Indoor and Outdoor Air Quality Assessment of RSU Campus Air Basin

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Abstract
The study provides a comprehensive evaluation of air quality within the Rivers State University Main campus. This research is pivotal as it addresses both indoor and outdoor air pollution, a critical concern for educational institutions where the health and productivity of students and staff are at stake. The study aims to assess air quality by examining particulate matter and gaseous pollutants across various campus locations and comparing these findings against national and international standards. It identified pollution sources and evaluated the awareness of campus residents regarding air quality and its health impacts. The study's methodology includes air quality measurements and a questionnaire survey to gather perceptions from the university community. Significantly, the research highlights the intertwined nature of indoor and outdoor environments, emphasizing the impact of air quality on health. The findings reveal that PM2.5 levels across all sampled locations, including the Main Gate, Hostel H/PG area, College of Medical Sciences, Lecture Hall, Institute of Pollution Studies, and Shopping Complex, consistently remained below the national standard of 35.0 µg/m³. However, PM10 concentrations, while higher, were still within the acceptable national limit of 150.0 µg/m³. The analysis also covers gaseous pollutants such as carbon monoxide (CO), nitrogen dioxide (NO_2), hydrogen sulfide (H_2S), ground-level ozone (O_3), and volatile organic compounds (VOC), with most measurements falling within safe limits, except for certain areas where CO levels slightly exceeded the national standard. The study further evaluates the toxicity potentials of these pollutants, highlighting areas with potential health risks, particularly in indoor environments. The Air Quality Index (AQI) assessments categorize most campus locations as "Unhealthy for Sensitive Groups," with some areas, such as the Hostel H/PG indoor environment, classified as "Unhealthy." The demographic survey reveals that the majority of respondents are students, with a significant portion identifying vehicle emissions and poor ventilation as primary sources of outdoor and indoor air pollution, respectively. The study highlights the necessity for targeted interventions and policies to mitigate pollution and protect public health. By focusing on a university setting, the study fills a gap in the existing literature and provides evidence-based recommendations for improving air quality, with implications for broader environmental management and policy-making.

Keywords: *Indoor, Outdoor, Air, Quality, Assessment &Basin*

Introduction

Air is a crucial blend of nitrogen and oxygen that is vital for living organisms, making its purity vital for human health and ecological balance (Quarcoo et al., 2012). The air in our environment frequently contains various harmful substances, such as particulate matter, irritating gases, and benzene (Lodovici & Bigagli, 2011). As a result, air pollution occurs when gases, particulate debris, and radioactive materials accumulate to levels that negatively impact both humans and natural systems (Rai et al., 2011), with exposure being unavoidable in rapidly growing urban areas (Barman et al., 2012). In spite of significant anxiety regarding human-generated emissions and the society's dependence on fossil fuels, insufficient air quality persists as a crucial global health issue, leading to millions of early deaths each year and hitting vulnerable groups the hardest (Leung, 2015; WHO, 2018). Although earlier studies have pointed out the negative effects of local air contaminants on respiratory and cardiovascular health (Weinhold, 2008; Currie et al., 2009; Ling & van Eeden, 2009; Neidell, 2009; US EPA, 2016), more recent findings reveal that pollution also hinders cognitive abilities, reduces economic productivity, and impacts human capital development (Zweig et al., 2009; Currie et al., 2014; Ebenstein et al., 2016; Carneiro et al., 2021). Alongside external pollution, the quality of indoor air in residences, workplaces, and educational settings has become a significant issue in the last twenty years (Marios et al., 2011). Since students spend a notable amount of their day in educational institutions, poor indoor air quality can lead to respiratory issues directly or result in increased absenteeism indirectly (Annesi-Maesano et al., 2013; Sasso et al., 2019). Overcrowding, insufficient ventilation, and the state of the buildings further heighten pollution risks in schools (Annesi-Maesano et al., 2013; Bo et al., 2017; Zwoździak et al., 2015). Therefore, this research aims to evaluate both outdoor and indoor air quality at the Rivers State University (RSU) campus and analyze its effects on the academic setting and student health.

Materials and Methods

This experimental approach maintained internal validity by intentionally modifying independent variables to analyze treatment impacts (Ary, 2010). To ensure that data from different locations could be compared reliably, established protocols from entities such as ASTM, UOP, and GPA were followed closely, with methods from the American Society for Testing and Materials (ASTM) specifically utilized for evaluating air quality both indoors and outdoors. Assessment points that were geo-referenced throughout the area directed the monitoring of specific pollutants. Data acquisition included both primary and secondary sources; the primary data consisted of on-site air sampling, physical assessments, and structured surveys to gauge campus residents' understanding of pollution sources, while secondary data comprised academic texts, monographs, and scholarly articles. Measurements in the field were taken twice a day (in the morning and evening) over a span of five days. Gaseous pollutants were tracked using the Aeroqual Series 500 Gas Monitoring device, and particulate matter—including PM2.5, PM10, and total suspended particles (TSP)—was assessed utilizing the MET One Aerocet 531 Particle Counter. Both of these validated instruments come equipped with built-in data loggers that offer graphical analysis features to guarantee a high level of accuracy.

