College of Public Health and Human Sciences

Household Air Pollution and Lung Function in Adults

-- Results from PURE study

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Household air pollution (HAP) vs. health

- HAP is estimated to be responsible for **2.6 million deaths** each year worldwide

- **3 billion people** at risk due to reliance upon cooking and heating with solid fuels

- **Solid fuels:** wood, coal, animal dung, crops, etc.

Research Gaps: Air pollution vs. Lung function

Previous studies:

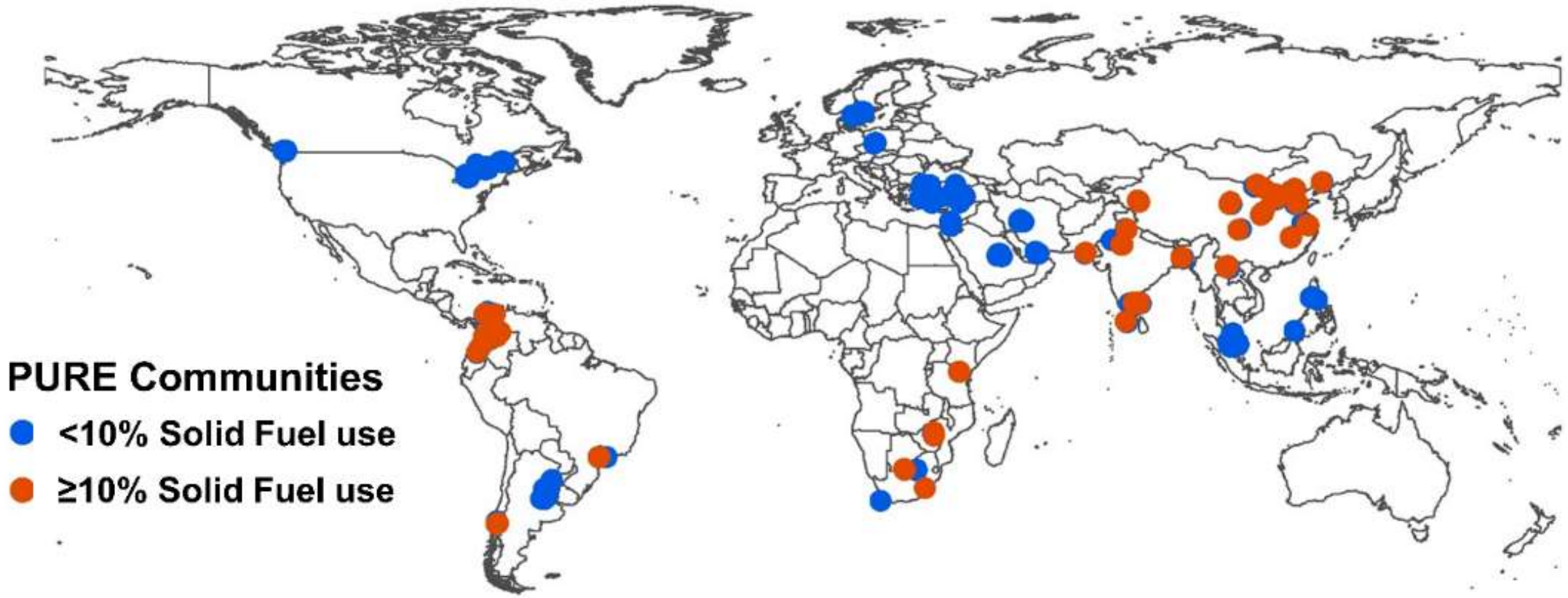
- Focus on ambient air pollution and health
- Most in developed countries

Few studies on HAP and health

- Lack of evaluation of lung function
- Most with small sample size (< 100)
- Limited geographic settings

