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Original Research Article

The impact of ambient air pollution on the respiratory health of healthcare workers at UNTH: a cross-sectional study on prevalence, symptomatology and mitigation strategies

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ABSTRACT

Background: Ambient air pollution is a growing public health concern, especially in low- and middle-income countries, where healthcare workers may be exposed despite operating in clinical environments. Sources such as generator fumes and vehicle emissions can contribute to chronic respiratory symptoms among hospital staff.
Methods: A descriptive cross-sectional survey was conducted among 332 healthcare workers selected through stratified random sampling. Data was obtained using a structured, pre-tested questionnaire and analyzed using SPSS version 27. Associations between variables were tested with statistical significance set at $p<0.05$.
Results: While over half of the respondents reported no symptoms, the most frequently experienced symptoms were headache, nasal congestion, and throat irritation. Symptoms were typically mild, occurred occasionally, and were often relieved when away from work. Although many respondents were aware of the health effects of air pollution, fewer adopted consistent protective practices. Generator fumes and car emissions were the most reported pollution sources. Age and work experience were significantly associated with the presence of symptoms.
Conclusions: There is a moderate burden of respiratory symptoms among healthcare workers at UNTH linked to ambient air pollution, with older and more experienced workers at greater risk. While awareness is relatively high, a gap exists between knowledge and protective behavior, indicating a need for targeted interventions.

Keywords: Air pollution, Healthcare workers, Mitigation strategies occupational exposure, Respiratory health, UNTH

INTRODUCTION

Ambient air pollution occurs when air pollutants reach high enough concentrations to affect human health and/or the environment. Major pollutants include particulate matter (PM_{10} and $PM_{2.5}$), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), and ozone (O_3).[1] According to the World Health Organization, ambient air pollution was responsible for approximately 4.2 million premature deaths worldwide in 2016, with 88% of these deaths occurring in low- and middle-income countries. In Africa, ambient air pollution contributed to an estimated 425,000 deaths in the same year with the greatest sources of morbidity from respiratory infections, heart disease, stroke, lung cancer, and chronic obstructive pulmonary disease (COPD).[1] Healthcare workers, although often

perceived as protected within clinical environments, may be continuously exposed to outdoor air pollution, especially in hospitals located near busy urban centres or industrial zones. Long-term exposure may contribute to the development and/or deterioration of chronic respiratory symptoms.

Healthcare workers in Nigeria face multiple occupational and environmental hazards with limited institutional protection. Despite the essential services they provide, they are often overlooked in workplace safety initiatives, occupational health surveillance, and environmental hazard mitigation.[2] Ambient air pollution is just one such neglected hazard, with minimal attention paid to its impact on hospital workers' respiratory health. Sadly, Nigeria, like many low to middle income countries, is currently grappling with a critical healthcare workforce shortage. The WHO estimates that Nigeria has approximately 1.95 doctors, nurses, and midwives per 1,000 population, far below the minimum threshold of 4.45 per 1000 required to achieve universal health coverage.[3] Furthermore, reports from the Nigerian Medical Association (NMA) indicate that over 5,600 Nigerian doctors emigrated to the United Kingdom alone between 2015 and 2022, primarily due to poor working conditions, low remuneration, and unsafe environments.[3] The ongoing emigration of healthcare professionals has intensified the workload on remaining staff, heightening their exposure to occupational risks. Also consider that regulation of occupational health and safety standards within Nigerian hospitals is generally weak. A national assessment by the International Labour Organization noted that most health facilities in Nigeria either lack formal occupational health programs or have programs narrowly focused on infection control, with minimal attention to environmental exposures such as poor air quality.[4] Hospitals situated near busy roads, industrial facilities, or urban areas are particularly vulnerable, yet few have air quality monitoring systems or protections for their workforce.[5]

