Supplementary Information

Utilizing Low-Cost Mobile Monitoring to Estimate the $PM_{2.5}$ Inhaled Dose in Urban Environment

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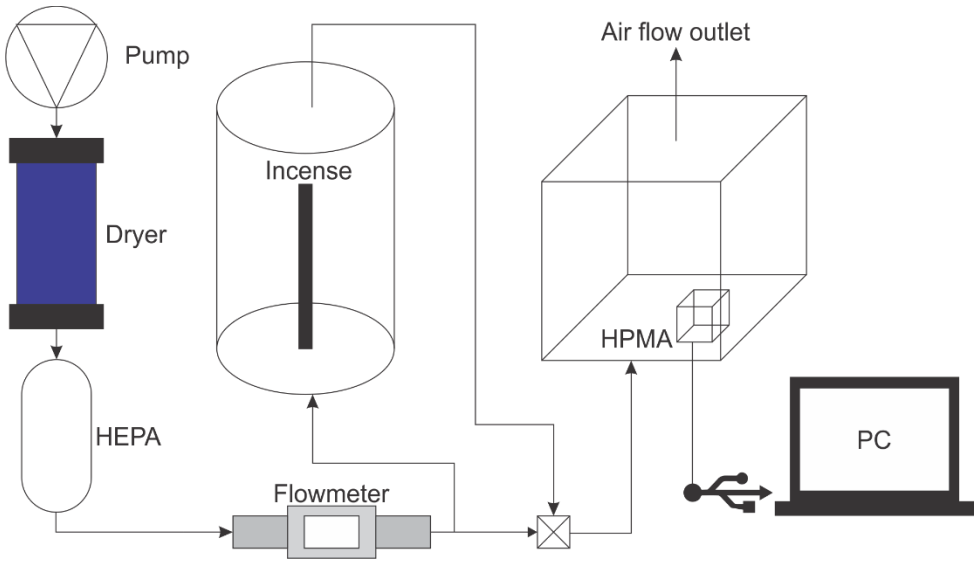

Fig. S1 Experiment setup to determine HPMA sensor CV.

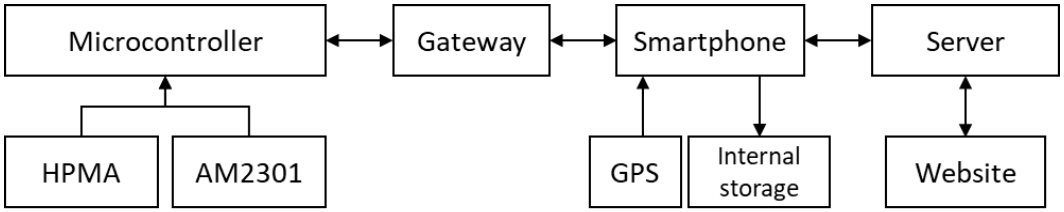

Fig. S2 Diagram of $PM_{2.5}$ mobile monitoring system.

