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Air Quality at Welding and Vehicle Repairs Environments: Morbidity Patterns and Recommendations

MBA, Orji Ugomma Fransisca[1] ; AMADI, Agwu Nkwa[2] ; ENEBELI, Ugo Uwadiako[3*] ; OBASI, Kalu Ojo[4] ; OFFIAH, Shadrach Awa Ukonye[5] ; UDO-INYANG, Florence Obiageli[6] ; IWUOHA, Gregory[7]

[1] Department of Environmental Health Sciences, Abia State University Uturu, Abia State, Nigeria. Email: ugoframba@yahoo.co.uk

[2]Department of Public Health, Federal University of Technology Owerri, Imo State, Nigeria. ORCID: https://orcid.org/0000-0002-6446-3579. Email: professoramadi@gmail.com

[3*] Department of Community Medicine, Rhema University Nigeria, Aba, Abia State, Nigeria. ORCID: https://orcid.org/0000-0001-5950-3719. Email: doctorenebeli@yahoo.com

[4]Department of Environmental Health Science, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria. ORCID: https://orcid.org/0000-0001-6405-302X. Email: ko.obasi@unizik.edu.ng

[5]Department of Anatomical Pathology, Abia State University Teaching Hospital, Aba, Abia State, Nigeria. ORCID: https://orcid.org/0000-0002-1691-7863.

[6]Department of Nursing Science, Rhema University, Aba, Abia State, Nigeria.

[7]Department of Public Health, Federal University of Technology Owerri, Imo State, Nigeria. ORCID: https://orcid.org/0009-0001-7510-5216. Email: gregory.iwuoha@futo.edu.ng

ABSTRACT

Background: Welding and vehicle repair environments expose workers to significant health risks due to poor air quality. This study examines the air quality in welding and vehicle repair environments and the morbidity patterns among welders and vehicle repair workers in Abia State, Nigeria, focusing on respiratory, ocular, and musculoskeletal conditions.

Methods: A cross-sectional study was conducted involving 924 participants (462 welders and 462 vehicle repair workers). Data collection utilized structured questionnaires to gather demographic information, health symptoms, and environmental assessments measuring key air pollutants, including particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), and carbon monoxide (CO). Statistical analysis involved descriptive statistics and comparative analyses against World Health Organization (WHO) and Federal Ministry of Environment (FMoE) Nigeria's standards.

Results: Respiratory symptoms (50.6%, 51.3%), musculoskeletal (68.6%, 67.7%) and ocular issues (68.6%, 58.4%) were reported by the welders and vehicle repair workers respectively. The air quality assessments revealed that the mean levels of $PM_{2.5}$ (103.53±9.94µg/m³ and 128.98±12.55µg/m³), NO_2 (152.20±5.87µg/m³ and 139.65±9.39µg/m³), and CO (24.16±6.32µg/m³ and 33.51±7.64µg/m³) in the welding and vehicle repair environments respectively were 5-6 times the WHO permissible limits and 2-5 times the FMoE limits. Statistically significant differences were found between the mean concentrations of the air pollutants with the WHO and FMoE permissible limits at the welding and vehicle repair environments.

Conclusion: Poor air quality in welding and vehicle repair environments contributes to heightened morbidity patterns among the workers. Interventions including improving awareness and enforcing workplace safety regulations are essential to mitigate these occupational health risks.

Keywords: Air quality, Welding hazards, Vehicle repair workshop, Occupational morbidity

Introduction

Welding and vehicle repair are vital trades in the informal economy of many developing countries, including Nigeria (Daniel et al., 2025). These activities, while economically significant, pose serious health risks to workers due to exposure to chemical and physical hazards. Welders are frequently exposed to toxic fumes, ultraviolet (UV) radiation, and high-intensity noise levels (Abubakar et al., 2025). Similarly, vehicle repair workers encounter hazardous chemicals, particulate matter, and ergonomic challenges, all of which contribute to a high occurrence of occupational morbidity including respiratory diseases, ocular injuries, and musculoskeletal disorders (Gupta, 2024).

Welding involves the fusion of metals through high-temperature processes, releasing a complex mixture of fumes containing metal oxides and other harmful substances such as hexavalent chromium, manganese, and nickel (Devar, 2025). Prolonged exposure to these fumes among welders and auto repair technicians has been linked to respiratory conditions such as chronic bronchitis, occupational asthma, and lung cancer (Sneha et al., 2024). The ultraviolet light emitted during welding can cause photokeratitis ('arc eye') and other ocular disorders, while the physical strain associated with prolonged awkward postures often results in musculoskeletal disorders. In the vehicle repair industry, workers are exposed to similar risks, including inhalation of volatile organic compounds (VOCs) and particulate matter from brake linings, paint sprays, and engine emissions. These pollutants can lead to acute and chronic respiratory issues, cardiovascular problems, and dermatological conditions. Moreover, noise levels in workshops often exceed recommended limits, contributing to noise-induced hearing loss (Sherpa et al., 2025).