Further compounding this issue is the fact that respiratory diseases associated with air pollution exposure including chronic bronchitis, asthma, chronic obstructive pulmonary disease (COPD), and lung cancer are typically progressive and irreversible.[6] This means that affected healthcare workers are left with reduced functional capacity, are at increased risk of absenteeism, early retirement, career termination by death or severe morbidity, and progressively escalating health maintenance costs. For healthcare workers whose duties often require sustained physical performance, the development of chronic respiratory illnesses can have devastating professional consequences. In the context of Nigerian tertiary hospitals, the intersection of poor ambient air quality, weak occupational health frameworks, severe healthcare worker shortages, and ineffective environmental regulation creates a high-risk setting for respiratory morbidity among healthcare personnel. Despite the seriousness of these threats, there is a marked lack of empirical studies connecting ambient air pollution exposure to respiratory outcomes among healthcare workers in Nigeria. Without empirical data, which in turn will drive interventions, the respiratory health risks facing healthcare workers will continue to be inadequately addressed. The objective of the study is to assess the impact of ambient air pollution on respiratory health among healthcare workers at the University of Nigeria Teaching Hospital, Ituku-Ozalla Enugu, Enugu State.

METHODS

The study was carried out in Enugu State, located in southeastern Nigeria. The state lies within the tropical rainforest zone and experiences a humid tropical climate with distinct wet and dry seasons. Average temperatures range from moderate values in the harmattan months to higher levels during the dry season, while rainfall varies widely across the year. The University of Nigeria Teaching Hospital (UNTH), Ituku-Ozalla, served as the specific study setting. The hospital occupies a large expanse of land along the Enugu Port Harcourt Expressway and functions as a major tertiary health facility with multiple clinical departments and a sizable workforce drawn from several health professions. This environment provided an ideal platform for examining the respiratory health of workers who operate daily in an environment potentially influenced by ambient air quality. The study started in June 2024 to January 2025.

A descriptive cross-sectional design was employed to evaluate the relationship between ambient air pollution and respiratory symptoms among healthcare personnel. The study population comprised health professionals working at UNTH, including nurses, midwives, pharmacists, medical laboratory scientists, physiotherapists, and radiographers. Only individuals aged 18-65 years who had worked in the hospital for at least six months and who provided informed consent were eligible for inclusion. Workers with pre-existing chronic respiratory disorders unrelated to occupational exposure, or those on extended leave during data collection, were excluded.

The minimum sample size was estimated using Cochran's formula for descriptive studies, assuming a 95% confidence level, a proportion of 0.5, and a precision of 0.05. After applying finite population correction and accounting for a 10% non-response rate, the final sample size was set at 332. A stratified random sampling technique was used to ensure fair representation of the major professional groups. The total workforce was divided into strata based on professional categories, and proportional allocation was used to determine the number of participants selected from each group. Random selection within each stratum was then conducted using standard randomization procedures.

Data was collected using a structured, self-administered questionnaire developed for the study. The instrument was pre-tested among a sample of healthcare workers outside the study population to assess clarity, flow, and relevance of items. Necessary modifications were made prior to deployment. The questionnaire captured socio-demographic information, the presence and pattern of respiratory symptoms, and respondents' knowledge and practices related to mitigation of air pollution exposure. Data collection spanned four weeks, during which eligible participants were approached at their duty posts or during departmental gatherings, briefed on the study purpose, and invited to complete the instrument.

Completed questionnaires were checked for accuracy and completeness before coding and entry. Data analysis was conducted using SPSS version 27. Descriptive statistics, including frequencies, percentages, means, and standard deviations were used to summarize key variables. Associations were examined using appropriate statistical tests, and significance was determined at $p<0.05$. Results are presented in tables and figures for clarity.

