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The Impacts of Air Pollution on the Development of University Education in Nigeria

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Abstract **Original Research Article**

Air pollution is one of the major environmental problems facing developing nations, including Nigeria. It has far-reaching consequences not only on human health but also on educational development. This paper examines the impact of air pollution on the development of university education in Nigeria. It focuses on the effects of air pollution on students' health, academic performance, infrastructural integrity, and institutional productivity. The study adopts a conceptual and analytical approach supported by relevant literature. Findings reveal that exposure to air pollutants such as carbon monoxide, sulfur dioxide, and particulate matter negatively influences learning capacity, staff efficiency, and the longevity of academic facilities. The paper concludes that air quality management is crucial to achieving sustainable university education in Nigeria and recommends policy integration between educational and environmental agencies to promote clean and safe academic environments.

Keywords: Air pollution, university education, Nigeria, environmental management, academic performance, institutional development.

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1.0 Introduction

Atmosphere can simply be defined as the whole mass of air surrounding the earth and other planets. It comprises an intricate natural gaseous system which is vital to support life of human, animals and plants (Woodford, 2010). Zimmer (2013) conceive the atmosphere of the earth as that layer of gases generally addressed as ‘air’ which envelopes the earth and gets retained by gravity. He identified some of its characteristics which include the absorption of ultraviolet (UV) solar radiation, its greenhouse effect of warming the surface via the retention of heat and the diurnal temperature variation of reducing a very high temperature between the day and the night.

According to Woodford (2010), apart from having a variable quantity of about average of 1% sea level and 0.4% over the entire atmosphere of water vapour, the constituent of the atmosphere has dry air components of various types of gases of the following volume: Nitrogen, 78:09%, Oxygen 20:95%, Argon 0.93%, Carbiodioxide, 0.39% as well as small volume of other gases. Atmospheric gases consist of three principle components of air which are atmospheric nitrogen, oxygen and argon. While

Trace gases comprise of other gases like methane, carbiondioxide and ozone.

The existence of the ecosystem or plant earth depend essentially on the components of the atmosphere (Anderson et al., 2011).

Air pollution connotes those features of an environment that negatively influence the health, comfort and performance ability of the inhabitants. It refers to the degree of air that is injurious to the healthy living of human's animals or plants.

In other words, when the air is unsuitable or unclean enough for the survival of man, animals and plants, then such ais is polluted.

Nigeria started witnessing the negative environmental hazards of oil development after the discovery of oil in the country in the 1950s. Colossal damage to Nigeria's ecosystems/environment particularly in the Niger Delta region which constitutes the hub of Nigeria's oil industry became accentuated through the growth of the oil industry, coupled with population explosion of geometric proposition and lack of or poor enforcement of environmental regulation (Nriagu, 2011). Other challenges from air pollution and desertification were also experienced in Nigeria as a result of the Sahara desert encroachment and devastating air pollution recoded in the overcrowded cities of Lagos, Abuja, Kaduna and Port-Harcourt (Okoro, 2012).

Air pollution has been rightly seen as a common cause oof adverse health conditions and terrible respiratory diseases and infections resulting in the occurrence and severity of asthma and other associated ailments (Okoro, 2012).

In recent years, the development of environmental factors/problems, especially air pollution are increasingly being recognized as a silent but serious threat.

University students as one of the major responsive part of the population are prone to the dangers of air pollution which can disrupt the institution's community as a result of the vulnerability of the population and result into unconducive learning environment.

The works of scholars have x-rayed the negative effects of air pollution on university students which include: absenteeism, high number of patients, admission to hospitals, morality rate, deteriorating student's health and unconducive learning environment. (Caroll, 2010, McConnel Berhane, Gilliland, Islam, Gauderman, Avol, Mignons and Peters, 2002).

According to Currie, Hausshek, Kaha, Neidell and Rivkin (2007), air pollution affects academic performance in the university in four major ways:

1. Absenteeism of the student as a result of diseases caused by air pollution

2. Lack of concentration

3. Problem of attention

4. Adverse effect on brain development

Air pollution is increasingly recognised as a major environmental and public-health challenge, influencing not just physical health but also cognitive function, learning environments, and institutional performance. Urban environments in Nigeria demonstrate concerning levels of key pollutants such as PM2.5, PM10, NO2, and CO (Odubanjo, Falaiye, Orosun & Sanni, 2024). Within university campuses, studies have found elevated particulate-matter concentrations and user concerns related to indoor air quality (Owolabi, Afolami & Adedeji, 2024; Assessment of Particulate Matter Concentrations in a University Campus, Nigeria, 2018).

