Source strengths of fine particulate matter during various domestic activities

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The indoor environment harbours a range of particulate matter (PM) sources and studies have documented them and their emission rates. The indoor sources of PM may be less variable, than those outdoors, on a global scale however the resultant levels are dependent on build types and use, which are influenced by range of socio-environmental factors. Knowledge of the contribution of various household activities to indoor PM is vital to advance exposure estimates

The present study was part of a larger study (Sidra *et al.*, 2015) and monitored levels of $PM_{2.5}$ during different household activities in residential built environments of Lahore, Pakistan. Thirty households were selected from all over the metropolis and real time monitoring of fine particulate matter was conducted using a DustTrak aerosol monitor (model 8520, TSI Inc.). Monitoring was conducted for a period of 72 hours in the kitchens and living rooms of each sampling site and the occupants were required to maintain an activity diary as well to document the various activities during the day.

The source strengths of PM arising from different activities were determined by identifying the time period during which a specific activity was performed and calculating the average levels of $PM_{2.5}$ during that time. The major activities identified included cooking, cleaning, material movement such as making beds and shifting of items, presence of people, space heating during winters and cigarette smoking. In Pakistan, cooking involves heavy frying particularly during breakfast preparation so the cooking activity was further divided into two categories: cooking including extensive frying (during breakfast), and cooking with little or no frying (during lunch and dinner). Cleaning activities included both floor sweeping and dusting of surfaces. Gas heaters were employed during the winter season for space heating and PM levels during the usage period were also isolated to determine its impact on indoor air quality. The average $PM_{2.5}$ along with maximum and minimum levels generated while performing different activities is summarized in table 1.

The average time spent in performing each activity was also noted. It was observed that cooking consumed most time of the day as preparation of three square meals took an average of 4-5 hours. Cleaning consumed 30-45 minutes per day, while movement of people while getting ready for work or school, material movement or to perform any other activity was random. On questioning the occupants, it was revealed that 62% females spent more than 17 hours at home. Since the major proportion of domestic chores is carried out by women in Pakistan, it was also speculated that their exposure was higher than other members of the family.

Table 1: Levels of $PM_{2.5}$ recorded during various activities in residencies of Lahore, Pakistan

Type of activity	No. of activities (N)	Ave (µg/m³)	Max (µg/m³)	Min (µg/m³)	St. Dev (µg/m³)
	Kitchen				
Cooking Breakfast	30	884	5779	86	1138
Cooking Lunch/Dinner	30	481	1527	66	390
Cleaning	30	279	866	61	185
	Living room				
Activities of people	23	420	2257	94	340
Cleaning	30	320	1900	90	348
Smoking	4	1022	1821	222	513
Space heating	3	626	1118	354	226

Indoor air quality is a much ignored issue in Pakistan as people are unaware of the looming hazards in the indoor environments. According to recent figures, $PM_{2.5}$ levels in Pakistan are the cause of more than 9,000 premature deaths per annum which represent 20% of acute lower respiratory infection (ALRI) mortality among children under five years of age, 24% of cardiopulmonary mortality, and 41% of lung cancer mortality among adults in the major cities of the country. About 12% of the deaths occur in children below five years of age and 88% are among adults (Sánchez-Triana *et al.*, 2014). There are relatively few studies investigating indoor air quality in Pakistan and people believe indoor air to be much cleaner and safer than that outdoors. Moreover, source appointment and source strength also needs to be investigated at larger scales so that suitable prevention measures may be taken.

References

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