How Do Household Energy Transitions Work?*

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Table of contents

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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 **?@tbl-a-het-personal** shows limited evidence that the *ATT*s across cohorts and time demonstrate meaningful heterogeneity.

```
temp_table <- read_xlsx(here("outputs",
  "chemical composition tables.xlsx"), sheet = "outdoor")

temp_table_out <- temp_table %>%
  pivot_longer(cols = -wave) %>%
  separate_wider_delim(value,
    delim = "(", names = c("conc", "ci")) %>%
  mutate(ci = paste("(", ci, sep = "")) %>%
  pivot_wider(names_from = wave,
    values_from = c(conc, ci),
    names_vary = "slowest")

colnames(temp_table_out) <- c("Name", "Mean", "95% CI",
  "Mean", "95% CI", "Mean", "95% CI")

tt(temp_table_out) %>%
    group_tt(j = list(
    "Wave 1" = 2:3,
    "Wave 2" = 4:5,
    "Wave 4" = 6:7)) %>%
  format_tt(escape = TRUE)
```

	Wave 1		Wave 2		Wave 4	
Name	Mean	95% CI	Mean	95% CI	Mean	95% CI
Al	110	(108-113)	66.7	(65.5-67.8)	60.9	(59.8-62.1)
Fe	85.2	(82.9-87.5)	57.9	(57-58.9)	64.1	(63-65.2)
Pb	6.26	(5.82-6.71)	4.32	(4.06-4.57)	7.69	(7.27-8.11)
Si	139	(136-142)	76.7	(75.4-77.9)	128	(126-129)
Chloride	56.1	(54.5-57.8)	32.2	(31.5-32.9)	15.6	(14.9-16.4)
EC	123	(121-125)	112	(111-113)	103	(101-104)
ws-Na	11.4	(10.8-12)	9.28	(8.88-9.68)	9.23	(8.76-9.7)
Ammonium	136	(133-138)	152	(151-154)	78.3	(77.3-79.4)
Nitrate	225	(222-227)	259	(257-261)	146	(145-148)
ns-S	87	(85.3-88.7)	70	(69.2-70.9)	75.9	(74.9-76.9)
OC	1080	(1070-1080)	901	(898-904)	649	(645-653)
Sulfate	223	(220-225)	206	(205-208)	132	(131-134)
wi-Ca	79.4	(77.2-81.7)	40.7	(39.8-41.6)	79	(77.6-80.4)
wi-K	81.4	(79.5-83.3)	33.7	(33-34.3)	37.8	(37-38.6)
wi-Mg	39.8	(38.6-41)	21.2	(20.6-21.7)	38.6	(37.7-39.4)
ws-Ca	33.5	(32.5-34.5)	23.5	(22.8-24.2)	15.1	(14.3-15.9)
ws-K	52.4	(50.8-54)	25.4	(24.9-25.9)	17.9	(17.4-18.4)
ws-Mg	6.98	(6.41-7.55)	3.19	(2.97-3.41)	2.96	(2.72-3.2)

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.