The quality of air in welding and vehicle repair workshops is often compromised due to inadequate ventilation and high concentrations of airborne pollutants. Studies have shown that levels of particulate matter ($PM_{2.5}$ and PM_{10}), nitrogen dioxide (NO_2), and carbon monoxide (CO) frequently exceed permissible exposure limits set by the World Health Organization (WHO) and local regulatory bodies. This poor air quality exacerbates the risk of respiratory diseases among workers and may have long-term public health implications (Afolabi et al., 2021; Daniel et al., 2025; Esievo et al., 2024; Lala et al., 2023).

The demographic characteristics of welders and vehicle repair workers also influence their health outcomes and safety practices. The majority of these workers are male, young to middle-aged, and possess limited formal education. Economic challenges, including low income and job insecurity, often compel them to prioritize immediate financial needs over long-term health considerations (Okumus et al., 2023; Umoh et al., 2023).

Understanding the interplay between air quality and morbidity patterns is crucial for developing effective interventions. This study aims to fill the knowledge gap by providing comprehensive data on the occupational health risks faced by welders and vehicle repair workers in Abia State, Nigeria. By identifying key determinants of morbidity and barriers to safety compliance, the findings will inform targeted strategies to enhance workplace safety and promote the well-being of these essential workers.

This study aims to evaluate morbidity patterns and air quality in welding and vehicle repair environments, identifying factors influencing health outcomes. Specifically, the study aims to assess the demographic characteristics of welders and vehicle repair workers; identify common morbidity patterns, including respiratory, ocular, and musculoskeletal conditions; evaluate air quality in work environments; and propose recommendations to reduce occupational health risks.

Methods

This is a descriptive cross-sectional study conducted among 462 welders and 462 vehicle repair workers in Abia State, situated in the South-East Zone of Nigeria. The sample size was calculated using the Cochrane formula:

$$n = \frac{z^2\, q(1-p)}{d^2}$$

Where z is the standard normal deviation set at 1.96, p is the assumed population prevalence (50%), q is 1-p, d is the maximum acceptable random sampling error of 0.05; and at a 20% non-response rate and 2.0 effect modifier, the sample size (n) was 922 participants.

Participants were sampled using a multistage random sampling technique, and participants were selected from 18 randomly selected communities from 6 LGAs from the 3 senatorial zones. Structured questionnaires were used to capture demographic data and health symptoms. Air quality assessment utilized standard monitoring equipment, and the measured pollutants include CO, NO_2, and $PM_{2.5}$.

Data were analyzed using SPSS version 21.0, with results presented through descriptive statistics, chi-square tests, and t-tests comparing pollutant levels to World Health Organization (WHO) standards. Ethical approval was obtained from the Abia State University Ethics Committee. Permission was secured from the heads of the workplaces and informed consent from all the participants.

Results

Demographic Characteristics

A total of 924 participants were studied, made up of 462 welders and 462 vehicle repair workers. They were predominantly male (98.9%), and the majority were aged 30–59 years (75.2%).

Air Quality of Welding and Vehicle Repairs Environments

The air quality of welding and vehicle repair environments was generally poor. The mean concentrations of particulate matter ($PM_{2.5}$) were 103.53 ± 9.94μg/m³ and 128.98 ± 12.55μg/m³ in the welding and vehicle repair environments respectively, which are six times above the World Health Organization (WHO)'s limit of 15 μg/m³, and twice the Federal Ministry of Health (FMoE)'s limit of 40 μg/m³.

Nitrogen dioxide (NO_2) had a mean concentration of 152.20 ± 5.87μg/m³ and 139.65 ± 9.39μg/m³ in the welding and vehicle repair environments respectively, 5 times the WHO recommended limit of 25 μg/m³, and also above the FMoE's limit of 120μg/m³.

Carbon monoxide (CO) mean level was 24.16 ± 6.32µg/m³ and 33.51 ± 7.64µg/m³, six times the WHO's permissible limit of 4 µg/m³, and five times the FMoE's permissible limit of 5µg/m³. Statistically significant differences were found between the mean concentrations of the air pollutants with the WHO and FMOE permissible limits at the welding and vehicle repair environments as shown in *Table 1*.

Table 1. Air Quality of Welding and Vehicle Repairs Environments: Comparison with WHO and FMoE permissible limits

