Preliminary Assessment of Indoor Particulate Matter and Microclimate Conditions in Scientific Research Laboratories

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Background

Indoor pollutants such as particulate matter of varying sizes and microclimate factors, including temperature and relative humidity, significantly influence human health and well-being (Sani, 2023).

Continuous exposure to poor indoor air quality and unfavourable microclimate conditions across different indoor spaces can further contribute to both short- and long-term health impacts.

Exposure to PM, temperature and relative humdity (RH) in the workplaces can worsen existing hazards and create new ones, thereby increasing employees' risk of work-related health issues (NIEHS, 2023).

Indoor air quality (IAQ) and microclimate in enclosed workplaces, such as laboratories and offices, are critical yet often overlooked factors affecting health, productivity, and well-being (Chirico et al., 2023).

Problem statement & Objective

- Scientific research institutions in Ghana and beyond are vital for innovation and public health, yet many lack effective systems for identifying and assessing occupational hazards, including air quality and microclimate exposures.

- Laboratory activities can increase particulate matter (PM) levels and alter temperature and relative humidity (RH), affecting PM dispersion

- There is a critical need to monitor PM, temperature and RH to better understand indoor air quality and microclimate exposures within these institutions.

Study Objective: To determine indoor air quality and its association with microclimate conditions in laboratory areas of a scientific research institution

Methods

✓**Study site:** Scientific research institution, Greater Accra-Ghana

✓**Locations:** Environmental and Biological sample laboratories

✓**Duration:** 10:00 am to 5:00pm

Data Analysis:

✓Descriptive statistics summarized pollutants and climate variables.

✓*t*-tests and multiple linear regression assessed PM variations with temperature and humidity

✓**Measurements**

- Concentrations of PM_1, $PM_{2.5}$, PM_{10}, temperature and relative humidity
- Air Quality Score, which is estimated summarize overall air quality based on all parameters measured