Prospective Urban and Rural Epidemiology (PURE) Study

11 countries (Bangladesh, Brazil, Chile, China, Colombia, India, Pakistan, Philippines, South Africa, Tanzania, and Zimbabwe) → 28 centers → 191 rural communities (≥10% using solid fuel primarily for cooking) → 39,772 individuals (35-70 yrs old)



Exposure Assessment

Using proxy: solid fuel for cooking to represent exposure to HAP

b) Primary fuel used for cooking (check one only)

☐ Kerosene ☐ Charcoal ☐ Coal ☐ Gas ☐ Wood ☐ Agriculture/crop ☐ Gobar gas

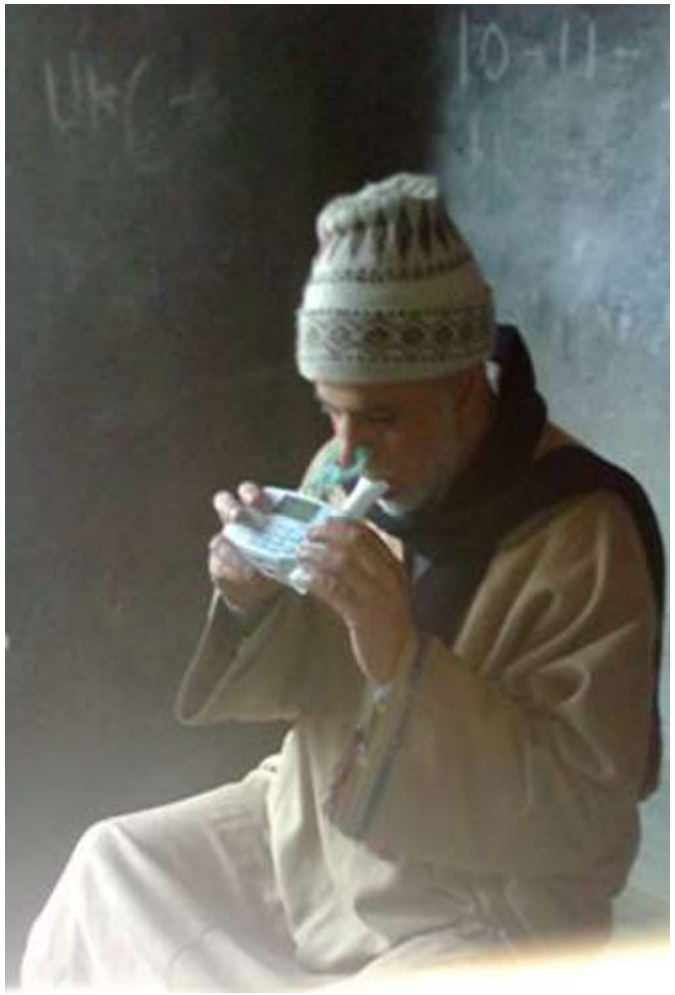
☐ Electricity ☐ Animal dung ☐ Shrub/grass ☐ Other _____

Solid fuel (charcoal, coal, wood, agricultural/crop, animal dung, shrub/grass) vs. gas/electricity

vs.

Health outcome: Lung function

- Important predictor of health and longevity
- FEV1 (forced expiratory volume in 1 second) and FVC (forced vital capacity): predictors for CVD, COPD
- FEV1: an independent predictor of mortality, CVD, and respiratory diseases
- Smokers usually have 200 ml decrease of FEV1 vs. non-smokers



Descriptive Statistics

- 39,772 individuals
  - 57% from China
  - 28% from South Asia: India, Pakistan, Bangladesh
  - 15% from Other countries

