



Indoor Air Pollution and Respiratory Health among Honduran Women

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This work was supported by the College Research Council, CSU; the Environmental Health Student Association, CSU; and SKC Inc.

ABSTRACT

Improved cookstoves have the potential to substantially reduce indoor air pollution. Studies examining the relationship between stove use and pulmonary function have been inconsistent, relying mostly on proxies of exposure, such as type of stove or fuel. We conducted a cross-sectional survey among 79 non-smoking Honduran women, 38 with traditional stoves and 41 with improved stoves with chimneys. For 59 of these women, particulate matter (PM_{2.5}) was assessed via 8-hour indoor, outdoor, and personal monitoring. Carbon monoxide (CO) was assessed via 8-hour indoor monitoring and 20-minute outdoor monitoring. Kitchen parameters, carbon dioxide, and relative humidity were determined to estimate ventilation rates that may affect CO and PM_{2.5}. Pulmonary function testing, including forced expiratory volume in one second (FEV₁) and peak expiratory flow (PEF), respiratory symptoms, and demographic characteristics were assessed. Stove quality was scored on a 4-level subjective scale representing potential for indoor emissions, ranging from poorly functioning traditional stoves to well-functioning improved stoves. Personal PM_{2.5} means corresponding to this scale were 236, 119, 82, and 66 µg/m³, respectively. Corresponding kitchen PM_{2.5} means were 1258, 532, 294, and 218 µg/m³, respectively; kitchen CO means were 9.18, 3.29, 1.30, and 0.16 ppm, respectively. Usual presence of cough, wheeze, and headache was reported more frequently among traditional stove users as compared to improved stove users (p<0.01). Data collected will allow for examination of the association between air quality measurements and respiratory function, while adjusting for important covariates.

BACKGROUND

- In 2000, more than 1.6 million deaths were attributed to indoor air pollution (IAP) exposures associated with the burning of solid fuels
- Nearly 50% of the world's population relies on biomass burning for cooking and heating
- Studies examining the relationship between stove use and adverse health effects have been inconsistent, relying mostly on proxies of exposure, such as type of stove, fuel, or time spent cooking
- Some indoor air pollution studies have demonstrated the importance of evaluating personal cooking practices and household parameters in addition to fuel and stove type
- Few studies have quantitatively assessed both indoor air pollution levels and health effects while adjusting for potential confounders
- Measure personal, indoor, and outdoor CO and PM_{2.5} concentrations
- Evaluate the contribution of domestic factors (fuel type, cooking practices, and housing conditions) on measured indoor air pollution concentrations
- Develop a four-level subjective stove scale and assess how well the scale predicts quantitative air quality measurements
- Perform lung function measurements and ascertain respiratory symptom prevalence, and determine whether impaired lung function is associated with exposure to elevated personal/indoor air pollution concentrations

METHODS

- Cross-sectional study of 79 women; 41 with improved (*Justa*) stoves with chimneys and 38 with traditional stoves
- All 79 women: housing survey, questionnaire, lung function, and finger-stick blood sample
- Additional measurements for a subset of 59 women: personal, indoor, and outdoor air quality monitoring



EXPOSURE ASSESSMENT:

- PM_{2.5}: Time-weighted 8-hr personal, indoor, and outdoor monitoring; Samples collected on filters using calibrated sampling pumps; PEM samplers (SKC Inc., PA)
- CO (carbon dioxide, temperature, relative humidity): 8-hr indoor monitoring and 10-min outdoor monitoring before and after indoor monitoring; Data logged at 1-min intervals; Q-TRAK Plus IAQ Monitor (TSI Inc., MN)
- Housing Survey: Investigators recorded kitchen volume, building materials, and size of eaves and windows
- Questionnaire: Ascertained data on cooking practices (years using stove, fuel, cooking time)
- Stove scale: Investigators assessed stove quality using a 4-level subjective scale representing potential for indoor emissions, based on factors such as stove condition and maintenance

OUTCOME ASSESSMENT:

- Lung function: PEF and FEV₁; portable PiKo-1 peak flow meter (Pulmonary Data Services, Inc., CO); Participant performed 3 acceptable maneuvers and mean and maximum were recorded
- Questionnaire: standardized respiratory symptoms and diseases (American Thoracic Society)
- Height, weight, and waist circumference measured
- Finger-stick blood samples collected and dried on filter paper to measure a marker of inflammation (C-reactive protein, CRP)



Table 1. Demographic characteristics and respiratory symptoms among traditional and improved stove users (n=79).

	Traditional stove users (n=38)	Improved stove users (n=41)	p-value
<i>Demographic characteristics: mean (standard deviation)</i>			
Age (years)	37.8 (15.7)	45.0 (13.0)	0.03
Body Mass Index	25.6 (3.5)	26.9 (5.2)	0.20
Height (inches)	60.0 (2.7)	59.0 (2.1)	0.08
Education (years)	3.9 (2.8)	3.9 (2.6)	0.94
<i>Respiratory symptoms: number (percent)</i>			
Cough ¹	11 (29.0)	2 (4.9)	<0.01
Phlegm ²	7 (18.4)	3 (7.3)	0.18
Wheeze ³	9 (23.7)	0 (0)	<0.01
Nasal irritation ⁴	11 (29.0)	11 (26.8)	0.83
Headache ⁵	16 (42.1)	5 (12.2)	<0.01

1: Do you usually have a cough?
2: Do you usually develop a phlegm from your chest?
3: Does your chest usually sound wheezy or whistling?
4: Do you have current nasal stuffiness, runny nose, sneezing, and/or nasal itch?
5: Do you usually develop a headache during cooking?