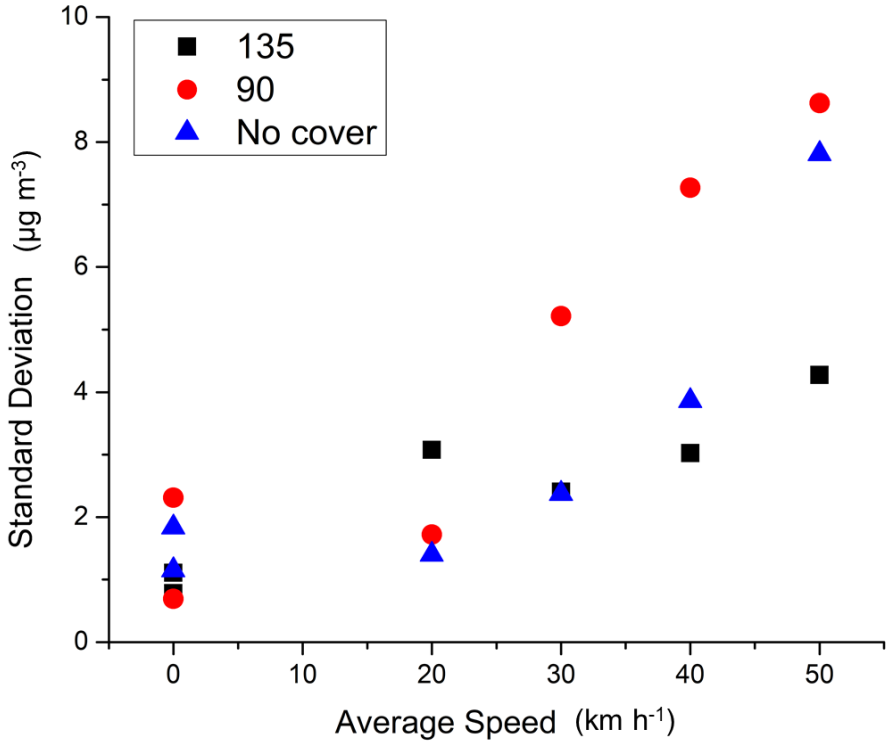

Fig. S3 Standard deviation of HPMA with cover type variation.

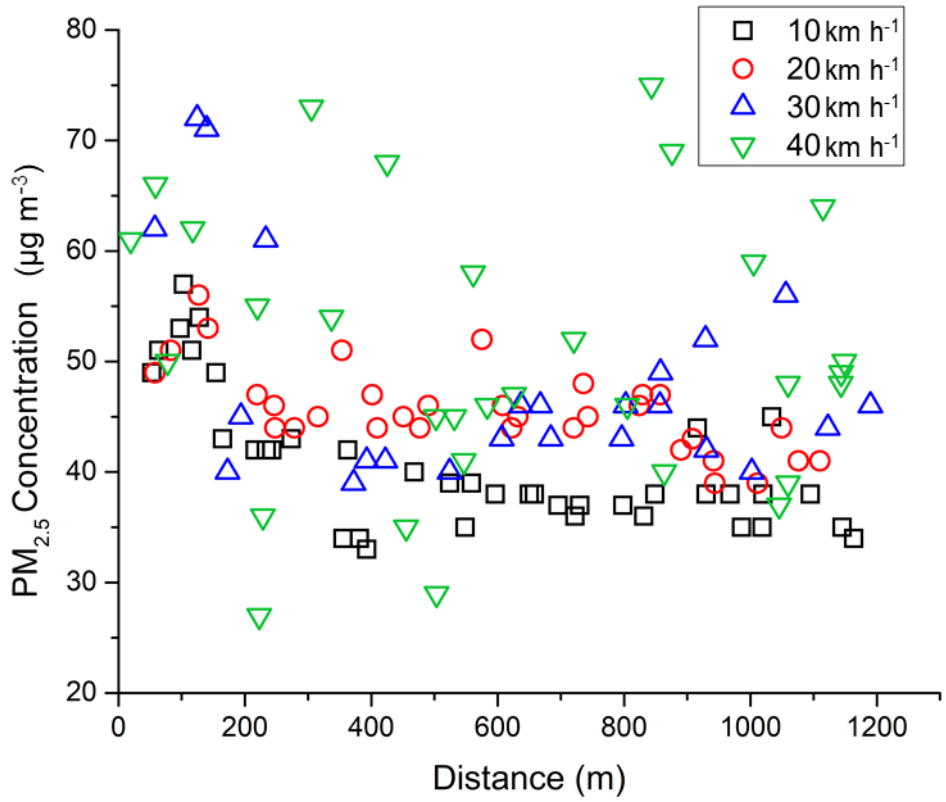

Fig. S4 HPMA sensor reading in speed variation vs distance.