Characteristic	Solid fuel	Clean fuel
Education n (%)		
≤ Primary	17,362 (62.1%)	6,093 (51.6%)
Secondary	9,797 (35.0%)	5,061 (42.8%)
Trade/college	664 (2.4%)	613 (5.2%)
Missing	138 (0.5%)	44 (0.4%)
Household wealth index (tertile) n (%)		
T1 (lowest)	17,678 (63.2%)	4,382 (37.1%)
T2 (middle)	8,050 (28.8%)	4,694 (39.7%)
T3 (highest)	2,209 (7.9%)	2,734 (23.2%)
Missing	24 (0.1%)	1 (0.0%)
Smoking n (%)		
Former	1,447 (5.2%)	906 (7.7%)
Current	7,247 (25.9%)	2,681 (22.7%)
Never	18,825 (67.3%)	8,085 (68.4%)
Missing	442 (1.6%)	139 (1.2%)
BMI (mean ±SD) kg/m^2	23.3 (4.3)	25.3 (4.6)
Ambient PM2.5 (mean ±SD) ug/m^3	38.5(21.3)	36.6 (23.8)
*Baseline respiratory conditions n (%)**		
Yes	1,209 (4.3%)	395 (3.3%)
No	22,749 (81.4%)	10,804 (91.5%)
Missing	4,003 (14.3%)	612 (5.2%)

* Baseline chronic respiratory conditions including asthma, COPD, and TB

Lung function among solid fuel and clean fuel users

n = 39,772 (Reference: clean fuel users)

Hypothesis: solid fuel users have reduced lung function comparing to clean fuel users

	Lung function outcomes		
Model	*FEV1 **ml** mean (95%CI)*	*FVC **ml** mean (95%CI)*	*FEV1/FVC % mean (95%CI)*
Model 1 (base model)	**-18.37** (-30.95, -5.79)	-2.81 (-17.37, 11.76)	**-0.52** (-0.77 -0.26)
Model 2 (add personal risk factors)	**-13.78** (-26.46, -1.10)	-1.97 (-16.68, 12.74)	**-0.39** (-0.65, -0.13)
Model 3 (add SES factors)	-8.08 (-21.33, 5.17)	1.79 (-13.58, 17.16)	**-0.27** (-0.54, -0.001)

Model 1: solid fuel + age + sex + height+ community random effect + center fixed effect

Model 2: Model 1 + BMI + smoking status+ ambient PM2.5+ baseline respiratory conditions