RESULTS

Table 1 represents the demographic characteristics of the respondents at the University of Nigeria Teaching Hospital (UNTH), Enugu. Regarding their age distribution, majority (42.2%) aged between 36-45 years, followed by 26-35 years (22.3%) and 46-55 years (16.5%). A smaller proportion were aged 18-25 years (14.9%) while only 4.1% were above 55 years. The mean age of respondents was 37.89 years with a standard deviation of 10.11. In terms of sex distribution, most respondents were female (73.6%), while males accounted for 26.4%. Regarding marital status, a larger proportion of respondents were married (61.5%), while 38.5% were single. None of the respondents reported being widowed or divorced. Analysis by professional group revealed that the majority were nurses or midwives (68.0%), followed by physiotherapists (10.6%), laboratory scientists (9.0%), radiographers (7.1%) while pharmacists made up the least proportion (5.3%). Regarding years of work experience, about half of the respondents (50.3%) had more than 10 years of work experience, 31.7% had worked for 5-10 years, while 18.0% had less than 5 years of experience. Concerning work schedule, most respondents (58.7%) engaged in rotational shifts, 37.9% worked regular day shifts, and the minority (3.4%) worked night duty only. With respect to the use of personal protective equipment (PPE), 62.4% of respondents reported always using PPE, 37.6% used it sometimes, and none reported never using PPE (Table 1).

The analysis revealed that more (58%) of the respondents didn't experience any respiratory symptoms (Figure 1).

Regarding the most commonly experienced symptoms among the respondents, headache emerged as the most frequently reported, with 57.5% indicating they had experienced it. Nasal congestion was the next most prevalent symptom, reported by 18.7% of participants. This was followed by throat irritation, noted by 15.7%, and shortness of breath, which was reported by 8% of the respondents. The least frequently mentioned symptoms were chest tightness and frequent sneezing, each reported by only 1.4% of the participants (Figure 2).

Table 1: Demographic characteristics of the respondents in Unth, Enugu.

Variable	Frequency (n=322)	Proportion (%)	Mean± SD
Age (years)			
18-25	48	14.9	37.89± 10.11
26-35	72	22.3	
36-45	136	42.2	
46-55	53	16.5	
Above 55	13	4.1	
Sex			
Female	237	73.6	
Male	85	26.4	
Marital status			
Single	124	38.5	
Married	198	61.5	
Widowed	0	0	
Divorced	0	0	
Professional group			
Nurse/midwife	219	68.0	
Laboratory scientist	29	9.0	
Pharmacist	17	5.3	
Physiotherapist	34	10.6	
Radiographer	23	7.1	
Years of work experience in years			
Less than 5	58	18.0	
5-10	102	31.7	
Greater than 10	162	50.3	
Work schedule			
Regular day shifts	122	37.9	
Rotational shifts	189	58.7	
Night duty only	11	3.4	
Use of PPE			
Always	201	62.4	
Sometimes	121	37.6	
Never	0	0	

In terms of frequency, the majority (45.9%) experienced symptoms occasionally, while 32.6% had symptoms once a week. A smaller proportion reported experiencing symptoms 2-3 times per week (14.1%) and daily (7.4%). Regarding the timing of symptom occurrence, 37.7% of respondents reported that symptoms mostly occurred after work hours, while 34.1% experienced them during work hours. A smaller percentage reported symptom onset during weekends or off-duty periods (20.0%), and 8.2% noted symptoms occurring randomly. In assessing

severity, about half of the respondents (51.1%) described their symptoms as mild, while 35.6% rated them as moderate and 13.3% as severe. Concerning work impact, 15.6% of respondents had taken sick leave due to symptoms, whereas the majority (84.4%) had not. Furthermore, Majority (56.2%) of the respondents reported that their symptoms were reduced when they were away from work, such as during vacation or off-duty periods, while 43.8% did not observe any change in symptoms during such times (Table 2).

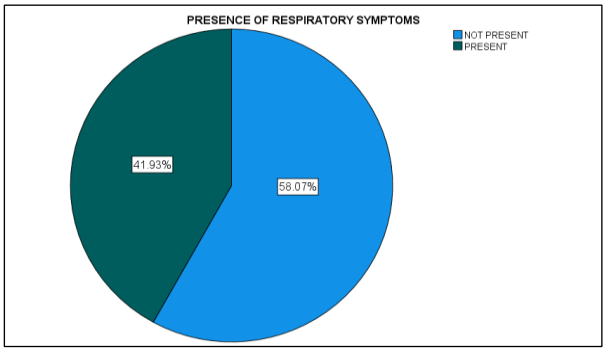

Figure 1: Prevalence of respiratory symptoms.