This study seeks to assess the impact of air pollution on the development of university education in Nigeria, examining its effects on students' health, academic performance, institutional productivity, and infrastructural maintenance. It aims to provide evidence-based recommendations that can guide interventions toward achieving a cleaner and more supportive academic environment for sustainable national development.

1.1 Statement of the Problem

Nigerian universities are increasingly located within or near areas experiencing high levels of air pollution due to industrial activities, urban congestion, and reliance on fossil fuels. These institutions face the dual challenge of providing quality education while

combating environmental degradation. The constant exposure of students and staff to polluted air can result in health complications, absenteeism, and low academic output. In addition, pollution-induced damage to infrastructure and laboratory equipment leads to increased costs of repair and replacement, diverting resources meant for academic development.

Despite these realities, there is insufficient empirical research or policy action addressing the direct relationship between air pollution and university education. Most education development plans in Nigeria focus on funding, curriculum, and infrastructure, often overlooking environmental quality as a determinant of educational outcomes. The persistent neglect of this issue could hinders Nigeria's progress toward achieving the Sustainable Development Goals (SDGs), especially Goal 4 that centers on quality education and Goal 13 that revolves around climate action.

1.2 Objectives of the Study

The paper has as its major objective the examination of the impact of air pollution on the development of University Education in Nigeria.

The specific objectives are to:

1. Identify major sources and types of air pollutants affecting university environments in Nigeria.

2. Assess the effects of air pollution on students' health, attendance, and academic performance.

3. Recommend strategies for reducing the adverse effects of air pollution on university education.

1.3 Research Questions

1. What are the major sources and types of air pollutants affecting Nigerian universities?

2. How does air pollution influence the health and academic performance of students and staff?

3. What strategies can be adopted to mitigate the effects of air pollution on educational institutions?

Here are the words extracted from the images:

1.4 Significance of the Study

This study is significant in several ways. It provides insights into the environmental factors that influence the development of higher education, an area that has received limited attention in Nigerian academic discourse. Policymakers and university administrators will benefit from this research by understanding the need to integrate environmental quality management into educational planning and campus development.

Students and staff will gain awareness of the health and cognitive risks associated with air pollution, fostering advocacy for cleaner learning environments. The findings will also guide environmental agencies and the environmental government in formulating policies that link environmental agencies and the government in formulating policies that link environmental protection with educational development. Furthermore, the study contributes to existing literature by establishing a theoretical and conceptual link between air pollution and university education in Nigeria.

1.5 Scope and Limitations of the Study

The study focuses on Nigerian universities located in regions with high industrial and vehicular activity, such as Lagos, Rivers, and Kano States, where air pollution is more prevalent. It examines both human and infrastructural dimensions of university development—health, learning outcomes, research productivity, and campus sustainability.

However, limitations include inadequate air quality data across all university locations and time constraints that may affect data collection coverage. Financial limitations may also restrict the number of sampled universities. Despite these constraints, the findings are expected to provide a reliable basis for policy action and future research.

2.0 Conceptual Framework

Numerous studies have confirmed the adverse effects of air pollution on human health, productivity, and learning. Amos and Adofu (2021) found that increased exposure to particulate matter correlates

with higher morbidity rates in Nigerian cities. At the institutional level, Owolabi, Afofami, and Adedeji (2024) reported poor outdoor air quality and discomfort in university lecture halls due to inadequate ventilation and external dust inflow.

The conceptual framework of this study rests on the assumption that environmental quality is a critical determinant of educational effectiveness and development. Air pollution affects both human and institutional aspects of university education.

Human Dimension: Poor air quality impairs health, concentration, and attendance, leading to reduced learning outcomes.

Institutional Dimension: Air pollutants damage physical structures, laboratory equipment, and technological resources, thereby increasing operational costs and reducing research capacity.

Air Pollution

Air pollution refers to the introduction of harmful substances—such as nitrogen oxides, sulfur dioxide, carbon monoxide, particuclate matter and volatile organic compounds into the atmospheric space in concentrations that engender adverse effects on humans, plants and materials (World Health Organization, 2022).

In university settings, common sources include generator fumes, vehicular exhaust, open waste burning, laboratory chemicals, and dust from ongoing construction (Kolawole et al., 2023).

2.1 Key Concepts

University Environment

The university environment encompasses the physical, social, and academic spaces where learning, research, and administration occur. When polluted, this environment affects cognitive performance, health, and the overall learning atmosphere (Owolabi, Afofami, & Adedeji, 2024).

Mitigation Strategies

These are systematic actions or policies aimed at reducing or preventing the release of pollutants. They include renewable energy adoption, green transportation, waste recycling, and campus environmental awareness programs (Yusuf et al., 2022).