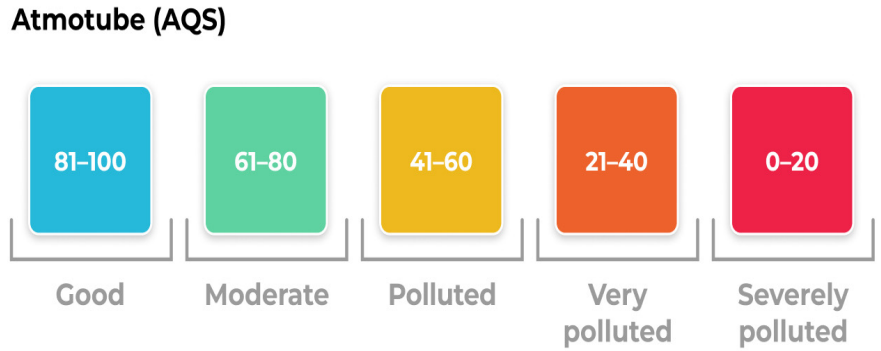


Fig 1: Atomtube Pro Sampler, App Interface and AQS scale

Key Findings

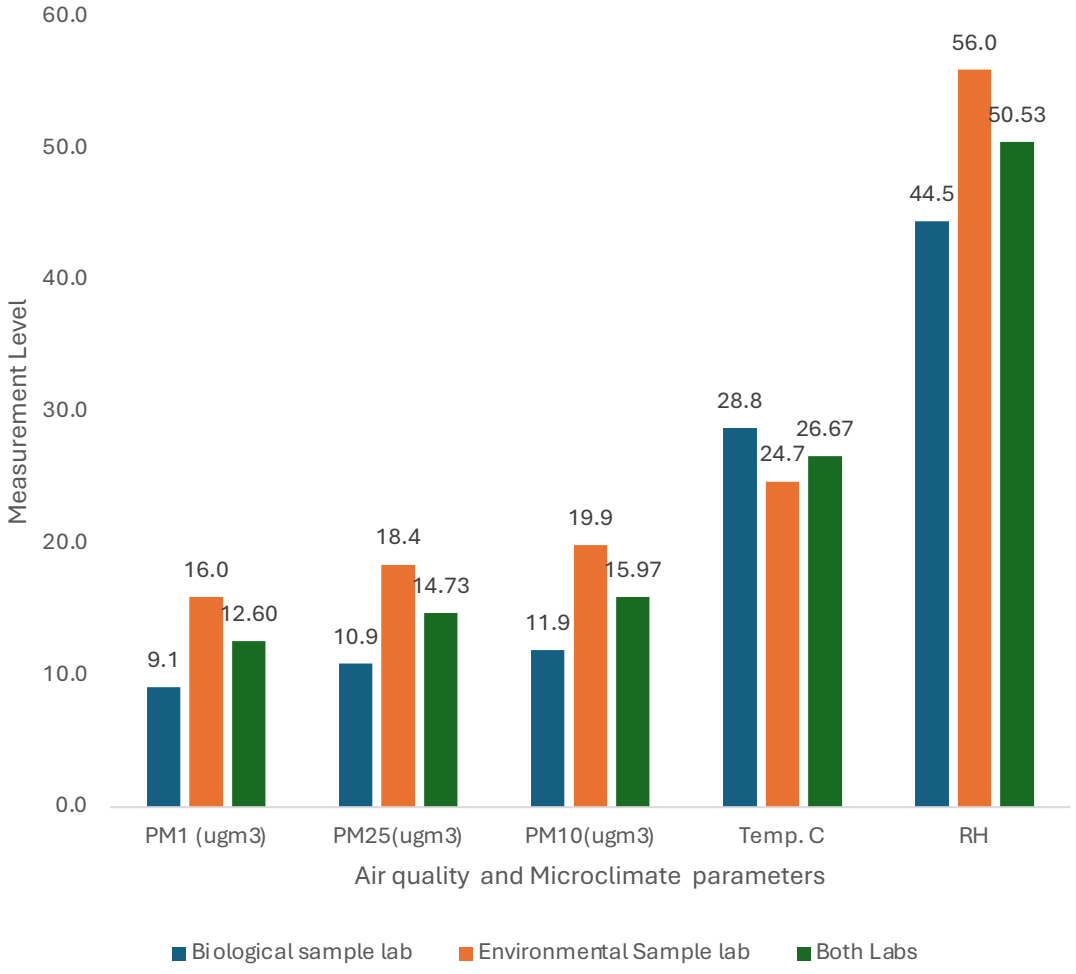


Fig 2: Average measurements of Air quality and Microclimate parameters

Table 1: Descriptive and paired test statistics of air quality and microclimate parameters

Measure	Descriptive statistics					Paired t-test statistics		
PM 1(µg/m³)	**Mean**	**Std Dev**	**Min**	**Max**	**Median**	**Std Error**	**t-statistics**	**p-Value**
Bio. Sample Lab	9.1	2.3	**1.0**	**16.0**	10.0	0.1	-26.4	**0.000**
Envir. Sample lab	16.0	7.0	**5.0**	**39.0**	15.0	0.2		
PM 2.5(µg/m³)								
Bio. Sample Lab	**10.9**	2.4	**2.0**	**22.0**	11.0	0.1	-26.7	**0.000**
Envir. Sample lab	**18.4**	7.6	**7.0**	**43.0**	17.0	0.3		
PM 10(µg/m³)								
Bio. Sample Lab	11.9	2.5	**3.0**	**27.0**	12.0	0.1	-27.2	**0.000**
Envir. Sample lab	19.9	8.0	**8.0**	**47.0**	19.0	0.3		
Temp (° C)								
Bio. Sample Lab	**28.8**	2.9	**25.0**	**33.0**	30.0	0.1	35.9	**0.000**
Envir. Sample lab	**24.7**	1.2	**22.0**	**27.0**	25.0	0.0		
RH								
Bio. Sample Lab	**44.5**	9.0	**30.0**	**76.0**	30.0	0.3	-20.2	**0.000**
Envir. Sample lab	**56.0**	12.8	**40.0**	**100.0**	51.0	0.5		

PM levels below WHO guidelines for daily average (15 µg/m³ for PM2.5)

Recommended indoor Temp (24 -28° C)) & RH (70%- 90%) for Tropical region in Africa

Table 2: : Regression model showing relationship between Air quality and Microclimate parameters

Measurements	Coeffcient (Confidence interval)	P-value
PM_1		
Temperature	0.024 (-0.076 – 0.124)	0.632
Relative humidity	0.308 (0.284 – 0.332)	**0.000**
$PM_{2.5}$		
Temperature	0.003 (-0.105 – 0.361)	0.951
Relative humidity	0.335 (0.309 – 0.361)	**0.000**
PM_{10}		
Temperature	-0.023 (-0.136 – 0.905)	0.694
Relative humidity	0.348 (0.321 – 0.375)	**0.000**