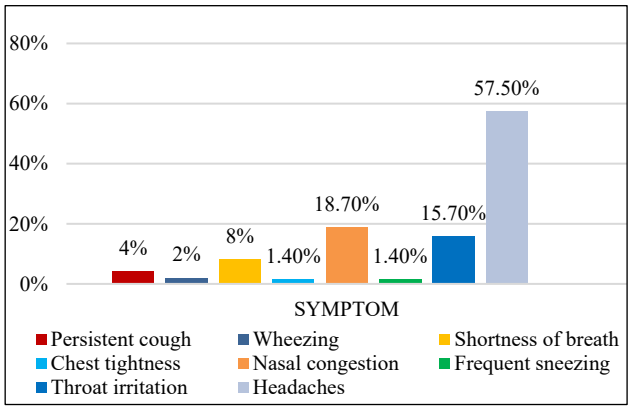

Figure 2: Distribution of respiratory symptoms based on frequency of occurrence among healthcare professionals in UNTH, Enugu (n=135).

Out of the 322 respondents, 59.9% reported being aware of ambient air pollution and its associated health effects, while 40.1% lacked such knowledge. In terms of personal actions, 44.7% of respondents indicated that they take personal measures to reduce their exposure to air pollution, whereas a slightly higher proportion (55.3%) reported not adopting such practices. When asked about the use of face masks in potentially contaminated areas, 50.9% stated that they always wore masks, 46.3% used them sometimes, and only 2.8% never used them. Regarding institutional-level awareness, 59.3% of respondents were aware of existing workplace measures aimed at mitigating air pollution, while 40.7% were not. Finally, a large majority (93.5%) expressed interest in attending workshops or training sessions on how to minimize exposure to air pollution, indicating a strong willingness to improve knowledge and practices (Table 3).

Table 2: Assessment of the pattern and severity of symptoms among respondents in UNTH, Enugu.

Question	Frequency (n=135)	Proportion (%)
Frequency of symptoms		
Daily	10	7.4
2-3 times/week	19	14.1
Once a week	44	32.6
Occasionally	62	45.9
Time of occurrence		
During work hours	46	34.1
After work	51	37.7
Weekends/off-duty	27	20.0
Randomly	11	8.2
Severity of symptoms		
Mild	69	51.1
Moderate	48	35.6
Severe	18	13.3
Taken sick leave due to symptoms		
Yes	21	15.6
No	114	84.4
Reduction of symptoms when away from work (vacation, off-duty)		
Yes	79	56.2
No	56	43.8

Table 3: Assessment of the knowledge and practices regarding mitigation of ambient air pollution among respondents in UNTH, Enugu.

Question	Frequency (n=322)	Proportion (%)
Knowledge of ambient air pollution and its health effects		
Yes	193	59.9
No	129	40.1
Use of personal measures to reduce exposure to air pollution		
Yes	144	44.7
No	178	55.3
Frequency of wearing face masks during work in areas with possible air contamination		
Always	164	50.9
Sometimes	149	46.3
Never	9	2.8
Knowledge of institutional measures against air pollution in work place		
Yes	191	59.3
No	131	40.7
Interest in attending workshops on minimizing exposure to air pollution		
Yes	301	93.5
No	21	6.5

Analysis revealed that generator fumes were identified as the predominant source of ambient air pollution by the majority of respondents (73.1%). Car emissions were also reported by a substantial proportion (45.6%), whereas dust arising from roads or construction activities was the least acknowledged source (7.3%) (Figure 3).

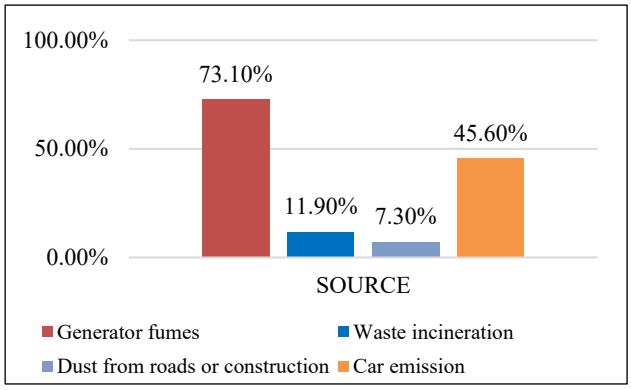

Figure 3: Sources of air pollution among healthcare professionals in UNTH, Enugu (n=193).

