

Indoor levels of particulate pollution in urban and rural environments in Pakistan

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Keywords: Indoor air quality, mass concentration, number concentration

Particulate pollution has emerged as a serious environmental health concern in Pakistan. The country is suffering from deterioration of air quality due to high population growth, absence of public transport and a significant increase in private vehicles. Additionally, rural areas experience high levels of indoor air pollution due to the use of biofuels as an energy source. In Pakistan, almost 70% of the population lives in rural areas and use wood, dung, crop residue or natural gas as a fuel for cooking and heating. Despite the evidence that air quality, both indoors and outdoors, is deteriorating with enormous speed very little work has been done in this regard.

Measurements of particulate mass and number concentration have been made at two rural sites (Chak NO.35/2.L. and Bhaun) and one urban site (Lahore). Three measurement campaigns were carried out in winter, summer and spring to understand the dynamics of particulate pollution. The sampling was conducted in kitchens (using either biomass fuel or natural gas) and living rooms all the sites continuously for a period of one week in each setting. Mass concentration of particles (PM10, PM2.5, PM1) was monitored using two different GRIMM: analysers (Model 1.108 and Model 1.101) while the number concentration was measured with Condensation Particle Counter (TSI 3010, 3781). The data on temperature, humidity, housing characteristics and occupant activities was also recorded.

The values of the number concentration in a living room at Lahore were in the range 13,771 - 181,029 cm⁻³. While at rural sites a maximum concentration of 156,056 cm⁻³ was obtained. On the other hand, the highest number concentrations were recorded in the urban kitchen using natural gas (245,803 cm⁻³) as compared to rural kitchens using biomass fuel (219,609 cm⁻³) and natural gas (226,231cm⁻³). With reference to the mass concentration of particulate matter, rural kitchens using biomass fuels had an average concentration of 2,000 – 4,000 µg/m³ with a maximum of 8,000µg/m³ (Figure 1). Whilst, in kitchens using natural gas at both rural and urban sites average concentrations were of 900 - 1300 µg/m³ with the highest of 5,000 µg/m³.

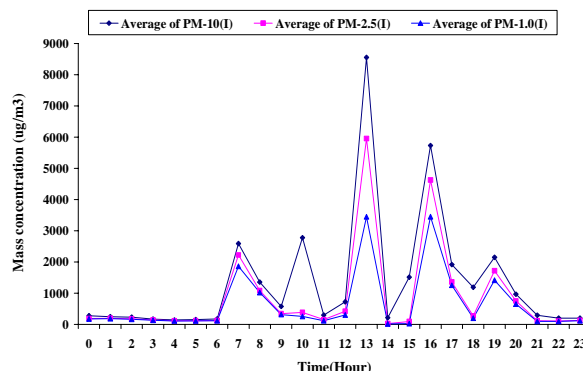


Figure 1. Mass concentration of PM10, PM2.5 and PM1 in a kitchen using solid mass fuel at rural site in Pakistan

While in the living room in Lahore and rural sites it was generally in the range 131 µg/m³ to 1,200 µg/m³ (Figure 2). The concentrations were generally higher in rural living rooms as compared to urban ones. During smoking and cleaning the concentration could rise up to 7,854 µg/m³.

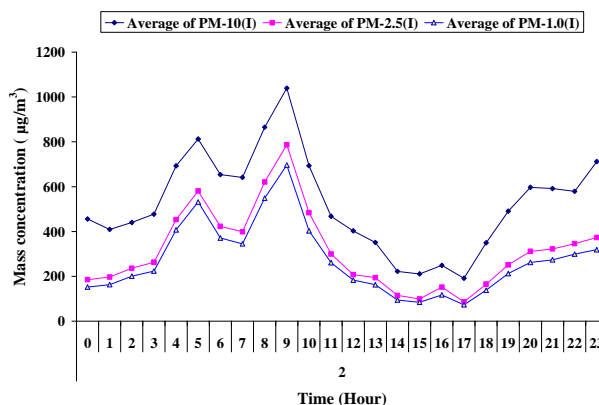


Figure 2. Mass concentration of PM10, PM2.5 and PM1 in a living room at an urban site in Pakistan

The present study showed considerably high concentrations of particulate matter particularly in the kitchen using biomass fuel as compared to living areas. Thus women and children are exposed the most due to amount of time spent in the kitchen. The mass and number concentration of particulate matter in urban and rural settings was well above of any standards for particulate matter pollution