Exposure to Fine Particulate Matter and Its Association on Urinary Malondialdehyde Levels of Public Transport Drivers in Jakarta

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Recent Publications :

1. Household Food Insecurity, Nutritional Knowledge of Mothers on Nutritional Status among Children Under Five Years in Gili Iyang Island, Indonesia (2025)
2. Utilization of Plastic Waste With Ecobricks: Education and Training for Junior High School Students (2025)
3. Enhancing Infant Immunization Rates: Determinants of Complete Routine Vaccination in an Urban Indonesian Primary Health Center (2025)
4. Empowering Communities Through Waste Management Education: A Case Study of Private Islamic Boarding School An-Nusyur In Sumenep Regency, Madura Island (2024)

Introduction: Air Pollution

>2 million deaths are caused by air pollution, **0.47 million of those deaths are due to $PM_{2.5}$** (Chuang *et al.*, 2011; Shah *et al.*, 2013)

Every 10 μg/m³ increase in $PM_{2.5}$ exposure can cause cellular damage and **increase the risk of disease by 1.6 times** in the exposed population (Kloog *et al.*, 2013)

The transportation sector contributes **80%** of air pollution (Haryanto, 2018)

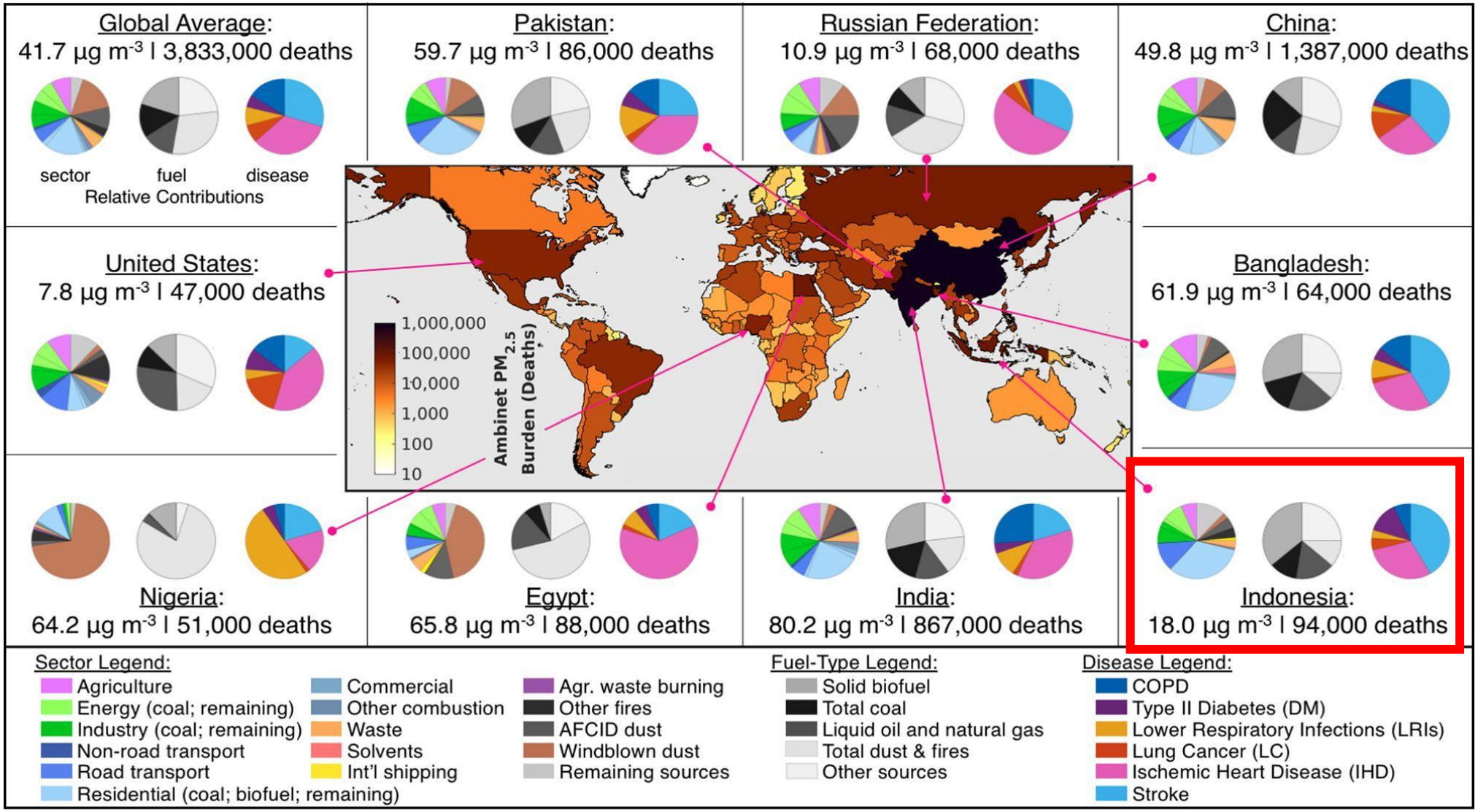
ASIA

The concentration of $PM_{2.5}$ from vehicle emissions in 21 major cities exceeds the WHO guideline value (10 μg/m³) (Cheng *et al.*, 2016)

JAKARTA

$PM_{2.5}$ exposure on roadways is 30–200% higher compared to non-road areas (Both *et al.*, 2013)

Introduction: PM $_{2.5}$ Sources and Related Disease Outcomes



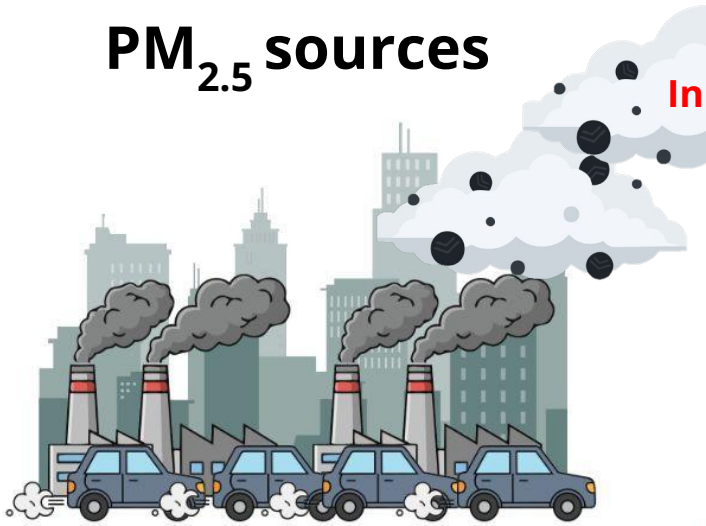
Source: McDuffie, E.E., Martin, R.V., Spadaro, J.V. *et al.* (2021)

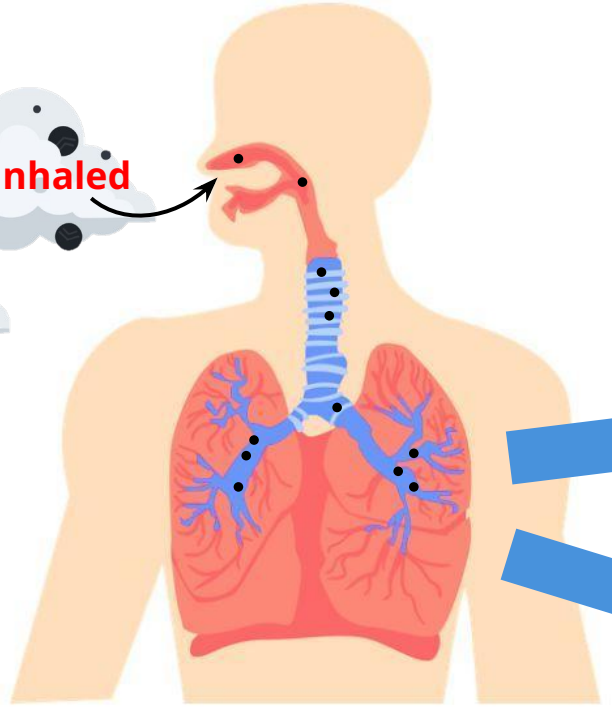
Introduction: $PM_{2.5}$ in Jakarta

Source: IQAir $PM_{2.5}$ (µg/m³) Data Cohort 2017-2024

$PM_{2.5}$ and Disease: What Happens Inside the Body?