Based on findings, respiratory diseases were the most frequently identified health condition associated with air pollution, reported by 90.1% of respondents. This was followed by cardiovascular diseases (36.7%) and cancer (20.5%). Skin conditions were the least reported, identified by only 6.6% of respondents (Figure 4).

The highest proportion of respondents with symptoms were aged 36-45 years (37.8%) and 46-55 years (22.2%), compared to lower proportions in the 26-35 (13.3%) and 18-25 (18.5%) age groups. Similarly, years of work experience were significantly associated with respiratory symptoms ($p<0.0001$). A greater proportion (68.9%) of those who reported respiratory symptoms had worked for over 10 years while just about a tenth (10.4%) had less than 5 years of work experience (Table 4).

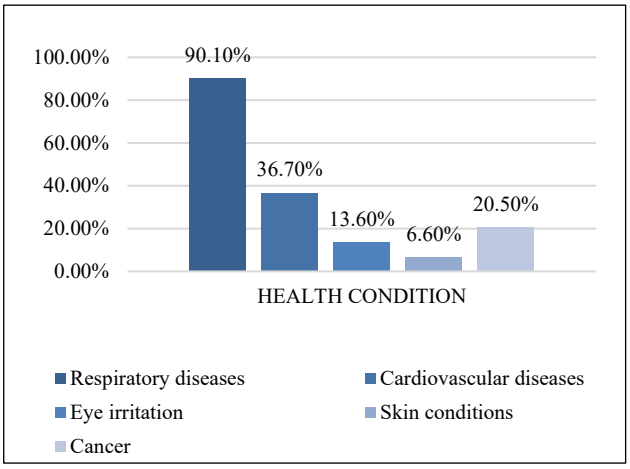

Figure 4: Health conditions most frequently associated with air pollution according to our respondents in UNTH, Enugu (n=193).

Table 4: Factors influencing development of respiratory symptoms among respondents in. UNTH, Enugu.

Demographic variable	With respiratory symptoms, N (n=135)	Proportion (%)	Without respiratory symptoms, N (n=187)	Proportion (%)	X^2	P value
Age in years						
18-25	25	18.5	23	12.3	26.02	<0.0001*
26-35	18	13.3	54	28.9		
36-45	51	37.8	85	45.5		
46-55	30	22.2	23	12.3		
Above 55	11	8.1	2	1.1		
Sex						
Female	100	74.1	137	73.3	0.0266	0.8704
Male	35	25.9	50	26.7		
Professional group						
Nurse/midwife	91	67.4	128	68.4	0.5097	0.9725
Laboratory scientist	13	9.6	16	8.6		
Pharmacist	6	4.4	11	5.9		
Physiotherapist	15	11.1	19	10.2		
Radiographer	10	7.4	13	7.0		
Marital status						
Single	58	43.0	66	35.3	1.9472	0.1629
Married	77	57.0	121	64.7		
Years of work experience						
Less than 5 years	14	10.4	44	23.5	32.262	<0.0001*
5-10 years	28	20.7	74	39.6		
Greater than 10 years	93	68.9	69	36.9		

Continued.