Model 3: Model 2 + education+ household wealth index + % income on food

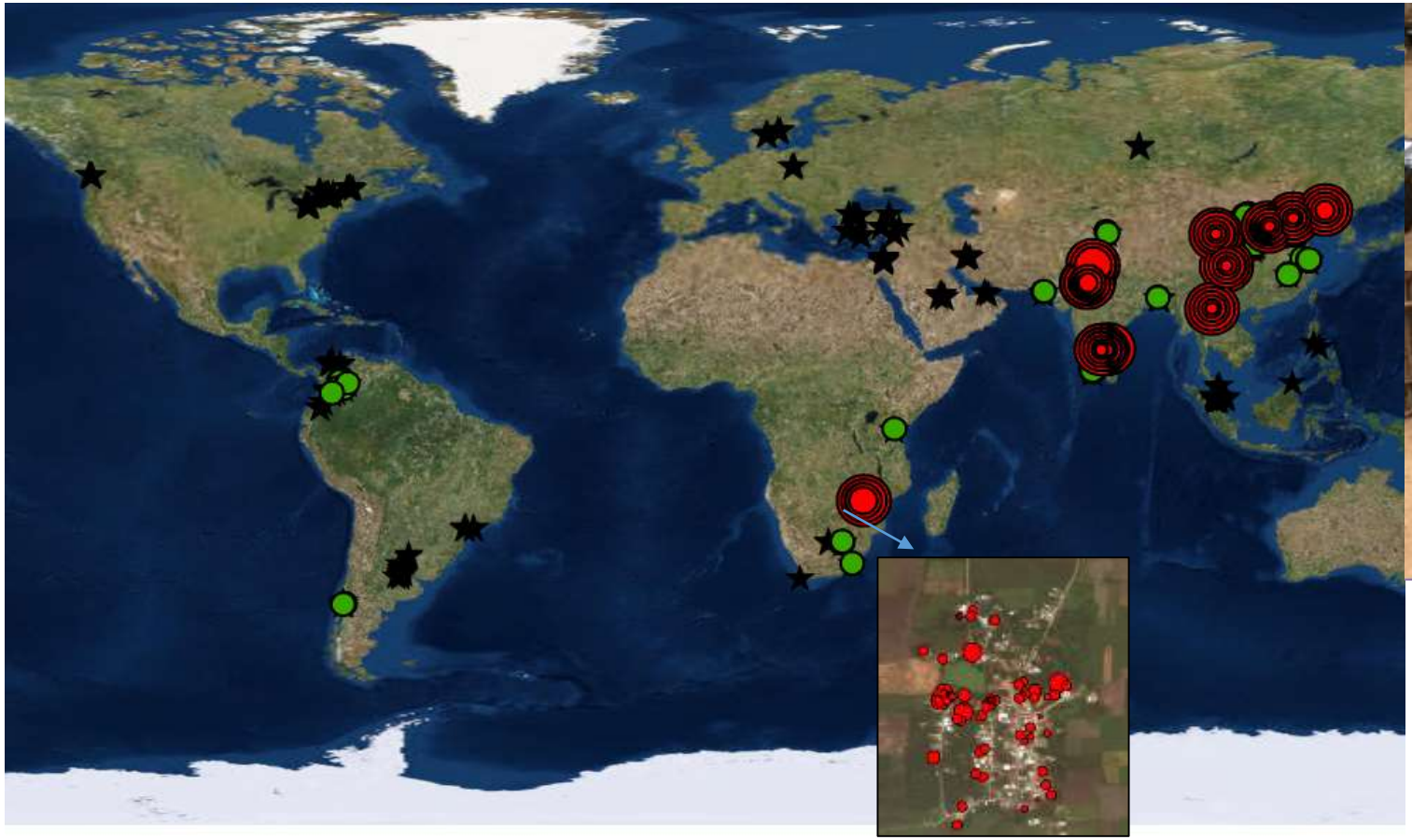
* Missing data indicator terms were modeled for categorical variables with missing data

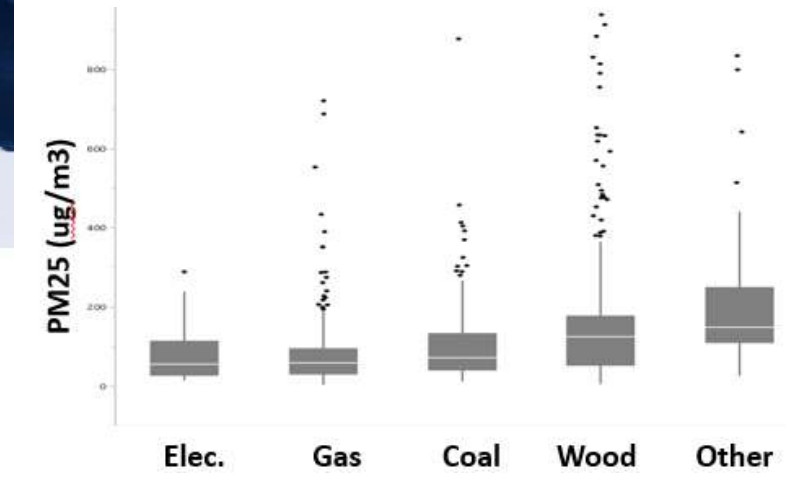
Stratified Analysis: Solid fuel vs. Lung function