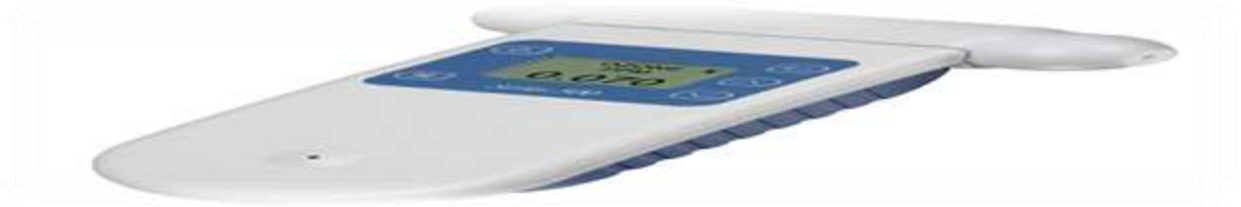

Figure 3.1: Aeroqual Series 500 Gas Monitoring meter

Figure 3.2: MET One Aerocet 531 Particle Counter

The Aeroqual Series 500 device functions based on an electrochemical method, assessing gas pollutants by allowing them to diffuse into the sensor, which then produces an electrical signal in relation to the low concentration levels. Equipment was systematically placed across various representative sampling locations, which included the Institute of Pollution Studies, certain classrooms, the shopping center, campus housing, and a gatehouse to encompass both residential and workplace settings. The recorded pollutant information was uploaded to a computer using specialized Aeroqual and MET One software, while the geographical coordinates of the stations were referenced with a Garmin eTrex GPS device.

The ambient and indoor variables that were assessed comprised carbon monoxide, carbon dioxide, nitrogen dioxide, hydrogen sulfide, ground-level ozone, volatile organic compounds, and particulate matter categorized as PM2.5 and PM10. To meet the specific aims of the research, a purposive sampling method (Stratton, 2021) was utilized to distribute structured surveys to 150 residents of the campus. The reliability of the instruments was confirmed through face and content validity via thorough evaluations conducted by the research supervisor at the Institute of Geosciences and Environmental Management (IGEM), guaranteeing that all inquiries effectively addressed the study's aspects. Additionally, indoor air quality (IAQ) and Toxicity Potential (TP)—defined by Sonibare et al. (2005) as the calculated ratio of found pollutant concentrations to established statutory thresholds—were analyzed to measure the toxic equivalency and the potential health dangers linked to exposure to pollutants. $Toxicity\ Potential, TP = \frac{M_p}{S_p}$

M_p – The measured pollutant concentration;

S_p – The statutory limit set for such pollutants using National Standards.

TP is useful in determining the harmful effects of the emissions from the source pollutants within the indoors on human health (Ayodele *et al.,* 2016). IAQ refers to the extent to which human requirements are met indoors. The requirements of the people are pleasant and fresh air, which has no negative impact on their health (Fanger, 2006). In this method, the coefficient may be constant or may vary but the relationship contains at least one variable raised to a power and this index may be taken in several forms for assessment of air quality. The Modified Oak Ridge National Air

Quality Index also has the advantage of the relative ranking of overall air quality status at different locations of the study area with different air pollutants parameters.
AQI in the study area was estimated with the help of a modified mathematical equation developed by the Oak Ridge National Laboratory (ORNL), USA (Panwar, 2014) as given below:

$$AQI = \left[5.7 \sum \frac{C_i}{C_s}\right]^{1.37}$$

Where C_i = value of air quality parameters PM10, PM2.5, NO_2, O_3, H_2S and CO
C_s = standard or prescribed limit for air quality parameters
5.7 and 1.37 are constants To reflect the status of air quality and its effects on human health, ranges of the AQI values were categorized as clean air (0-25), light air pollution (26-50), moderate air pollution (51-75), heavy air pollution (75-100), severe air pollution (>100).Data from the survey was analyzed with descriptive statistics including frequency tables, percentages, cross-tabulations and graphs using Microsoft Excel computer packages. Qualitative data was analyzed as text-based information in tables. The results of the parameters measured were statistically analysed and compared with relevant regulatory standards. Spatial variation of the ambient air quality across the study was presented. Interpretation was done with reference to the health and environmental impacts and relevant national and international standards (Federal Ministry of Environment and World Health Organisation, WHO).

Results

Table 1: Summary of PM in the Study Area

Sampling Locations	Environs	$PM_{2.5}$ (µg/m³)				PM_{10} (µg/m³)			
		Day 1	Day 2	Day 3	Mean ± SD	Day 1	Day 2	Day 3	Mean ± SD
Main Gate	Indoor	27.0	30.6	25.6	**27.7 ± 2.58**	50.8	76.6	73.309874	**66.9 ± 14.04**
	Outdoor	21.4	28.7	30.9	**27.0 ± 4.97**	49.4	78.3	122.2	**83.3 ± 36.66**
Hostel H/PG	Outdoor	23.5	26.2	26.7	**25.5 ± 1.72**	53.3	76.6	92.7	**74.2 ± 19.81**
	Indoor	29.5	30.7	28.3	**29.5 ± 1.20**	124.5	148.8	100.2	**124.5 ± 24.30**
College of Medical Sciences	Indoor	23.7	19.9	27.9	**23.8 ± 4.00**	72.4	36.5	99.4	**69.4 ± 31.55**
	Outdoor	20.8	27.1	30.3	**26.1 ± 4.83**	55.2	98.6	108.0	**87.3 ± 28.17**
Lecture Hall (SC-6)	Indoor	21.8	29.5	34.4	**28.6 ± 6.35**	51.5	158.2	162.9	**124.2 ± 63.00**
	Outdoor	22.1	25.8	29.9	**25.9 ± 3.90**	51.4	92.6	117.4	**87.1 ± 33.34**
Institute of	Indoor	26.9	30.5	23.3	**26.9 ± 3.60**	115.6	142.2	89.0	**115.6 ± 26.60**