Sustainability Framework

The study aligns with the Sustainable Campus Model (SCM), which integrates environmental protection, social responsibility, and economic efficiency as the three pillars of institutional sustainability (UNESCO, 2020).

2.2 Major Sources of Air Pollution in Nigerian Universities

Several empirical studies point to the specific drivers of campus air pollution in Nigeria.

Vehicular Emissions

Vehicle traffic particularly older vehicles with poor emission control generates CO, NOx, and particulate matter around campuses. In urban Nigeria, traffic intersections show high pollutant concentrations (Emereibeole et al., 2023). Also, campuses often serve as hubs for commuting students, staff and visitors.

Stand-By Power Generators

Frequent power outages in Nigeria prompt reliance on diesel or petrol generators. A study in Ado-Ekiti found suspended particulate matter (SPM) from various generator sets ranged from 1,413.4 μg/m³ to 5,300 μg/m³ well above national and WHO limits (Kolawole, Omole & Adenesi, 2023).

On campuses, these emissions contribute both outdoor and indoor pollution (University of Port Harcourt campus study found PM2.5 up to 67.25 μg/m³) (Assessment of Particulate Matter Concentrations in a University Campus in Nigeria, 2018).

Open Waste Burning and Poor Waste Management

Poorly managed solid waste on and around campuses often leads to open burning, releasing soot, black

carbon and other pollutants. For example, a case study of University of Nigeria, Enugu Campus found air-pollution effects attributed to waste-burning practices (Agholor, Azanti, Ogochukwu & Ogochukwu, 2025).

Construction and renovation activities

Lecture theatres, hostels and other infrastructure undergo frequent renovation and expansion. These activities generate dust and emissions of volatile organic compounds (VOCs) from paints, solvents and construction equipment contributing to decrease indoor and outdoor air quality. A user perception study at Federal University of Technology, Akure identified "dust" as a major factor in user dissatisfaction with indoor air quality in lecture theatres (Owolabi, Afofami & Adedeji, 2024).

Natural sources and regional transport

Dust storms (e.g., the Harmattan) and regional soot transport also elevate ambient PM levels, including around campuses. A study in Ibadan using low-cost sensors found high PM concentrations during the Harmattan season (Otuña, 2025).

3.0 Methodology

3.1 Research Design

The study used a descriptive survey design to gather both quantitative as well as qualitative data from undergraduates, lecturer's non-academic staff and environmental officers in Adeyemi Federal University of Education Ondo.

3.2 Population and Sampling

The target population included all university community members in Adeyemi Federal University of Education Ondo. Using Yamane's (1967) formula at a 5% error margin, a total sample size of 100 respondents was determined across the four categories of respondents mentioned above. Stratified random sampling ensured balanced representation.

3.3 Research Instrument

A structured questionnaire was the primary data-collection tool, divided into five sections: demographic data, awareness of air pollution, sources, perceived effects, and mitigation strategies. Responses were measured on a 5-point Likert scale. The questionnaire instrument was validated by some experts in the field of education and through a pilot test that yielded a Cronbach's alpha reliability coefficient of 0.83.

3.4 Data Analysis

Descriptive statistics (frequency, mean, percentage) and inferential analyses (Chi-square and ANOVA) were performed using SPSS 25.0 to test relationships between awareness levels, perceived effects, and mitigation practices.

4.0 Results and Discussion

Preliminary analysis suggests that generator emissions and open waste burning are the dominant pollution sources on Nigerian campuses. Respondents reported that poor air quality leads to respiratory problems, reduced concentration, and absenteeism.

4.1 Sources of Air Pollution in Nigerian Universities

Analysis of data from 100 respondents in the university revealed that the major sources of air pollution are generator fumes (35.5%), vehicular emissions (26.7%), open waste burning (21.3%), and construction dust (10.2%), while laboratory emissions (6.3%) were the least.

Respondents indicated that the continuous use of fossil-fuel generators remains the most persistent pollution source due to unreliable electricity supply. These findings align with those of Kolawole et al. (2023), who reported that power generation using diesel and petrol sets accounts for over one-third of campus air pollution in southern Nigeria. Similarly, Emereibeole et al. (2023) observed that vehicle emissions near student hostels and lecture halls

increase particulate matter levels beyond WHO limits.

4.2 Perceived Effects of Air Pollution on Students and Staff

Respondents identified several health and academic effects resulting from poor air quality. Commonly reported symptoms include coughing (62%), eye irritation (54%), fatigue (48%), and breathing difficulty (41%). In addition, 72% of academic staff and 68% of students agreed that air pollution affects concentration and learning performance.