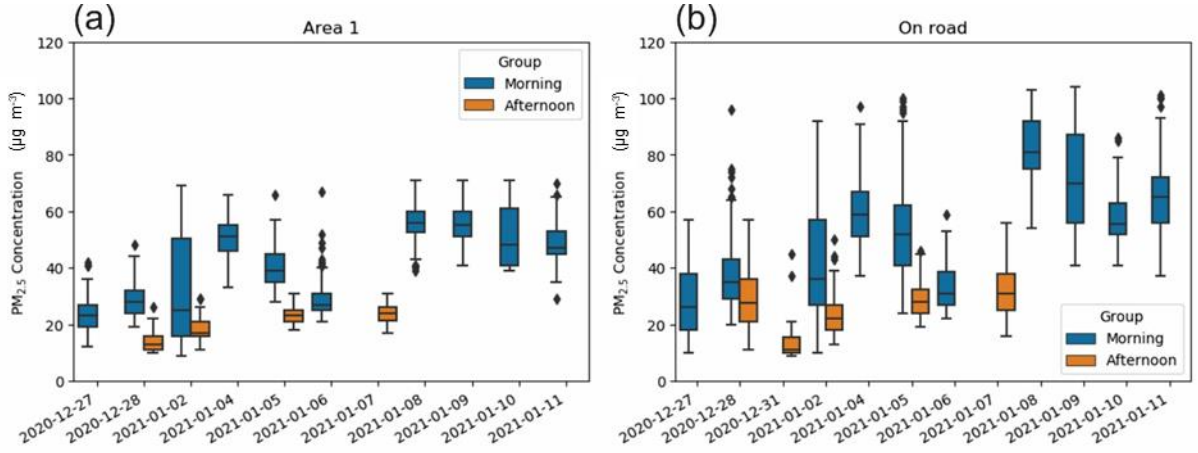

Fig. S5 Box plot of PM $_{2.5}$ (a) in the residential area and (b) on-road.

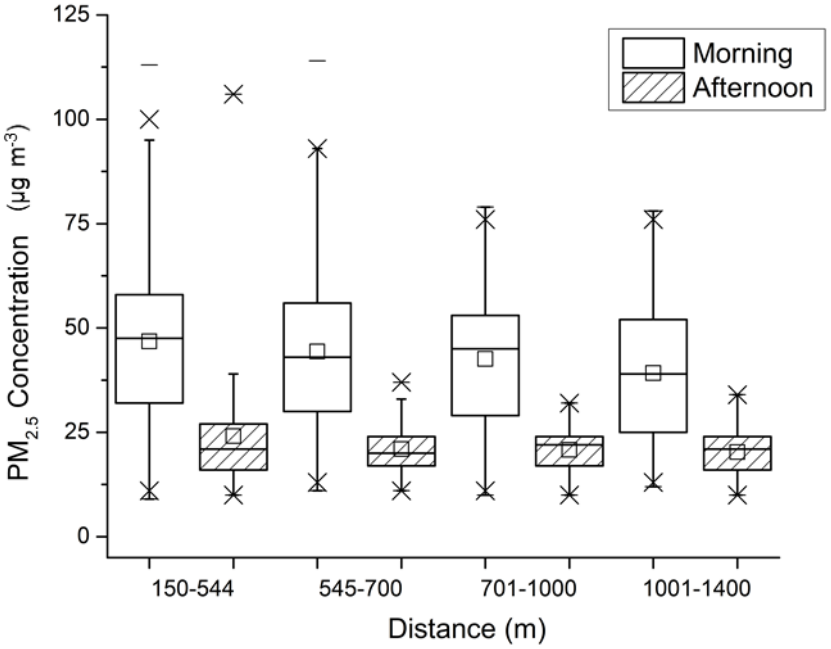

Fig. S6 PM$_{2.5}$ concentration vs distance to the nearest major road.

Table S1 Overview of measurement time.

Date	Time (UTC+7)		Weather
	Start	End	
2020/12/27	07:30:00 AM	08:45:00 AM	Sunny
2020/12/28	07:30:00 AM	08:50:00 AM	Partly Cloudy
	04:20:00 PM	05:20:00 PM	Cloudy
2021/1/2	08:00:00 AM	09:00:00 AM	Partly Cloudy
	04:00:00 PM	05:15:00 PM	Partly Cloudy
2021/1/4	07:40:00 AM	09:00:00 AM	Sunny
2021/1/5	07:40:00 AM	09:00:00 AM	Sunny
	04:00:00 PM	05:00:00 PM	Cloudy
2021/1/7	04:30:00 PM	05:30:00 PM	Cloudy
2021/1/8	08:00:00 AM	09:00:00 AM	Sunny
2021/1/9	08:20:00 AM	09:40:00 AM	Cloudy
2021/1/10	08:15:00 AM	09:20:00 AM	Sunny
2021/1/11	07:40:00 AM	08:40:00 AM	Sunny

Table S2 Parameters and values used in Monte-Carlo simulation.