	n	*FEV_1 ml* mean (95% CI)	*FVC ml* mean (95% CI)	*FEV_1/FVC %* mean (95% CI)
Region				
China	20,946	-**20.08** (-37.28, -2.89)	-5.64 (-25.87, 14.58)	-**0.51** (-0.86, -0.15)
South Asia	10,210	-13.43 (-46.36 19.50)	-20.70 (-57.70, 16.30)	0.34 (-0.28, 0.97)
Other	7,754	15.07 (-20.90, 51.04)	23.65 (-16.26, 63.56)	-0.14 (-0.86, 0.59)
Age group				
>=55	12661	17.41 (-7.36, 42.18)	11.44 (-17.06, 39.94)	0.051 (-0.49, 0.59)
<55	27111	-**22.90** (-40.23, -5.57)	-7.92 (-27.98, 12.14)	-0.33 (-0.67, 0.01)
Household asset index				
T1 poor	22060	-7.89 (-29.95, 14.18)	10.67 (-15.14, 36.48)	-**0.58** (-1.05, -0.11)
T2 middle	12744	-**25.41** (-48.34, -2.48)	-21.14 (-47.34, 5.06)	-0.19 (-0.64, 0.26)
T3 rich	4943	0.57 (-32.63, 33.77)	8.97 (-28.52, 46.46)	-0.021 (-0.61, 0.56)
Outdoor $PM_{2.5}$ ($\mu g/m^3$)				
<50	24541	-3.89 (-23.94, 16.17)	3.74 (-19.53, 27.01)	-0.12 (-0.51, 0.27)
>=50	15231	-**21.30** (-41.11, -1.49)	-11.08 (-33.99, 11.82)	-0.41 (-0.84, 0.011)

Model 3: solid fuel, community random effect, center fixed effect, age, sex, height, smoking, BMI (continuous), baseline respiratory conditions, outdoor PM2.5, education, % income spent on food, and household wealth index tertile