Pollution Studies	Outdoor	23.4	28.2	21.3	**24.3 ± 3.54**	59.8	86.6	62.2	**69.5 ± 14.83**
Shopping Complex	Indoor	24.4	27.4	21.4	**24.4 ± 3.00**	86.6	104.2	68.9	**86.6 ± 17.65**
	Outdoor	22.9	24.0	21.7	**22.9 ± 1.15**	63.4	68.1	58.7	**63.4 ± 4.70**
Range		**19.9 – 34.4**				**49.4 – 162.9**			
National Standards		**35.0**				**150.0**			

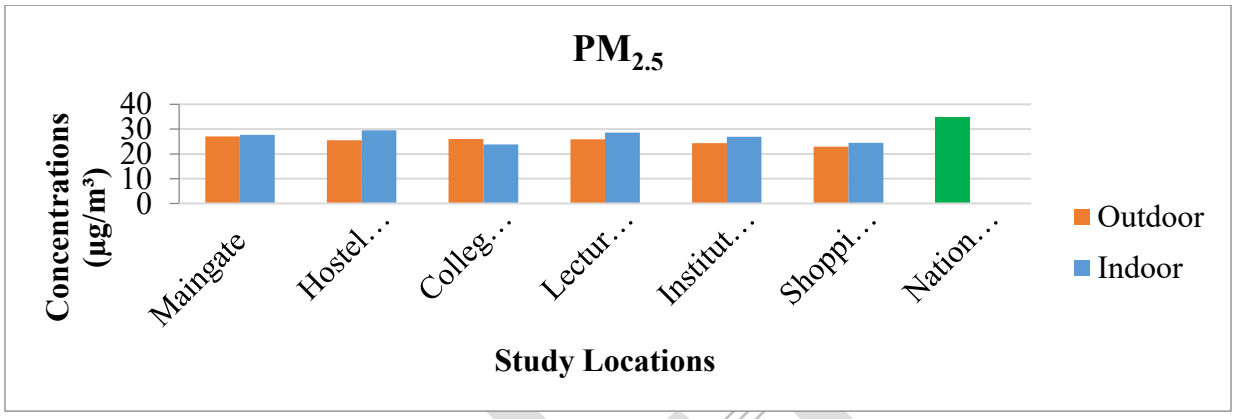

Figure 1: Illustration of $PM_{2.5}$ in the Study Locations

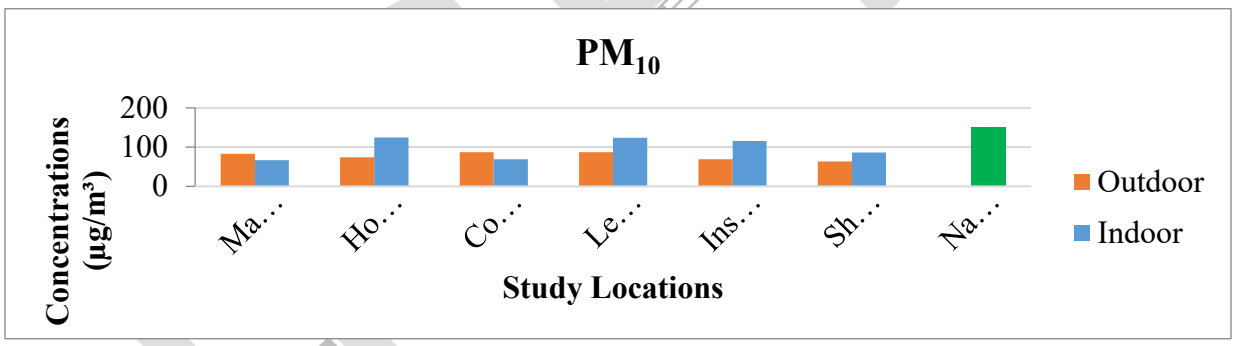

Figure 1: Illustration of PM_{10} in the Study Locations

The physical monitoring results for particulate matter presented in Table 1 alongside Figure 1 and Figure 2 reveal substantial spatial variations in fine and coarse airborne particles across the university campus. Fine particulate concentrations ($PM_{2.5}$) ranged from 19.9 $\mu g/m^3$ to 34.4 $\mu g/m^3$ across all locations, remaining below the national safety threshold of 35.0 $\mu g/m^3$. Indoor environments recorded slightly higher average $PM_{2.5}$ levels than outdoor areas, led by Lecture Hall SC-6 (28.6 $\pm$ 6.35 $\mu g/m^3$), Main Gate (27.7 $\pm$ 2.58 $\mu g/m^3$), and the Institute of Pollution Studies (26.9 $\pm$ 3.60 $\mu g/m^3$). Conversely, coarse particulate matter (PM_{10}) exhibited severe elevated concentrations spanning from 49.4 $\mu g/m^3$ to 162.9 $\mu g/m^3$. Peak PM_{10} levels were observed indoors at Lecture Hall SC-6 (124.2 $\pm$ 63.00 $\mu g/m^3$), Hostel H/PG (124.5 $\pm$ 24.30 $\mu g/m^3$), and the Institute of Pollution Studies (115.6 $\pm$ 26.60 $\mu g/m^3$), with individual daily readings at SC-6 exceeding the national standard of 150.0 $\mu g/m^3$.

