Poor urban environments: use of paraffin and other fuels as sources of indoor air pollution

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Table 1 Adjusted linear regression model of maximum hourly mean CO level by pattern of paraffin use compared with no paraffin use*

	Ratio of means	95% Confidence intervals
No paraffin	1.0	
Paraffin for any one of cooking, heating or lighting	1.11	0.67, 1.83
Paraffin for any two of cooking, heating or lighting	1.97	1.33, 2.92
Paraffin for cooking, heating and lighting	2.06	1.30, 3.25
Number of people per room in household	1.05	0.94, 1.17
Number of people smoking in the house at the time of monitoring	0.82	0.53, 1.27

*Model adjusted $r=0.213$.

Indoor air pollution in poor communities may arise largely from dependence on combustible fuels. This study aimed to describe exposure to indoor air pollutants during winter in a poor urban environment where a range of fuel types, including paraffin, are used.

Method

A stratified random sample of 75 houses was used, with stratification into four zones being based on housing type and availability of electricity. Air sampling was conducted at times to include peak fuel use periods in each household using electrochemical Exotox Model 75 continuous monitors (calibrated daily) for sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO) and temperature and humidity; and Gill Air model 224-XR pumps for total suspended particulates (TSP). Data on fuel utilisation, household ventilation (including opening of doors or windows) during the monitoring period and household characteristics (including chimneys) were collected on the day after the air monitoring using an interviewer administered questionnaire.

Maximum hourly average values of SO_2 , NO_2 and CO were modelled against fuel use patterns using linear regression models. Log transformations of the pollutant levels were used to represent the positively skewed distributions of air pollutant levels. Households were categorised according to the patterns of use of paraffin as follows: (a) no paraffin use; (b) paraffin used for any one of the following: cooking, heating, lighting; (c) paraffin used for any two of the above; (d) paraffin used for all three of the above activities. Adjustment was made for crowding (number of people per room in the house) and smoking in the home at the time of monitoring.

Results

Questionnaires and air pollution data from 72 households were collected. Fifty two of the households reported using at least two different fuels during the monitoring period. Electricity

(69% of households) and paraffin (64% of households) were the most commonly used fuels. Gas and wood were used in only 10% and 4% of households respectively, and then only in combination with electricity or paraffin. No houses had chimneys and all but two houses reported opening of windows or doors to circulate fresh air during the monitoring period.

The mean maximum hourly average was 0.015 ppm (range 0.00–0.24) for NO_2 , 0.54 ppm (range 0.00–6.77) for SO_2 and 29.64 ppm (range 0.00–338.98) for CO. The number of households where standards were exceeded by the maximum hourly averages by NO_2 and CO was six (9%) and 20 (30%) respectively (WHO standard) and for SO_2 the number was 28 (42%) (Californian standard) (no WHO or USEPA standard for maximum hourly average for SO_2 exists). TSP measures ranged from a minimum of 7.15 $\mu\text{g}/\text{m}^3$ to a maximum of 432.59 $\mu\text{g}/\text{m}^3$. Comparisons of TSP levels with international standards have not been made, as these are now centred around PM10 and PM2.5 particles.

Table 1 shows the positive association between paraffin use and indoor CO levels. Results of the modelling of pollutant levels of SO_2 , NO_2 and TSP against pattern of fuel use showed no significant associations. There was no significant association between temperature and pollutant levels.

Discussion

Paraffin was the most commonly used alternative fuel to electricity in this sample. Standards for SO_2 and CO were exceeded in a large proportion of houses, and for NO_2 in a much lesser proportion. The significant association between paraffin use and CO is important. The effects of CO exposure may range from no appreciable health effect at very low levels through to shortness of breath, headaches, irritability, unconsciousness and death with increasingly high levels of exposure.^{1,2} Importantly, chronic low levels of indoor CO exposure may exacerbate ischaemic heart symptoms in patients with cardiovascular disease, impair exercise capacity of patients with cardiopulmonary disease, and may impair exercise capacity of normal subjects.¹ Besides the effects of combustion, the use of paraffin as a household fuel has other demonstrated health effects, including respiratory effects as a complication of ingestion.^{3,4} The financial cost of using electricity for individual families is such that paraffin will continue to be widely used, and measures to reduce the resulting exposure to pollutants need to be explored.

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