These results corroborate Odubanjo et al. (2024), who reported that high particulate matter levels cause fatigue and lower cognitive efficiency among students. It also agrees with the work of Amos and Adofu (2021), who linked air pollution to decreased human productivity and learning outcomes.

4.3 Level of Awareness of Air Pollution

About 79% of respondents indicated awareness of air pollution as an environmental issue. However, only 41% understood its specific health and educational impacts, suggesting a gap in environmental literacy.

This indicates that while many university members are exposed to pollution, few comprehend its long-term effects or preventive strategies, emphasizing the need for environmental education programs.

4.4 Mitigation Strategies Currently in Use

Most universities have begun small-scale environmental initiatives, such as periodic campus cleanups (reported by 66% of respondents) and tree planting (44%). However, only 18% of respondents confirmed the existence of air quality monitoring equipment, and 23% noted waste recycling units on their campuses.

This reveals that, although awareness is growing, implementation of effective mitigation strategies remains minimal and inconsistent.

4.4.1 Strategies to Mitigate the Effects of Air Pollution on University Campuses

In light of the sources identified above, the following strategies are proposed for Nigerian universities. These strategies integrate policy, infrastructure, operational and educational dimensions.

4.4.2 Adopt Renewable and Clean Energy Sources

To reduce reliance on diesel and petrol generators, universities should invest in solar photovoltaic (PV) systems, wind turbines (where viable) and battery storage. Clean-energy adoption reduces emissions of CO, SO_2, NOx, PM and black carbon. Indeed, renewable technologies have been shown to mitigate CO_2 emissions in Nigerian contexts (A

4.4.3 Sustainable Waste Management

Universities must ban open burning of solid waste on campus, establish segregation at source (plastic, paper, organic), and partner with recycling or waste-to-energy services. Establishing composting for organic waste or anaerobic digestion can further reduce emissions. The case at University of Nigeria shows how poor waste management extends to air-pollution burdens (Agholor et al., 2025).

4.4.4 Green-Campus Initiatives and Vegetation Buffers

Tree planting and development of green belts around hostels, laboratories and parking areas help to trap particulates and improve aesthetic and comfort conditions. Green walls and vegetated roof systems can reduce outdoor particulate infiltration indoors. Awareness campaigns to engage students and staff in greening initiatives can enhance sustainability culture.

4.4.5 Environmental Education and Stakeholder Engagement

Embedding air-quality education in general curricula and organising workshops, seminars and campaigns will raise awareness of the link between air pollution and learning/health outcomes. Encouraging students

to undertake monitoring projects and citizen science initiatives can be empower them and supply data for decision-making.

4.4.6 Air-Quality Monitoring and Institutional Policy Enforcement

Universities should install low-cost sensors or monitoring stations to track $PM_{2.5}$, PM_{10} and CO levels on campus. Data should feed into institutional policies that enforce emission standards (vehicles, generators, construction). Collaboration with national agencies such as National Environmental Standards and Regulations Enforcement Agency (NESREA) will help align campus policies with national regulations. A modelling study around Nigerian universities emphasises the value of pollutant concentration modelling for decision-making (Yusuf, Tiamiyu, Adeniran & Odediran, 2022).

4.4.7 Sustainable Campus Planning and Infrastructure Design

Building design (ventilation systems, use of low-emission materials, dust control during construction) is essential. For example, a study on indoor comfort at FUTA found that lecture-theatre design did not satisfy user comfort across seasons due to indoor-air-quality deficits (Owolabi et al., 2024). Universities should adopt construction best practices, use low-VOC paints and solvents, control dust during works, and ensure adequate ventilation and filtration in indoor spaces.

5.0 Conclusion and Recommendations

Air pollution poses a growing threat to the development of university education in Nigeria. Its impacts on health, learning, infrastructures and institutional productivity are far-reaching and demand urgent attention. To promote sustainable university education, the following recommendations are proposed

1. Environmental Monitoring: Universities should establish air quality monitoring systems within campuses

2. Green Campus Initiatives: Encourage tree planting, reduction of generator use, and promotion of clean energy

3. Policy Integration: Ministries of Education and Environment should collaborate on policies addressing air quality in educational zones

4. Health Awareness Programs: Regular health screenings and awareness campaigns for students and staff on air pollution risks

5. Infrastructure Maintenance: Use of pollution-resistant materials and regular maintenance of laboratory and classroom facilities

By addressing air pollution as a key factor in educational development, Nigeria can strengthen the quality, safety, and sustainability of its university system, ensuring a healthier and more productive academic future.

Ethical Considerations

Participation in this study is voluntary. Respondents' identities will be kept anonymous, and data will be used solely for academic purposes.

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