Table 2: Summary of Gaseous Pollutants in the Study Area

Sampling Locations	Environs	Mean ± SD				
		CO	NO_2	H_2S	O_3	VOC
Main Gate	Indoor	6.57 ± 1.43	0.17 ± 0.05	0 ± 0	0.04 ± 0.05	2.33 ± 1.15
	Outdoor	10.02 ± 2.78	0.16 ± 0.02	0 ± 0	0.04 ± 0.06	1.67 ± 0.58
Hostel H/PG	Outdoor	12.73 ± 4.3	0.16 ± 0.04	0 ± 0	0.05 ± 0.04	1.67 ± 0.58
	Indoor	11.16 ± 3.91	0.14 ± 0.01	0.07 ± 0.01	0.13 ± 0.05	1.00 ± 0.00
College of Medical Sciences	Indoor	5.51 ± 2.74	0.14 ± 0.02	0.02 ± 0.02	0.13 ± 0.02	1.00 ± 1.00
	Outdoor	5.36 ± 2.30	0.19 ± 0.06	0 ± 0	0.08 ± 0.08	1.00 ± 1.00
Lecture Hall (SC-6)	Indoor	5.93 ± 2.45	0.17 ± 0.03	0.02 ± 0.02	0.01 ± 0.02	0.67 ± 0.58
	Outdoor	5.74 ± 1.97	0.18 ± 0.01	0.01 ± 0.02	0.05 ± 0.07	0.33 ± 0.58
Institute of Pollution Studies	Indoor	5.04 ± 0.61	0.17 ± 0.00	0.09 ± 0.09	0.13 ± 0.01	0.50 ± 0.50
	Outdoor	5.34 ± 1.60	0.16 ± 0.01	0.03 ± 0.05	0.05 ± 0.09	0.67 ± 0.58
Shopping Complex	Indoor	10.09 ± 3.39	0.19 ± 0.02	0.1 ± 0.01	0.13 ± 0.02	0.50 ± 0.50
	Outdoor	14.42 ± 0.60	0.17 ± 0.00	0.05 ± 0.04	0.05 ± 0.05	1.00 ± 0.00
National Standards		**10.00**	**0.200**	**–**	**0.18**	**–**

