Assessing and Modeling Exposure to Indoor Air Pollution among Rural Women in Guatemala

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Abstract: Cooking stoves that rely on biomass fuel are a major source of indoor air pollution in rural areas of developing countries. It is estimated that about half (53%) of all households in the poor countries of Latin American use biofuels (wood, dung and/or crop residues) to cook. Combustion by-products cause significant mortality and morbidity in the developing countries. The World Health Organization's World Health Report 2002 estimates that exposure to by-products of biofuel combustion may be responsible for 40% of acute lower respiratory infection and 20% of Chronic Obstructive Pulmonary Disease in the poor nations of Latin America. The purpose of this study, conducted in Summer, 2002, was to model indoor air pollution exposures to carbon monoxide and particulate matter and to characterize pulmonary effects in 88 households in rural Guatemala among houses that use open fires for cooking (n=45) and houses that use improved cookstoves (*planchas*) with chimney flues (n=43). The following hypotheses were tested: 1) households that have chimney-vented biofuel stoves and other structural characteristics, such as cross ventilation and separate kitchen areas, will have lower exposure to by-products of fuel combustion as compared to households that use open fires; 2) women who live in homes with chimney-vented biofuel stoves will have better pulmonary function with spirometry testing and less irritative pulmonary symptoms as compared to women who use open fires; and 3) characterization of household types by floor and roof materials, door and window openings will assist in creating an exposure model. There were significant differences in exposures to carbon monoxide (CO diffusion tubes, open fire: 8.68 ppm; *plancha*: 5.57 ppm , Mann-Whitney U, < 0.001) and particulate matter (PM_4, open fire: 1740 $\mu g/m^3$; *plancha*: 267 $\mu g/m^3$, Mann-Whitney U, 0.004). Exhaled breath CO between the two groups showed statistically significant increased levels in the open fire group for both before and after fire measurements as compared to the *plancha* group (Mann-Whitney U, 0.034). A linear regression model using a subset of these households (n=29) demonstrated that there was a decrease in after fire Forced Vital Capacity (FVC, a pulmonary function parameter) that could be explained by household structural and ventilation characteristics, the presence of wheeze, as well as carbon monoxide exposure measures, with a resulting adjusted $r^2 = 0.723$. Since monitoring pollution levels is difficult and expensive, the long-run purpose of the models presented in this study would enable an estimation of exposures by using demographic and household parameters that can be determined by survey alone.