OUTDOOR $PM_{2.5}$ AND BC EXPOSURE ASSESSMENT IN URBAN SLUMS OF MUMBAI

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Most of urban slums in Mumbai, where 41% of its population lives, are located in the periphery of major traffic highways, railway lines and landfill sites, raising concerns of high air pollution. The disease pattern analysis in various slums of Mumbai shows that 18% to 45% of the diseases reported are related to air pollution. However, so far no extensive studies have been conducted to investigate the existing air pollution exposures of the Mumbai slum population. This study was conducted in four urban slums of Mumbai to assess the outdoor air pollution exposures of $PM_{2.5}$ (particulate matter mass concentration $\leq$ 2.5 μm aerodynamic diameter) and Black Carbon (BC) and their spatio-temporal variations both within and between the slums.

Eleven days of mobile monitoring were conducted in four urban slums of Mumbai namely Santosh Nagar, Hanuman Nagar, Malwani and Bhandup. In each monitoring trip, a person outfitted with a back pack containing DustTrak for measuring real time $PM_{2.5}$ concentration, microAeth for measuring real time black carbon concentration and a GPS unit, walked along a predesigned path in each neighborhood.

Average $PM_{2.5}$ concentrations of 34 ± 8 μg/m^3 and BC concentration of 5916 ± 3564 ng/m^3 was observed among all the four slums. $PM_{2.5}$ concentrations exhibited intra- and inter-slum homogenous spatial distributions whereas BC showed spatial distributions. Higher BC concentrations were observed in three of the four slums which are in the periphery of heavy traffic roads.

Further analysis has shown that the contribution of local sources to BC is in the range of 64% -75% where as it is only 19%-37% for $PM_{2.5}$ n which explains the higher within slum spatial variation in BC compared to $PM_{2.5}$. Multi variable regression models developed to examine the contributions of different exposure predictor variables in predicting the outdoor $PM_{2.5}$ and BC concentrations, show that type of road is a significant predictor of outdoor $PM_{2.5}$ and BC concentrations. The model explained 71% and 70% variability in BC and $PM_{2.5}$ concentrations, respectively.

The study thus shows that the people living in all four monitored slums are exposed to high levels of $PM_{2.5}$ and BC, with the population residing along heavy and medium traffic roads being the most exposed. The extrapolation of these results to all slums of Mumbai suggests that about half of the city's population is indeed at higher risk regarding air pollution exposure, especially of combustion origin, with the poor ventilation and air tightness of the slum homes raising the concerns even more.

Detailed survey using structured questionnaire and additional assessment of air pollution exposures in winter is currently underway.

Table 1: Summary statistics for outdoor $PM_{2.5}$ (μg/m^3)

	S.Nagar	H.Nagar	Malwani	Bhandup
N	590	485	229	213
Mean	35	30	34	30
S.D.	3	3	7	9
Min.	20	14	15	12
Max.	90	74	68	85

Table 2: Summary statistics for outdoor BC (μg/m^3)

	S.Nagar	H.Nagar	Malwani	Bhandup
N	590	485	229	213
Mean	3.8	6.0	6.1	6.0
S.D.	1.6	5.9	5.2	5.2
Min.	0.2	0.2	0.2	0.1
Max.	20.0	43.0	28.0	35.0

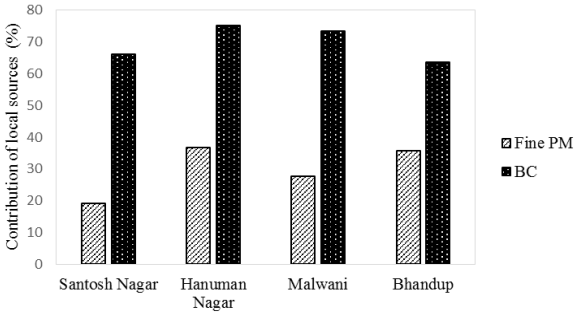

Figure 1: Local source contributions in the $PM_{2.5}$ and BC

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