends affected by large-scale policy changes
- Movement between indoor and outdoor

Health outcomes

- Overall lower BP, some evidence of heterogeneity
- Improvements in respiratory symptoms
- BP impacts largely mediated by PM_{2.5} and temperature



Questions?

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