Parameter	Symbol	Random Number Distribution
$PM_{2.5}$ concentration ($\mu g\ m^{-3}$)	C	Lognormal
Body weight (kg)	BW	Normal
Inhalation rate ($m^3\ day^{-1}$)	I	Triangular

Table S3 Body weight average (BW) of each age group.

Age	Average (kg)	Standard Deviation (kg)
0-5 months	6.9	1.2
6-11 months	8.3	1.6
12-23 months	10	2.1
2-3 years	13	3
4-6 years	17.8	5
7-9 years	23.9	6.6
10-12 years	31.4	8.8
13-15 years	43.1	10.3
16-19 years	52.5	9.2
20-39 years	58.7	9.8
40-55 years	59.8	10.4
56-65 years	56.5	10.4
66-75 years	52.5	9.8
>75 years	49.2	9.3

Table S4 Inhalation rate (I) of each age group.

Age	Description	Inhalation rate ($m^3 day^{-1}$)		
		Minimum	Likeliest	Maximum
0-5 years	Toddler	0.2	0.27	0.36
6-10 years	Child	0.17	0.25	0.37
11-20 years	Teenager	0.17	0.24	0.33
>21 years	Adult	0.17	0.23	0.31

Table S5 p-values of Spearmann correlation between meteorological factors and $PM_{2.5}$

Morning	**Temperature**	**RH**	**$PM_{2.5}$**
Temperature	1.00	2.59×10^{-89}	4.19×10^{-37}
RH	2.59×10^{-89}	1.00	4.60×10^{-2}
$PM_{2.5}$	4.19×10^{-37}	4.60×10^{-2}	1.00

Afternoon	**Temperature**	**RH**	**$PM_{2.5}$**
Temperature	1.00	1.81×10^{-194}	4.98×10^{-9}
RH	1.81×10^{-194}	1.00	5.05×10^{-12}
$PM_{2.5}$	4.98×10^{-9}	5.05×10^{-12}	1.00

Area 1	**Temperature**	**RH**	**$PM_{2.5}$**
Temperature	1.00	2.25×10^{-15}	1.27×10^{-13}
RH	2.25×10^{-15}	1.00	2.67×10^{-26}
$PM_{2.5}$	1.27×10^{-13}	2.67×10^{-26}	1.00

On road	**Temperature**	**RH**	**$PM_{2.5}$**
Temperature	1.00	1.24×10^{-150}	1.18×10^{-9}
RH	1.24×10^{-150}	1.00	3.85×10^{-1}
$PM_{2.5}$	1.18×10^{-9}	3.85×10^{-1}	1.00

Additional Notes on 2.1.1 Sensor Selection and Testing

The low-cost sensor has been applied in several studies to conduct mobile monitoring; for example, Mazaheri et al., 2018, Sinaga et al., 2020; and Wu et al., 2020 use Shinyei PPD60PV-T2, Sensirion SHT31, and SDS019-TRF, respectively. One important aspect of sensor selection is the sensor reading coefficient of variation (CV). The extent of variability to the average is described by CV. It is important to know the CV of the sensor reading since it is related to sensor precision. Low-valued CV means the PM sensor has high repeatability of measuring PM concentration in a certain condition.

Additional Notes on 2.1.2 Monitoring System Design

The PM concentration measurement principle measures scattered laser intensity. Ambient air drawn into the sensor will pass through the laser beam. Particulate matter carried in with the air will scatter laser light. A photodiode in an HPMA sensor measures light scattering. The internal circuit converts the signal from the photodiode in the sensor to the output in the form of a mass concentration of particulate matter (Honeywell, 2019).

References

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