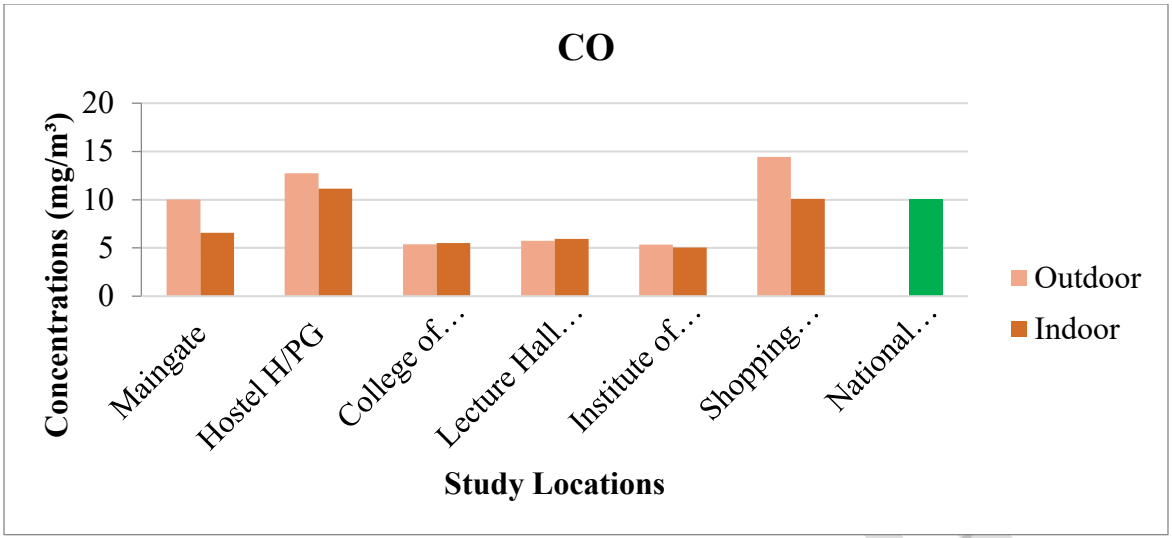

Figure 3: CO Levels in Rivers State University

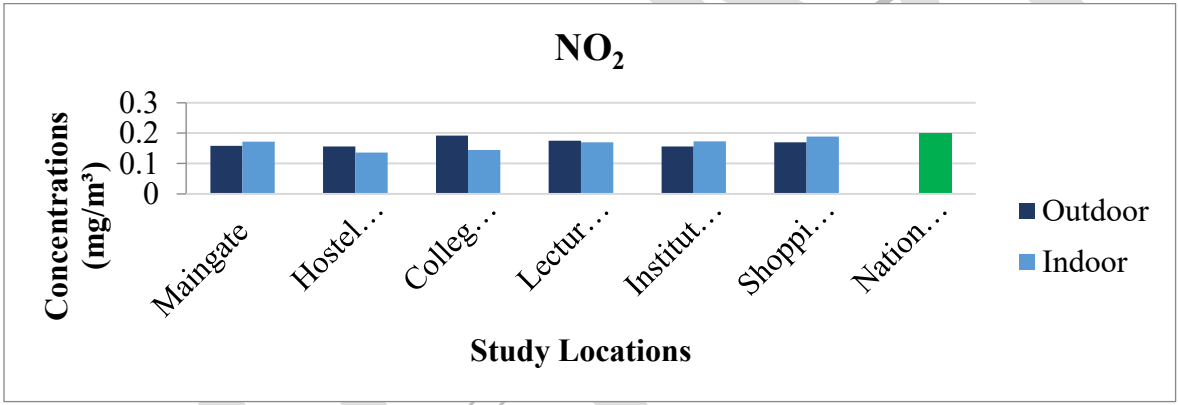

Figure 4: NO_2 Levels in Rivers State University

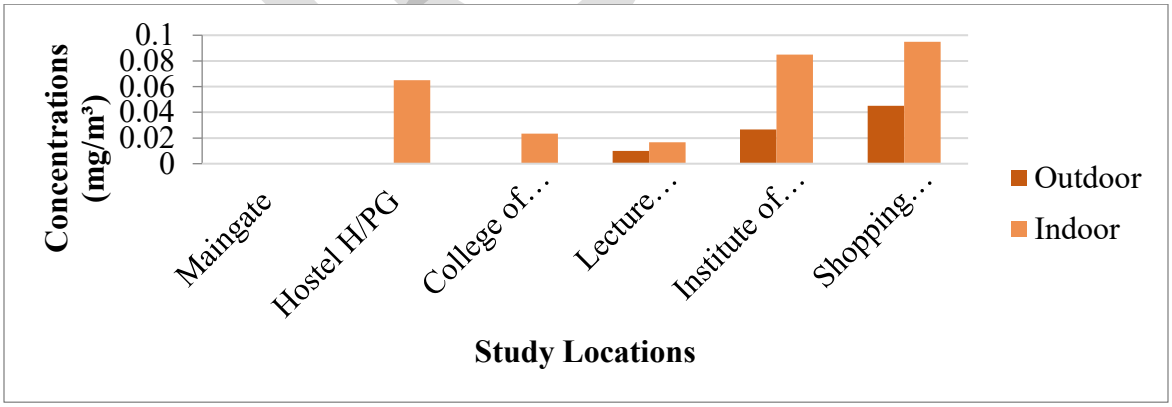

Figure 5: H_2S Levels in Rivers State University

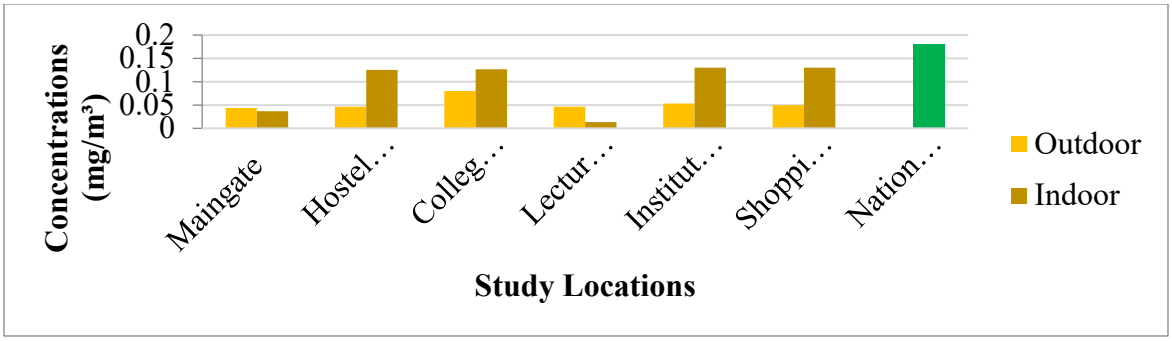

Figure 6: H_2S Levels in Rivers State University

The measurements for gaseous pollutants summarized in Table 2 and illustrated in Figure 4.3, Figure 4, Figure 5, and Figure 6 indicate localized concentrations of toxic gases. Average carbon monoxide (CO) levels breached the national benchmark of 10.00 ppm at several locations, peaking outdoors at the Shopping Complex (14.42 $\pm$ 0.60 ppm), Hostel H/PG (12.73 $\pm$ 4.30 ppm), and the Main Gate (10.02 $\pm$ 2.78 ppm). Nitrogen dioxide (NO_2) remained within statutory limits (0.200 ppm) across all sites (0.14 to 0.19 ppm). Trace amounts of hydrogen sulfide (H_2S) were detected indoors at the Shopping Complex (0.10 $\pm$ 0.01 ppm) and Institute of Pollution Studies (0.09 $\pm$ 0.09 ppm). Ground-level ozone (O_3) reached notable indoor concentrations at the Shopping Complex, Institute of Pollution Studies, and Hostel H/PG (0.13 ppm each), staying below the limit of 0.18 ppm. Volatile organic compounds (VOCs) peaked at the Main Gate (2.33 $\pm$ 1.15 ppm indoors; 1.67 $\pm$ 0.58 ppm outdoors) and Hostel H/PG (1.67 $\pm$ 0.58 ppm outdoors).