$PM_{2.5}$ sources





Inflammation and Allergic Reaction

Asthma, Bronchitis, Persistent cough

Inducing inflammatory response

Cytokine pro-inflammatory:
TNF-α, NF-kβ, IL-6, IL-1β

Producing Reactive Oxygen Species (ROS) or Reactive Nitrogen Species (RNS)

Superoxide, hydroxyl, alkoxyl radical, peroxyl radical, nitrite oxide, nitrite anion, etc.

Superoxide dismutase, glutathione peroxidase, glutathione-S-transferase, etc.

Antioxidant

ROS/RNS

Oxidative Stress

Lipid peroxidation | Protein damage | DNA damage

Malondialdehyde (MDA) as one of oxidative stress biomarker

Cell damage □ aging

Cardiopulmonary disease

Other non-communicable disease

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Location : East Jakarta – start from Kampung Melayu Terminal

Study duration : April – May 2019

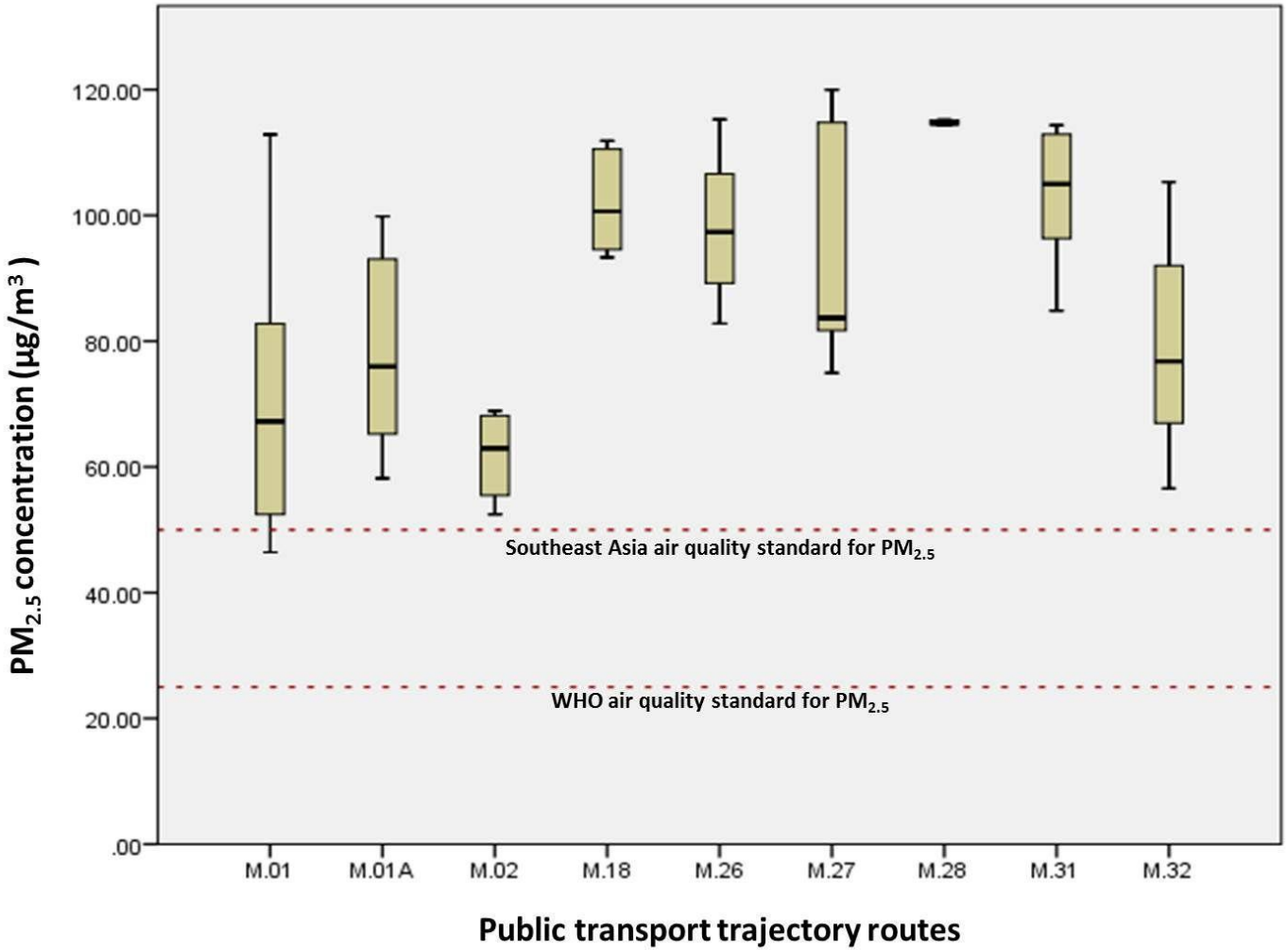
Study design: Cross-sectional

Sample : 130 of 544 public transportation drivers, divided into 9 trajectories

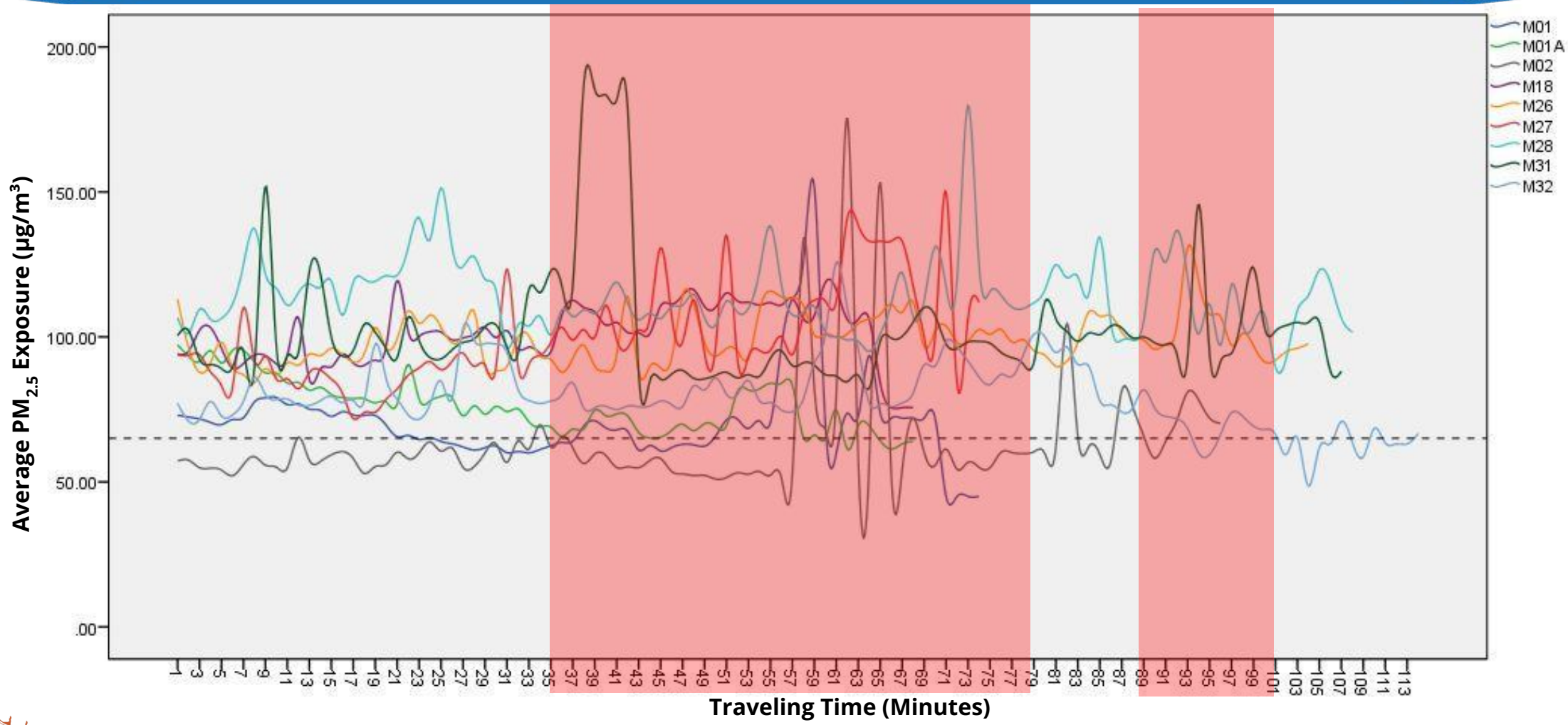
Air sampling time : from 8 a.m to 3 p.m (during dry season)

Figure of Jakarta's public transportation called "Angkot (Angkutan Kota)"

Results: Average concentration of $PM_{2.5}$ exposure per public transport trajectory in Jakarta 2019