Demographic variable	With respiratory symptoms, N (n=135)	Proportion (%)	Without respiratory symptoms, N (n=187)	Proportion (%)	X^2	P value
Work schedule						
Regular day shifts	43	31.9	79	42.2		
Rotational shifts	86	63.7	103	55.1	3.9484	0.1389
Night duty only	6	4.4	5	2.7		

*Means statistical significance

DISCUSSION

The study revealed that a significant number of healthcare workers at the University of Nigeria Teaching Hospital (UNTH) reported experiencing respiratory symptoms, reflecting a moderately high prevalence. This finding is statistically significant and indicates that a considerable portion of the hospital workforce may be affected by symptoms related to ambient air pollution, despite operating within a healthcare setting where preventive measures are expected to be in place. These findings are supported by a study conducted in the United States, which emphasized air pollution as a key factor influencing both the risk and severity of respiratory infections[7]. The results further reinforce the growing evidence that even in structured and regulated environments like hospitals, prolonged exposure to environmental pollutants particularly generator fumes and vehicular emissions can adversely affect respiratory health. However, this study's findings differ from those of a study conducted in Lagos among traffic workers, where no significant respiratory symptoms were reported despite high levels of environmental exposure.[8] This contrast may be explained by differences in symptom perception, access to healthcare, or adaptation to chronic exposure among outdoor workers. It is also possible that healthcare workers, due to their occupational knowledge, may be more likely to recognize and report subtle respiratory symptoms, which may go unnoticed or unreported in other populations.

The findings revealed that the most reported symptom was headache, followed by nasal congestion and throat irritation. Symptoms occurred most often occasionally or once a week and were mostly mild to moderate severity. Notably, 59% of respondents indicated that symptoms improved when away from work, suggesting a strong link between occupational exposure and symptom manifestation. These findings were significant and indicate a workplace-related etiology. The mild to moderate severity observed could reflect low dose but chronic exposure, typical of settings where air pollution sources like generator fumes and car emissions persist at sub-acute levels. The most common timing after work hours suggests a cumulative effect of exposure throughout the workday. This pattern is in tandem with findings from a study in Lagos, which revealed a similar distribution of mild and recurrent symptoms among urban workers in pollution-prone environments.[9] Likewise, a Chinese study documented that adults who made frequent visits to the hospital often experienced mild upper respiratory symptoms associated with exposure to ambient pollutants.[10] However, the prominence of headache over more typical lower respiratory symptoms (like coughing or wheezing) contrasts with some studies in higher-exposure industrial settings. This may be due to the relatively lower levels of particulate matter at UNTH compared to factories or outdoor urban traffic hubs.[11,12] Alternatively, it may reflect underreporting or differing thresholds of symptom perception among healthcare workers.

The study found that while most of respondents had knowledge of ambient air pollution and its health impacts, only few reported actively adopting personal mitigation measures. Approximately half reported always wearing face masks in high-risk areas, and institutional awareness was moderate, a strong willingness to learn was evident, with over 93% expressing interest in attending workshops on air pollution mitigation. These findings highlight a knowledge-practice gap, where awareness does not consistently translate into preventive behavior. This may be due to factors such as perceived invulnerability, low prioritization of environmental health within clinical duties, or lack of institutional reinforcement of practices. The results align with those of a study carried out in Nigeria which noted a similar disconnection between knowledge and action among healthcare workers in Nigerian urban hospitals.[13] It is also consistent the findings of a study, which revealed that while knowledge levels were high among Colombian medical students, actual implementation of air quality protection behaviors was often limited by time constraints and institutional support.[14] In contrast, a study conducted in urban China to assess knowledge and perceptions of air pollution found a much higher rate of preventive practices, possibly due to stronger policy enforcement and public health campaigns.[15] The disparity may be attributed to contextual differences in environmental policies, workplace culture, and access to protective equipment.

The findings of this study demonstrated a significant association between age and the development of respiratory symptoms. The trend revealed that older healthcare workers were more likely to report experiencing symptoms compared to their younger counterparts. This suggests that advancing age may play a role in increasing vulnerability to ambient air pollution in the occupational setting. One possible explanation for this trend is the age-related decline in respiratory function and physiological resilience. As individuals age, their pulmonary defenses, mucociliary clearance, and immune responses may become less effective, making them more susceptible to the effects of airborne pollutants.