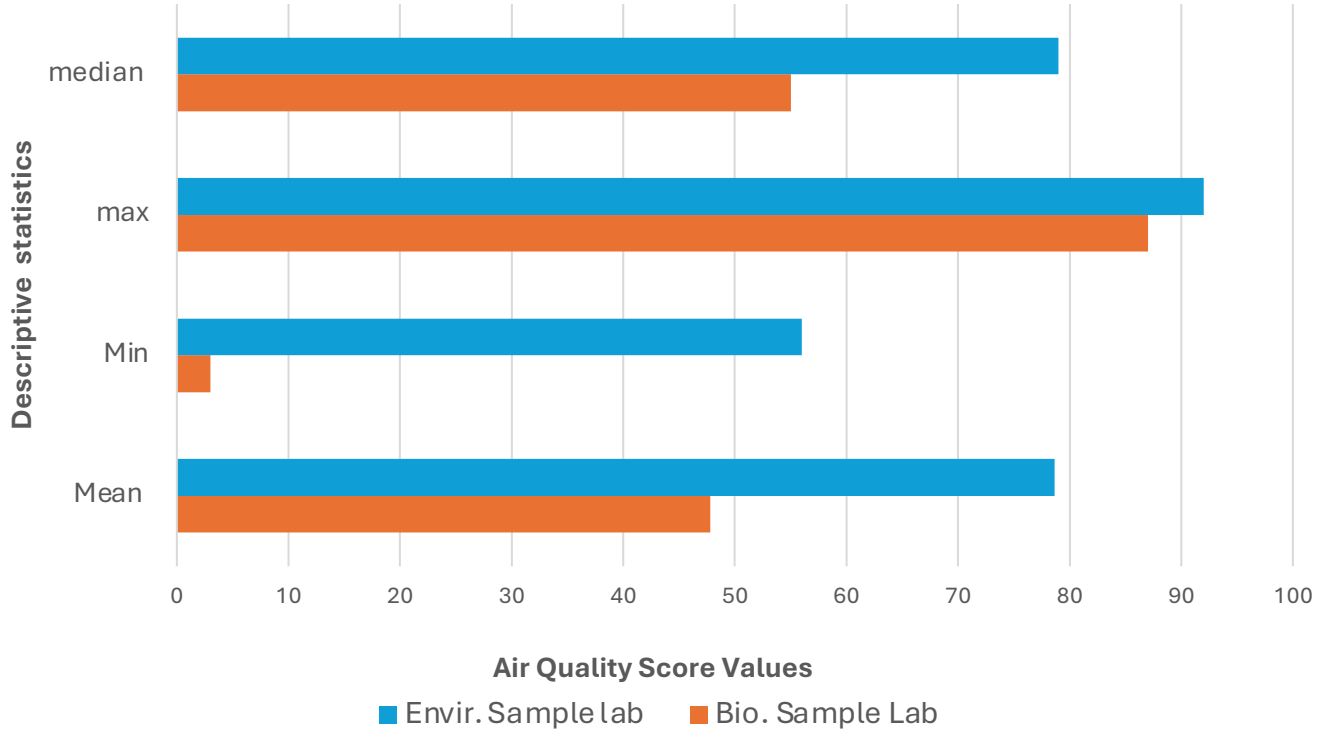
Overall, the regression model for PM_1, $PM_{2.5}$, and PM_{10} in relation to temperature and relative humidity was statistically significant; however, analysis of the individual predictors showed that temperature did not contribute significantly, whereas relative humidity did.

Key Findings

Air quality Score Values

Biological lab staff face higher exposure risks due to severely polluted and fluctuating air quality

Environmental lab staff experience more stable and generally better conditions with lower risk



Conclusion and Recommemdation

- Both temperature and relative humidity significantly influence overall air quality in laboratories.
- Lower AQS values in the biological sample lab indicate poorer and more variable air quality compared to the environmental lab, suggesting that staff in the biological lab are exposed to higher and more unpredictable air-quality risks;

- Findings underscore the need for improved targeted monitoring and control strategies within research laboratories to reduce exposure risks and enhance occupational health.

References

- Sani Dimitroulopoulou, Marzenna R. Dudzińska, Lars Gunnarsen , Linda Hägerhed, Henna Maula, Raja Singh, Oluyemi Toyinbo, Ulla Haverinen-Shaughnessy (2023). Indoor air quality guidelines from across the world: An appraisal considering energy saving, health, productivity, and comfort. Environment International Volume 178 (2023), 108127

- Oskars Kalva (2023). The Role Of Microclimate In The Formation Of Indoor Air Pollution. Thermal Science 27(00):105-105 DOI:10.2298/TSCI220215105K

- NIEHS. (2023). *Occupational Health : Why the Environment Matters*. 1–2. Retrieved from https://www.niehs.nih.gov/sites/default/files/health/materials/occupational_health_why_the_environment_matters_508.pdf

- Chirico, F., Settimo, G., & Magnavita, N. (2023). Indoor Air Quality and Indoor Environmental Quality: The role of occupational health surveillance and the cooperation between public and occupational health stakeholders. *Journal of Health and Social Sciences*, *8*(4), 262–269. https://doi.org/10.19204/2023/NDOO1

- Aleksejs Prozuments, Anatolijs Borodinecs, Adamah Messan, Kokouvi Edem N'tsoukpoe, Philbert Nshimiyimana, Césaire Hema, Daniel Yamegueu Nguewo, Mohamed Tariq Kahn, Efe Orumwense, Christophe Ménézo Adey Feleke Desta (2025). Assessment of Indoor Thermal Comfort Criteria and Challenges Across the African continent. Journal of Sustainable Architecture and Civil Engineering Vol. 2 / No. 38 / 2025 pp. 161-176. https://doi.org/10.5755/j01.sace.38.2.40349

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