Sensitivity analysis: PM2.5 vs. Lung function





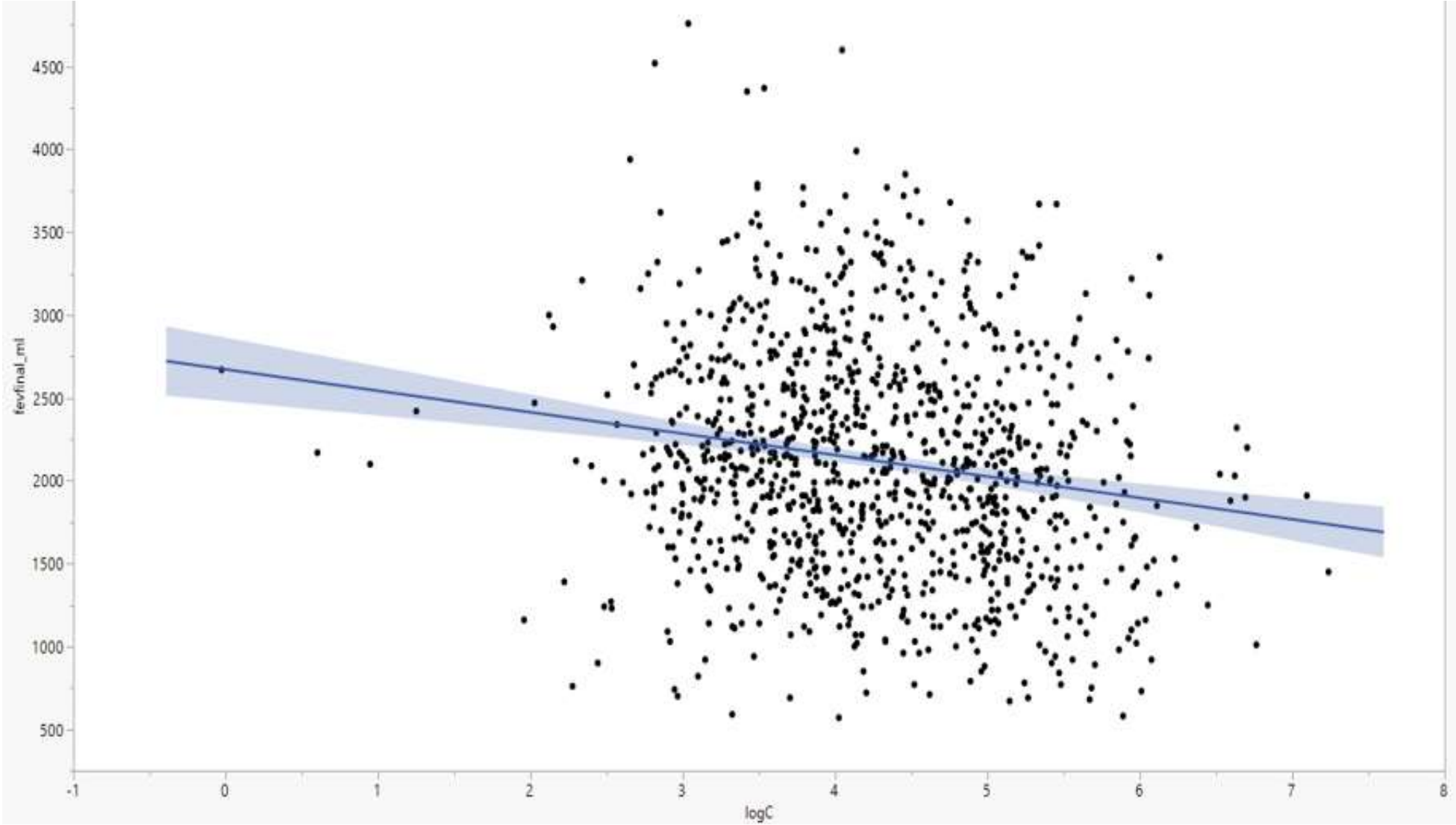
48-h kitchen PM2.5 vs. Fuel type

Household PM2.5 (ug/m3)