Results: Average PM $_{2.5}$ exposure (µg/m^3) per public transportation trajectory by traveling time (minutes) in Jakarta 2019



Results: Malondialdehyde level among public transportation drivers in Jakarta 2019

Table of a) correlation of $PM_{2.5}$ exposure, work experience, and work duration to MDA levels **and** b) association of driver characteristics to MDA levels (nmol/mL)

a

	Mean ± SD	r	p-Value
MDA (nmol/mL)	2.22 ± 1.52	1	-
$PM_{2.5}$ (µg/m³)	91.34 ± 19.18	−0.222	0.012*
Work experience (years)	17.32 ± 11.69	0.18	0.042*
Work duration (h)	9.08 ± 3.49	−0.155	0.081

*p<0.05, significant correlation to MDA levels.

b

Variables	n (%)	MDA levels (mean ± SD)	p-Value
Body mass index (BMI)			
Overweight – Obesity	48 (36.9)	2.66 ± 1.65	0.013*
Normal – Underweight	82 (63.1)	1.97 ± 1.47	
Smoking habit			
Smoking	83 (63.8)	2.25 ± 1.43	0.289
Not smoking	47 (36.2)	2.18 ± 1.81	
Alcohol consumption habit			
Yes	15 (11.5)	1.65 ± 0.91	0.195
No	115 (88.5)	2.30 ± 1.62	
Fitness activity			
Yes	32 (24.6)	2.09 ± 1.22	0.940
No	98 (75.4)	2.27 ± 1.67	
Vitamin consumption			
Yes	20 (15.4)	1.96 ± 1.51	0.427
No	110 (84.6)	2.27 ± 1.58	
Energy drink consumption			
Yes	45 (34.6)	2.32 ± 1.60	0.564
No	85 (65.4)	2.17 ± 1.56	

Results: Malondialdehyde level among public transportation drivers in Jakarta 2019

Table of multiple linear regression analysis of PM2.5 concentration on MDA Levels adjusted for other variables

Variables	B[a]	S.E[b]	95% CI for B		p-Value
			Lower	Upper	
$PM_{2.5}$ (µg/m³)	−0.016	0.007	−0.029	−0.002	0.025*
Body mass index (BMI)	−0.655	0.271	−1.191	−0.119	0.017*
Work experience	0.025	0.011	0.002	0.048	0.030*
Work duration per day	−0.070	0.038	−0.145	0.006	0.069
Alcohol consumption	0.580	0.360	−0.134	1.294	0.110
Smoking habit	−0.387	0.290	−0.962	0.187	0.184
Fitness activity	0.053	0.302	−0.545	0.652	0.860
Vitamin consumption	−0.271	0.372	−1.008	0.465	0.467
Energy drink consumption	−0.385	0.287	−0.954	0.185	0.183

[a]Slope of the regression line.

[b]Standard error of the regression line.

*p<0.05.

- Low $PM_{2.5}$ exposure, normal and underweight BMI status, and long working periods as drivers were associated with MDA levels ($p<0.05$).
- A significant **negative association between $PM_{2.5}$ exposure and MDA in this study contradicted the majority of studies** that found an increase in MDA is in line with high $PM_{2.5}$ exposure.
- **It was suspected that most of the public transport drivers were normal-underweight** (63.1%) compared to drivers who weighted overweight and obese (36.9%).
- **Drivers with normal-underweight BMI had a significant association in reducing MDA levels**.

Conclusion and Recommendation

- The average $PM_{2.5}$ exposure among public transportation drivers at Kampung Melayu Terminal was 91.56 µg/m³ (±20.05), ranging from 46.41 to 133.21 µg/m³, while the mean urinary MDA level was 2.23 nmol/mL (±1.57), with values between 0.109 and 8.006 nmol/mL.
- $PM_{2.5}$ exposure was significantly associated with MDA levels (p=0.025), and this association remained significant after adjusting for drivers characteristics.
- Our study suggests **regular health check-ups for drivers**, and **those who are overweight or obese should lose weight to reduce the risk of elevated MDA levels**.
- Public transportation company should consider **expanding vehicle fleet renewal and maintaining their vehicle's ventilation system** to avoid high $PM_{2.5}$ exposure while driving.

As of 2025, there are only 50 units of Mikrotrans Jakarta, all equipped with air conditioning (AC) and powered by electricity (EV).

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Thank you

ขอบคุณค่ะ

Terima kasih

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