Additionally, older workers may have accumulated more subclinical respiratory damage over time, even if their duration of exposure in the current workplace is not extensive. This finding aligns with previous research which reported that older workers exhibited a higher prevalence of air pollution-related symptoms, which they attributed to reduced physiological adaptation and age-linked decline in lung function.[16] It is also consistent with those of a Nigerian study, who found that older age was a predictor of self-reported respiratory issues in healthcare settings.[17] The study also revealed a significant association between the number of years of work experience and the occurrence of respiratory symptoms. Respondents with longer work experience were more likely to report symptoms than those with fewer years of service. This finding points to the role of cumulative occupational exposure in the development of respiratory health problems. Longer years of work may reflect prolonged and repeated exposure to suboptimal environmental conditions within the hospital, including emissions from generators, poor ventilation, and sustained contact with disinfectants or other airborne irritants. Over time, even low-level exposure to such pollutants may lead to chronic irritation or sensitization of the respiratory tract, resulting in the manifestation of symptoms. This trend is in agreement with the findings of a study that assessed the impact of duration of exposure and educational level as predictors of occupational respiratory symptoms, who reported that cumulative exposure over years of service was strongly associated with the development of respiratory complaints among hospital staff in Ethiopia.[18] Conversely, the absence of such an association in some non-clinical or short-term industrial studies may be due to more controlled exposure conditions or routine rotation of duties, which limit the buildup of long-term exposure effects. In contrast, healthcare workers may face consistent exposure without much variation in work environment or tasks, increasing their overall risk over time. These findings highlight the importance of prioritizing long-serving staff in occupational health monitoring and reinforcing environmental safety measures to reduce long-term exposure in healthcare settings.

This study investigated the prevalence, pattern, and influencing factors of respiratory symptoms associated with ambient air pollution among healthcare workers at the University of Nigeria Teaching Hospital (UNTH), Enugu. The findings revealed a moderate prevalence of respiratory symptoms among respondents, with headache, nasal congestion, and throat irritation being the most reported. Symptoms were mostly mild to moderate in severity and occurred occasionally, often after work hours, with some respondents noting relief during periods away from work. The study also showed that knowledge of ambient air pollution was fair among respondents, but this did not consistently translate into protective practices. While many were aware of the risks, fewer adopted personal mitigation measures, and a significant portion did not regularly use face masks. Encouragingly, most respondents expressed strong interest in receiving further training on how to reduce exposure. Importantly, age and years of work experience were significantly associated with the presence of respiratory symptoms, suggesting that both biological vulnerability and cumulative occupational exposure play critical roles. These findings underscore the need for targeted interventions to improve environmental health safety in hospital settings, especially for older and more experienced staff.

This study has few limitations. First, the reliance on self-reported data introduces possibility of recall bias and social desirability bias, as participants may underreport or exaggerate symptoms or behaviors, second, the cross-sectional design does not permit causal inferences between air pollution exposure and respiratory symptoms. third, unequal availability of workers across departments due to varying shift schedules might have affected uniform participation, despite the stratified sampling approach. Finally, while efforts were made to encourage complete responses, non-responses or incomplete data could have influenced the overall findings. Nonetheless, these limitations were anticipated and managed as much as possible through careful study design and implementation strategies.

CONCLUSION

This study assessed the prevalence, pattern, and determinants of respiratory symptoms associated with ambient air pollution among healthcare workers at the University of Nigeria Teaching Hospital, Ituku-Ozalla. The results demonstrated that although the majority of participants were knowledgeable about the health effects of air pollution, there was a notable gap in the translation of this knowledge into consistent preventive practices. Respiratory symptoms such as headache, nasal congestion, and throat irritation were commonly reported, with symptom relief occurring during time spent away from the hospital environment pointing to a likely occupational influence. Generator fumes and car emissions were identified as key pollution sources within the hospital setting. The study further revealed that advancing age and longer years of work experience were significantly associated with increased reporting of respiratory symptoms, suggesting that cumulative exposure and biological vulnerability may exacerbate risk over time. Overall, these findings emphasize the need for improved environmental safety protocols, enhanced staff education, consistent use of protective measures, and regular health surveillance to mitigate the adverse effects of ambient air pollution on hospital personnel.

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