- 3 - 25
- 26 - 50
- 51 - 100
- 101 - 200
- 201 - 300
- >300

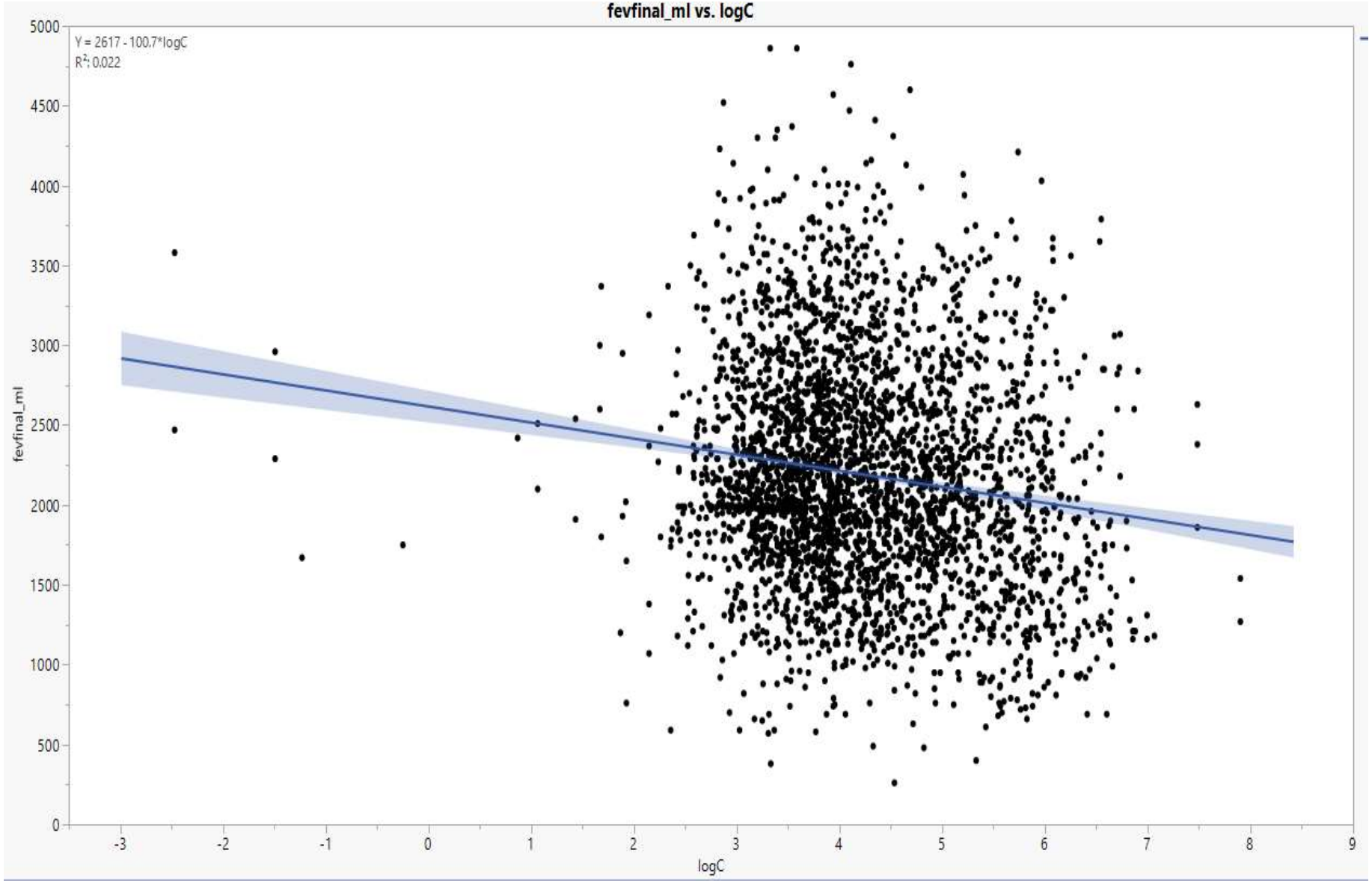
Monitoring Ongoing

Log Personal PM2.5 vs FEV1



X= log personal PM2.5
Y= FEV1 (ml)

Log Household PM2.5 vs FEV1



X= log household PM2.5
Y= FEV1 (ml)

Sensitivity analysis: PM2.5 vs. Lung function

Association of household PM2.5 or personal PM2.5 measured at follow-up visit and lung function at baseline, among people **not changing cooking fuel** from baseline to follow-up

	Household PM models n= 2606	Personal PM models n= 683
Lung Function mean (95%CI)	0.06 (-0.08, 0.19)	-0.26 (-0.63, 0.10)
FEV1 **ml**	0.01 (-0.14, 0.17)	-0.42 (-0.90, 0.07)
FVC **ml**	0.001 (-0.001, 0.004)	-0.001 (-0.01, 0.01)
FEV1/FVC **%**	0.001 (-0.001, 0.004)	-0.001 (-0.01, 0.01)
Model 3: PM, center fixed effect, community random effect, age, sex, height, smoking, BMI (continuous), baseline respiratory conditions, outdoor PM2.5, education, % income spent on food, and household wealth index tertile		

Next Steps

- Complete analysis of measured PM2.5 and lung function
  - Lung function collected after PM2.5 measures in China

- Develop model to predict PM2.5 concentrations for all PURE households

- Evaluate association of HAP and lung function **changing over time** using repeated measures

Conclusions

- Overall, no associations between HAP and lung function when adding SES factor
- Except small decrease in ratio of FEV1/FVC : **-0.27%** (-0.54, -0.001) for solid fuel users vs. clean fuel users
- Personal PM model having larger association than household PM model
- Important differences by region and individual/household characteristics: eg. larger associations in China, younger adult; middle-class; higher outdoor PM
- Although effect sizes were modest, which contributes new information on association between HAP and lung function

Thank you

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