FUTURE ANALYSES

- Utilize multivariate regression methods to determine which combination of parameters (stove quality, cooking habits, and factors affecting ventilation rates) most accurately predicts air quality measurements
- Evaluate the multivariate relationship between personal and indoor air quality and health effects (respiratory symptoms, lung function, and C-reactive protein levels)
- Assess the effect of outdoor air pollution on the relationship between personal/indoor air pollution and respiratory health

SUMMARY AND CONCLUSION

- The usual presence of cough, wheeze, and headache was reported more frequently among traditional stove users as compared to women with improved stoves (Table 1)
- Women with traditional stoves reported more severe, current symptoms, including cough and eye irritation, as compared to women with improved stoves (data not shown)
- Varying levels of indoor air pollution measured in homes with improved stoves support the use of a multi-level stove scale (Figure 1)
- Use of a stove scale in conjunction with factors affecting ventilation could provide a cost-effective alternative to air quality monitoring
- Results may provide the foundation for future intervention strategies and large-scale prospective epidemiologic investigations

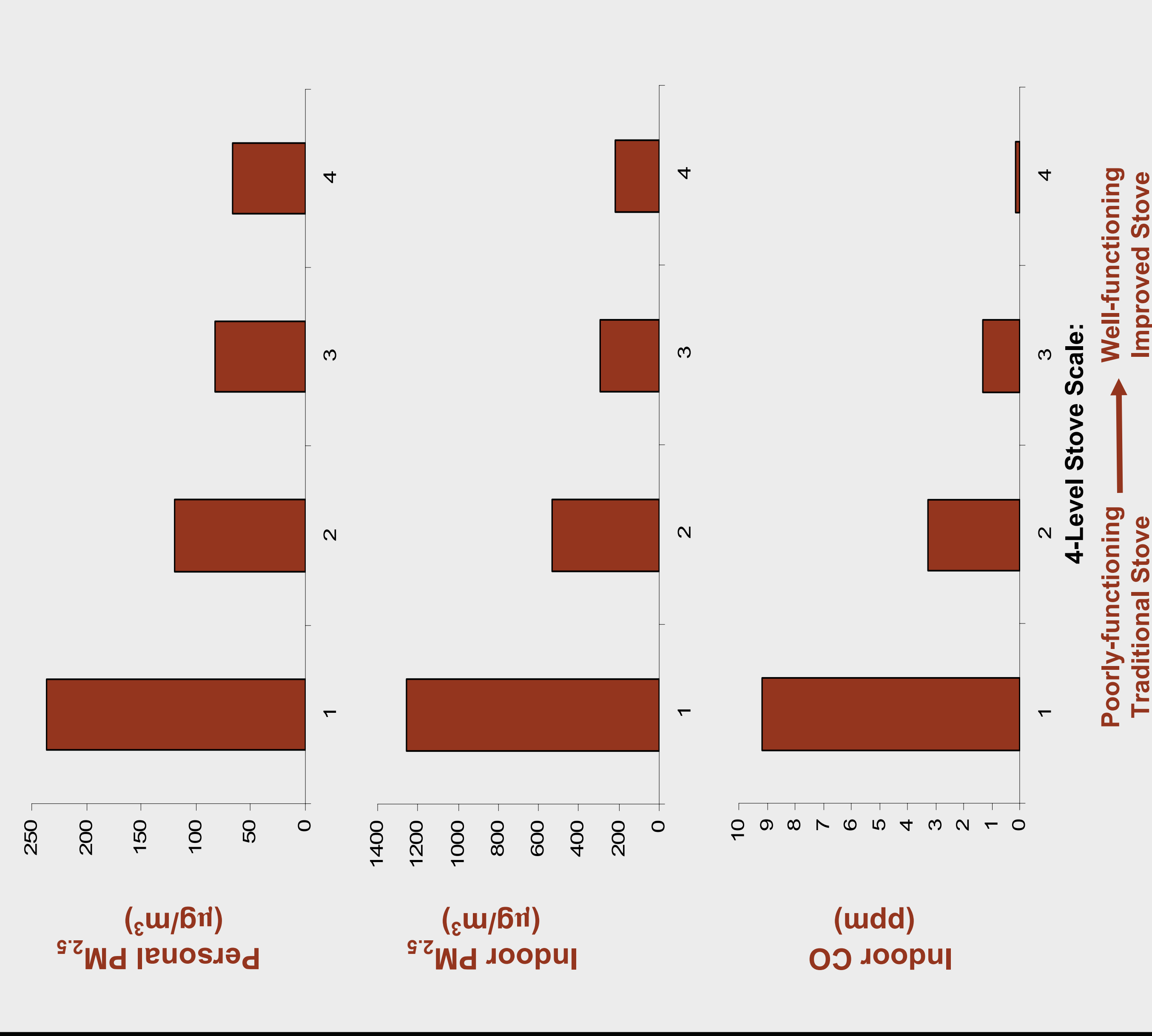


Figure 1. Personal PM_{2.5}, Indoor PM_{2.5}, and Indoor CO 8-hour mean concentrations corresponding to a subjective stove scale (n=59).