Table 3: Toxicity Potentials of the Air Pollutants in the Study Area

Sampling Locations	Environs	Toxicity Potential				
		$PM_{2.5}$	PM_{10}	CO	NO_2	O_3
Main Gate	Indoor	0.79	0.45	0.66	0.86	0.20
	Outdoor	0.77	0.56	1.00	0.79	0.24
Hostel H/PG	Outdoor	0.73	0.49	1.27	0.78	0.26
	Indoor	0.84	0.83	1.12	0.68	0.69
College of Medical Sciences	Indoor	0.68	0.46	0.55	0.72	0.70
	Outdoor	0.74	0.58	0.54	0.96	0.44
Lecture Hall (SC-6)	Indoor	0.82	0.83	0.59	0.85	0.07
	Outdoor	0.74	0.58	0.57	0.88	0.26

Institute of Pollution Studies	Indoor	0.77	0.77	0.50	0.87	0.72
	Outdoor	0.69	0.46	0.53	0.78	0.30
Shopping Complex	Indoor	0.70	0.58	1.01	0.95	0.72
	Outdoor	0.65	0.42	1.44	0.85	0.28

The Toxicity Potential (TP) computations presented in Table 3 reflect pollutant severity relative to statutory limits, where values exceeding 1.00 signify toxic threshold breaches. Outdoor CO generated elevated toxicity potentials at the Shopping Complex (1.44), Hostel H/PG (1.27), and the Main Gate (1.00), alongside indoor readings at Hostel H/PG (1.12) and the Shopping Complex (1.01). NO_2 exhibited high toxicity potentials ranging from 0.68 to 0.96, while $PM_{2.5}$ (0.65 to 0.84) and PM_{10} (0.42 to 0.83) demonstrated moderate risk scores across all environments.

Table 4: AQI Evaluated for the Study Locations

Study Locations	Environs	AQI	Comment
Main Gate	Indoor	125	Unhealthy for Sensitive Groups
	Outdoor	112	Unhealthy for Sensitive Groups
Hostel H/PG	Outdoor	132	Unhealthy for Sensitive Groups
	Indoor	157	Unhealthy
College of Medical Sciences	Indoor	118	Unhealthy for Sensitive Groups
	Outdoor	123	Unhealthy for Sensitive Groups
Lecture Hall (SC-6)	Indoor	118	Unhealthy for Sensitive Groups
	Outdoor	115	Unhealthy for Sensitive Groups
Institute of Pollution Studies	Indoor	137	Unhealthy for Sensitive Groups
	Outdoor	103	Unhealthy for Sensitive Groups
Shopping Complex	Indoor	148	Unhealthy for Sensitive Groups
	Outdoor	136	Unhealthy for Sensitive Groups

The comprehensive Air Quality Index (AQI) evaluations detailed in Table 4 classify the overall campus atmosphere into specific risk categories. Indoor Hostel H/PG recorded an AQI of 157, placing it in the **Unhealthy** category. All other indoor and outdoor locations registered AQI scores between 103 and 148, categorizing the entire study area as **Unhealthy for Sensitive**

Groups.

Table 5: Demographic Information of the Respondents

Question	Options	Respondents (%)	Number of Respondents
Age Group	18-24	42.0%	63
	25-34	30.7%	46
	35-44	19.3%	29
	45 and above	8.0%	12
Gender	Male	55.3%	83
	Female	44.7%	67
Role on Campus	Student	77.3%	116
	Staff	12.0%	18
	Visitor	10.7%	16

The demographic breakdown of the 150 respondents provided in Table 4.5 shows a predominantly young target group, with 42.0% aged 18–24 and 30.7% aged 25–34. Males comprised 55.3% of the sample and females 44.7%, while students made up 77.3%, staff 12.0%, and visitors 10.7%.

Table 4.6: Primary Sources of Air Pollution

Question	Options	Respondents (%)	Number of Respondents
4. What do you perceive as the primary sources of outdoor air pollution on the RSU campus?	Vehicle emissions	62.0%	93
	Industrial activities nearby	21.3%	32
	Construction activities	29.3%	44
	Open burning of waste	12.0%	18
	Dust from unpaved roads	38.7%	58
	Others	8.0%	12

5. What do you perceive as the primary sources of indoor air pollution on the RSU campus?	Tobacco smoke	22.7%	34
	Use of cleaning chemicals	50.0%	75
	Indoor cooking	12.0%	18
	Mould and dampness	15.3%	23
	Poor ventilation	48.7%	73
	Others e.g., Printing etc.	5.3%	8

