

How Do Household Energy Transitions Work?*

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2024-10-05

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1 Introduction

China is deploying an ambitious policy to transition up to 70% of households in northern China from residential coal heating to electric or gas “clean” space heating, including a large-scale roll out across rural and peri-urban Beijing, referred to in this document as China’s Coal Ban and Heat Pump (CBHP) subsidy policy. To meet this target the Beijing municipal government announced a two-pronged program that designates coal-restricted areas and simultaneously offers subsidies to night-time electricity rates and for the purchase and installation of electric-powered heat pumps to replace traditional coal-heating stoves. The policy was piloted in 2015 and, starting in 2016, was rolled out on a village-by-village basis. The variability in when the policy was applied to each village allowed us to treat the roll-out of the program as a quasi-randomized intervention and evaluate its impacts on air quality and health. Household air pollution is a well-established risk factor for adverse health outcomes over the entire lifecourse, yet there is no consensus that clean energy interventions can improve these health outcomes based on evidence from randomized trials (Lai et al. 2024). Households may be differentially affected by the CBHP due to factors such as financial constraints and user preferences, and there is uncertainty about whether and how the policy may affect indoor and outdoor air pollution, as well as heating behaviors and health outcomes.

1.1 Subheading

1.1.1 Sub-subheading

1.1.2 Personal exposure

Table 1 shows limited evidence that the *ATTs* across cohorts and time demonstrate meaningful heterogeneity.

Table 1: Heterogenous treatment effects: Personal exposures

Cohort	Time	PM2.5		Black carbon	
		ATT ^a	(95% CI)	ATT ^b	(95% CI)
Average ATT					
All	All	0.17	(-19.6, 19.9)	-0.43	(-1.5, 0.6)
Cohort-Time ATTs					
2019	2019	7.43	(-24.4, 39.2)	-0.86	(-1.9, 0.2)
2019	2021	-12.97	(-36.6, 10.6)	-0.38	(-2, 1.2)
2020	2021	15.73	(-34.8, 66.3)	-0.14	(-1.8, 1.5)
2021	2021	-13.68	(-36.6, 9.3)	0.13	(-1.4, 1.6)

Note: ATT = Average Treatment Effect on the Treated, CI = confidence interval

^a Joint test that all cohort-time ATTs are equal: $F(3, 1260) = 0.501$, $p = 0.682$

^b Joint test that all cohort-time ATTs are equal: $F(3, 1151) = 0.965$, $p = 0.408$

1.1.3 Mediation analyses for blood pressure

Table 2 shows the cohort-time treatment effects for the mediation model for blood pressure.

Abbreviations and other terms

ATT

Lai PS, Lam NL, Gallery B, Lee AG, Adair-Rohani H, Alexander D, et al. 2024. Household Air Pollution Interventions to Improve Health in Low- and Middle-Income Countries: An Official American Thoracic Society Research Statement. *American Journal of Respiratory and Critical Care Medicine* 209:909–927; doi:[10.1164/rccm.202402-0398ST](https://doi.org/10.1164/rccm.202402-0398ST).

Table 2: Heterogenous treatment effects for blood pressure mediation model.

		Adjusted Total Effect		CDE Mediated By:						
Cohort	Time	ATT ^a	(95% CI)	Indoor PM		Indoor Temp		PM + Temp		
				ATT ^b	(95% CI)	ATT ^b	(95% CI)	ATT ^b	(95% CI)	
Brachial SBP										
2019	2019	-2.36	(-5.23, 0.50)	-2.15	(-5.14, 0.84)	-1.69	(-4.54, 1.15)	-1.24	(-4.20, 1.72)	
2019	2021	-1.51	(-4.01, 0.98)	-1.27	(-4.01, 1.47)	-0.41	(-2.92, 2.10)	0.01	(-2.71, 2.74)	
2020	2021	-1.26	(-4.97, 2.45)	-0.54	(-4.25, 3.17)	0.43	(-2.86, 3.73)	1.04	(-2.59, 4.67)	
2021	2021	2.39	(-0.49, 5.28)	2.68	(-0.42, 5.79)	1.95	(-1.74, 5.64)	1.88	(-1.92, 5.67)	
Central SBP										
2019	2019	-2.03	(-4.69, 0.63)	-1.75	(-4.61, 1.11)	-1.40	(-4.06, 1.27)	-0.89	(-3.73, 1.95)	
2019	2021	-1.96	(-4.45, 0.52)	-1.65	(-4.40, 1.11)	-0.93	(-3.18, 1.32)	-0.44	(-2.95, 2.07)	
2020	2021	-1.78	(-5.07, 1.52)	-1.00	(-4.36, 2.36)	-0.15	(-3.18, 2.88)	0.47	(-2.95, 3.89)	
2021	2021	2.11	(-1.09, 5.31)	2.45	(-0.83, 5.73)	1.66	(-1.73, 5.05)	1.63	(-1.82, 5.08)	
Brachial DBP										
2019	2019	-2.66	(-4.67, -0.65)	-2.47	(-4.70, -0.25)	-2.29	(-4.18, -0.40)	-1.94	(-4.03, 0.14)	
2019	2021	-2.37	(-4.01, -0.72)	-2.10	(-4.09, -0.11)	-1.81	(-3.21, -0.41)	-1.50	(-3.28, 0.27)	
2020	2021	0.20	(-1.54, 1.94)	0.31	(-1.43, 2.04)	1.14	(-0.65, 2.94)	1.23	(-0.70, 3.15)	
2021	2021	0.78	(-0.48, 2.05)	1.05	(-0.59, 2.69)	0.20	(-1.21, 1.62)	0.36	(-1.34, 2.06)	
Central DBP										
2019	2019	-2.67	(-4.57, -0.78)	-2.43	(-4.58, -0.28)	-2.52	(-4.34, -0.70)	-2.13	(-4.18, -0.08)	
2019	2021	-2.55	(-4.15, -0.94)	-2.20	(-4.18, -0.22)	-2.18	(-3.60, -0.76)	-1.80	(-3.58, -0.03)	
2020	2021	0.11	(-1.67, 1.90)	0.22	(-1.58, 2.01)	1.07	(-0.74, 2.87)	1.16	(-0.80, 3.13)	
2021	2021	1.09	(-0.06, 2.23)	1.39	(-0.16, 2.94)	0.51	(-0.80, 1.82)	0.70	(-0.94, 2.34)	

Note: Results combined across 30 multiply-imputed datasets. ATT = Average Treatment Effect on the Treated, CDE = Controlled Direct Effect, DBP = Diastolic blood pressure, SBP = Systolic blood pressure.

^a Adjusted for age, sex, waist circumference, smoking, alcohol consumption, and use of blood pressure medication.

^b Mediators were set to the mean value for untreated participants at baseline.