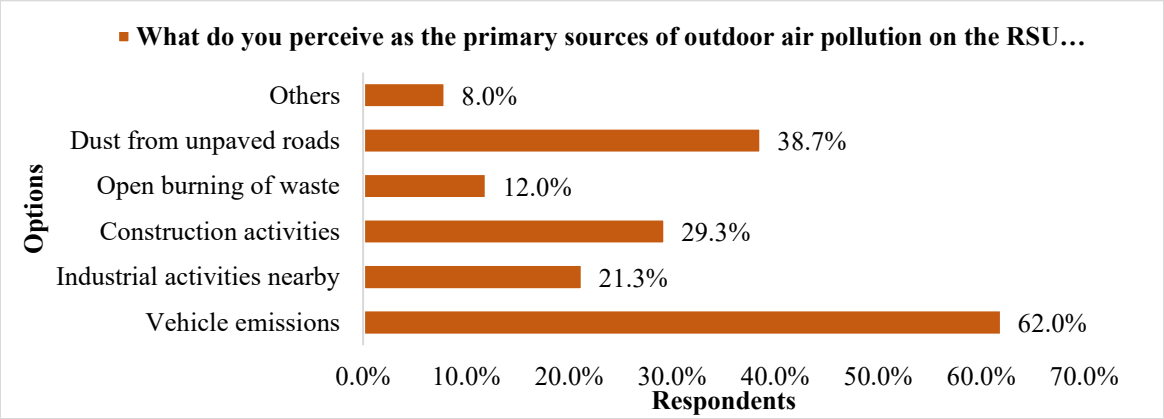

Figure 7: Respondents Perception of the Outdoor Air Pollution Sources

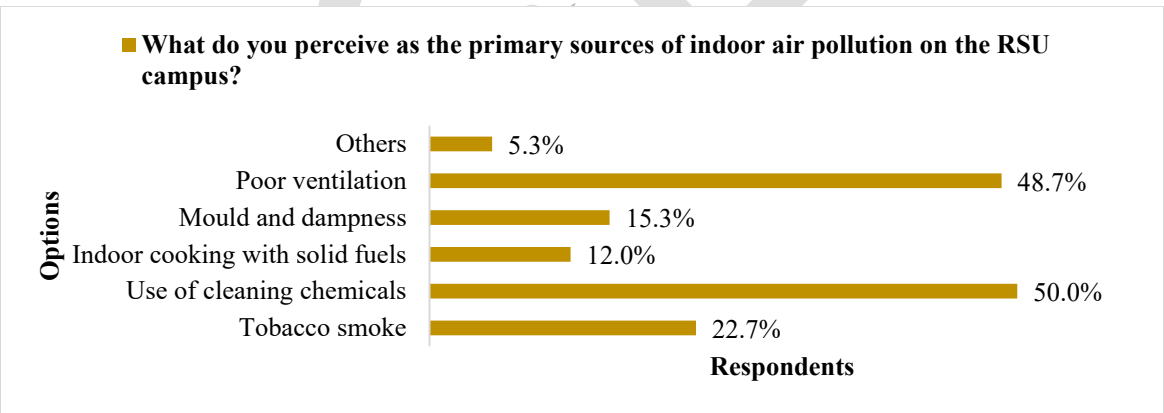

Figure 4.8: Respondents Perception of the Indoor Air Pollution Sources

The perceived pollution drivers summarized in Table 4.6 and illustrated in Figure 4.7 and Figure 4.8 identify vehicular emissions (62.0%), unpaved road dust (38.7%), and construction (29.3%) as primary outdoor sources. For indoor pollution, respondents singled out cleaning chemicals (50.0%), poor ventilation (48.7%), and tobacco smoke (22.7%).

Table 7: Awareness and Perception of Air Quality

Question	Options	Respondents (%)	Number of Respondents
6. How would you rate your awareness of the sources of air pollution on the RSU campus?	Very high	15.3%	23
	High	20.7%	31
	Moderate	34.0%	51
	Low	21.3%	32
	Very low	8.7%	13
7. How often do you think about air quality in your daily activities on campus?	Always	12.7%	19
	Often	29.3%	44
	Sometimes	38.0%	57
	Rarely	14.7%	22
	Never	5.3%	8
8. How would you rate the overall outdoor air quality on the RSU campus?	Very good	14.7%	22
	Good	26.7%	40
	Fair	39.3%	59
	Poor	14.0%	21
	Very poor	5.3%	8
9. How would you rate the overall indoor air quality in buildings on the RSU campus?	Very good	7.3%	11
	Good	29.3%	44
	Fair	32.7%	49
	Poor	18.0%	27
	Very poor	12.7%	19

The awareness and perception metrics in Table 4.7 reveal moderate pollution knowledge among campus inhabitants, with 34.0% rating their awareness as moderate, 20.7% as high, and 21.3% as low. Regarding daily air quality concerns, 38.0% think about it sometimes and 29.3% often. Outdoor air quality was rated fair by 39.3% and good by 26.7%, while indoor air quality was perceived as fair (32.7%), good (29.3%), poor (18.0%), or very poor (12.7%).

Table 4.8: Perceived Health Impacts

Question	Options	Respondents (%)	Number of Respondents
10. Do you believe that air pollution on the RSU campus affects your health?	Yes	19.3%	29
	No	25.3%	38
	Not sure	55.3%	83
11. If yes, what health issues do you associate with air pollution on the RSU campus?	Respiratory issues (e.g., asthma, bronchitis)	12.0%	18
	Allergies	4.7%	7
	Headaches	8.7%	13
	Fatigue	4.0%	6
	Eye irritation	28.7%	43
12. What measures would you take to protect yourself from air pollution on the RSU campus?	Wearing masks	20.7%	31
	Staying indoors during high pollution times	24.7%	37
	Using air purifiers	8.0%	12
	Keeping windows closed	10.0%	15
	Avoiding high-traffic areas	18.7%	28
	Others	2.0%	3

The health impact responses detailed in Table 8 indicate that 55.3% of respondents were unsure if air pollution affected their health, 25.3% believed it did not, and 19.3% responded affirmatively. Among affected individuals, eye irritation (28.7%) and respiratory issues (12.0%) were the most frequently reported symptoms. Personal protective measures included eye/face protection or masks (20.7%), avoiding high-traffic zones (18.7%), and remaining indoors (24.7%).

Table 9: Suggestions for Improvement

Question	Options	Respondents (%)	Number of Respondents
13. What steps do you think the RSU administration should take to reduce air pollution on campus?	Increase green spaces and trees	37.3%	56
	Implement stricter vehicle emission controls	24.7%	37
	Improve waste management practices	18.7%	28
	Enhance indoor air ventilation systems	25.3%	38

Raise awareness about air pollution and its impacts	40.7%	61
No idea	14.0%	21

The institutional recommendations summarized in Table 4.9 highlight key priorities, with 40.7% advocating for raised public awareness, 37.3% calling for expanded green spaces and tree planting, 25.3% requesting enhanced indoor ventilation, and 24.7% demanding stricter vehicle emission controls.

Discussion

The air quality monitoring and survey findings at Rivers State University (RSU) highlight significant environmental health risks driven by particulate matter and gaseous emissions. Particulate matter measurements in Table 1, Figure 1, and Figure 2 demonstrate that while $PM_{2.5}$ remained below national limits, indoor concentrations exceeded outdoor levels due to poor ventilation and human activity. Conversely, PM_{10} levels spiked up to 162.9 $\mu g/m^3$, surpassing national thresholds (150.0 $\mu g/m^3$). This trend aligns with findings by Zwoździak et al. (2015) and Bo et al. (2017), who observed that high occupant density and inadequate indoor ventilation significantly elevate indoor particulate loads in academic facilities.

Gaseous pollutant assessments in Table 2 and Figures 3–6 show that carbon monoxide (CO) exceeded safety limits (10.00 ppm) at high-traffic zones like the Shopping Complex (14.42 ppm) and Main Gate (10.02 ppm). This outdoor CO elevation directly translated to Toxicity Potential (TP) ratios exceeding 1.00 (Table 4.3), reflecting severe toxic pressure. These results corroborate the observations of Barman et al. (2012) and Sonibare et al. (2005), who identified vehicular traffic and fossil fuel combustion as primary drivers of localized CO toxicity in urban centers. The overall results show that Air Quality Index (AQI) values in Table 4.4 classified the campus as "Unhealthy for Sensitive Groups" (AQI 103–148), with Hostel H/PG reaching "Unhealthy" status indoors (AQI 157). Respondent perceptions (Tables 4.5–4.9, Figures 4.7–4.8) accurately identified vehicular exhaust (62.0%) and poor indoor ventilation (48.7%) as key pollution sources. This closely mirrors the global burden documented by WHO (2018) and Leung (2015), confirming that unmitigated indoor and outdoor air pollution directly contributes to respiratory and eye irritation symptoms among campus populations

Conclusion

This study assessed the condition of indoor and outdoor air quality at significant operational areas of Rivers State University (RSU) while also considering the health consciousness and perceptions of those on campus. The findings from physical monitoring indicated that coarse particulate matter (PM10) and carbon monoxide (CO) are significant environmental health threats within the university. Although levels of fine particulate matter (PM2.5) stayed within allowable limits, indoor settings consistently demonstrated higher amounts compared to outdoor areas, which can be attributed to inadequate ventilation, dust resuspension, and a high number of occupants. The intense vehicle traffic and the burning of fossil fuels related to university transport and commercial activities resulted in CO concentrations exceeding national safety standards in densely populated locations like the Shopping Complex, Main Gate, and Hostel H/PG. As a result, calculations of toxicity potential revealed notable toxic stress (TP>1.00) for CO, and evaluations of the Air

Quality Index (AQI) identified the campus environment as Unhealthy for Sensitive Groups outside and Unhealthy within residential hostel areas. Survey results indicated that campus residents accurately recognized that vehicle emissions, dust from unpaved roads, and inadequate indoor ventilation are key contributors to air pollution, with the most prevalent health issues being eye irritation and respiratory problems. The findings emphasize the critical need for environmental interventions by the institution to protect the health and cognitive performance of both students and staff.

Recommendations

i. The university leadership ought to upgrade older lecture halls, laboratories, and dormitory buildings by installing modern mechanical ventilation systems, high-efficiency particulate air (HEPA) filtration devices, and establishing regular schedules for maintaining indoor air quality to manage the accumulation of indoor particles and chemicals.

ii. The institution should implement rigorous traffic control regulations, enforce emission restrictions on commercial vehicles entering the campus, prohibit idling engines near teaching areas, and pave any remaining unpaved roads and pathways to minimize the resuspension of mineral dust.

iii. The university is encouraged to initiate focused tree planting projects and create green buffers alongside major traffic routes to naturally reduce gaseous and particulate pollutants while also conducting ongoing health awareness campaigns centered on air pollution reduction and personal safety measures.

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