Air Pollutant (unit)	**WHO Permissible Limit**	**FMoE Permissible Limit**	**Air Pollutant Concentrations (Mean ± SD)**	**Air Pollutant Concentrations vs. WHO limit**	**Air Pollutant Concentrations vs. FMoE limit**
Welding Environment:					
SO_2 (µg/m^3)	40	120	186.74 ± 8.47	<0.0001 (59.41-79.91)	<0.0001 (59.05-191.43)
NO_2 (µg/m^3)	25	120	152.20 ± 5.87	<0.0001 (121.07-133.37)	<0.0001 (26.02-36.37)
CO (µg/m^3)	4	5	24.16 ± 6.32	<0.0001 (14.21-25.76)	<0.0001 (13.21-24.76)
NH (µg/m^3)	0.5	0.6	1.18 ± 0.041	<0.0001 (0.60-0.79)	<0.0001 (0.59-0.69)
$PM_{2.5}$ (µg/m^3)	15	40	103.53 ± 9.94	<0.0001 (75.06-99.74)	<0.0001 (50.08-74.74)
PM_{10} (µg/m^3)	45	150	197.76 ± 15.13	<0.0001 (133.64-170.15)	0.0001 (28.64-65.35)
Vehicle Repair Environment:					
SO_2 (µg/m^3)	40	120	175.56 ± 13.12	<0.0001 (126.58-152.83)	<0.0001 (44.29-71.83)
NO_2 (µg/m^3)	25	120	139.65 ± 9.39	<0.0001 (102.27-126.12)	0.011 (7.27-31.12)
CO (µg/m^3)	4	5	33.51 ± 7.64	<0.0001 (20.66-27.66)	<0.0001 (21.66-28.67)
NH (µg/m^3)	0.5	0.6	1.88 ± 0.82	0.020 (0.36-2.39)	0.025 (0.26-2.29)
$PM_{2.5}$ (µg/m^3)	15	40	128.98 ± 12.55	<0.0001 (97.79-129.82)	<0.0001 (70.79-104.81)
PM_{10} (µg/m^3)	45	150	184.48 ± 16.63	<0.0001 (118.03-161.87)	0.011 (13.12-58.88)

The morbidity patterns of welders and vehicle repairers

Respiratory symptoms (50.6%, 51.3%), musculoskeletal (68.6%, 67.7%) and ocular issues (68.6%, 58.4%) were reported by the welders and vehicle repair workers respectively (*Table 2*). The most reported respiratory symptoms were cough (79.2%, 75.9%), chest pain (71.8%, 65.1%) and fast breeding (41.9%, 50.5%) among the welders and vehicle repair workers respectively as in *Figure 1*. The majority (95.7% of welders and 94.9% of vehicle repair workers) indicated that the respiratory symptoms started after their present work. Only 44.9% of welders and 48.1% of vehicle repair workers received treatment for these respiratory symptoms from the hospital.

As shown in *Figure 2*, the most common ocular problems reported by the respondents were itching (64.6%, 54.6%), tearing (47.5%, 39.7%), foreign body sensation (27.3%, 15.8%), and blurry vision (24.2%, 18,9%) among welders and vehicle repair workers respectively. Most (89.9% welders and 90% vehicle repair workers) with ocular issues were not having the problems before they started their present job, and only 49.5% welders and 42.2% of the vehicle repair workers had received treatments from hospitals.

The commonly reported musculoskeletal issues were low back pain (28.6%, 21%), waist pain (24.5%, 23.6%), and stiff joints (9.5%, 11.5%) among welders and vehicle repair workers respectively (*Figure 3*). The majority (94.4% welders and 93.3% vehicle repair workers) with musculoskeletal issues reported having the problems while in their present job, and only 50.2% welders and 37.4% of vehicle repair workers with musculoskeletal sought treatment from hospitals.

Table 2. The morbidity patterns of welders and vehicle repairers

Morbidity pattern	**Welders** Frequency (%)	**Vehicle Repair Workers** Frequency (%)	**Total** Frequency (%)
Respiratory symptoms			
Reported respiratory symptoms			
Yes	234 (50.6)	237 (51.3)	471 (51.0)
No	228 (49.4)	225 (48.7)	453 (49.0)

Morbidity pattern	**Welders** Frequency (%)	**Vehicle Repair Workers** Frequency (%)	**Total** Frequency (%)
Presence of the respiratory symptoms before or after starting this welding work:			
Before starting	10 (4.3)	12 (5.1)	22 (4.7)
After starting	224 (95.7)	225 (94.9)	449 (95.3)
Ever received any treatment from hospital for the respiratory symptoms:			
Yes	105 (44.9)	114 (48.1)	219 (46.5)
No	129 (55.2)	123 (51.9)	252 (53.3)
Ocular problems			
Reported problems			
Yes	317 (68.6)	270 (58.4)	587 (63.4)
No	145 (31.4)	192 (41.6)	337 (36.6)
Presence of the ocular problems before or after starting this welding work:			
Before starting	32 (10.1)	27 (10.0)	59 (2.9)
After starting	285 (89.9)	243 (90.0)	528 (97.1)
Ever received any treatment from hospital for the ocular problems:			
Yes	157 (49.5)	114 (42.2)	271 (47.8)
No	160 (50.5)	156 (57.8)	316 (52.2)
Musculoskeletal problems			
Reported musculoskeletal problems			
Yes	321 (68.6)	313 (67.7)	634 (68.6)
No	141 (31.4)	149 (32.3)	290 (31.4)
Presence of the musculoskeletal problems before or after starting this welding work:			
Before starting	18 (5.6)	21 (6.7)	39 (6.2)
After starting	303 (94.4)	292 (93.3)	595 (93.8)
Ever received any treatment from hospital for the musculoskeletal problem:			
Yes	161 (50.2)	117 (37.4)	278 (43.8)
No	160 (49.8)	196 (62.6)	356 (56.2)

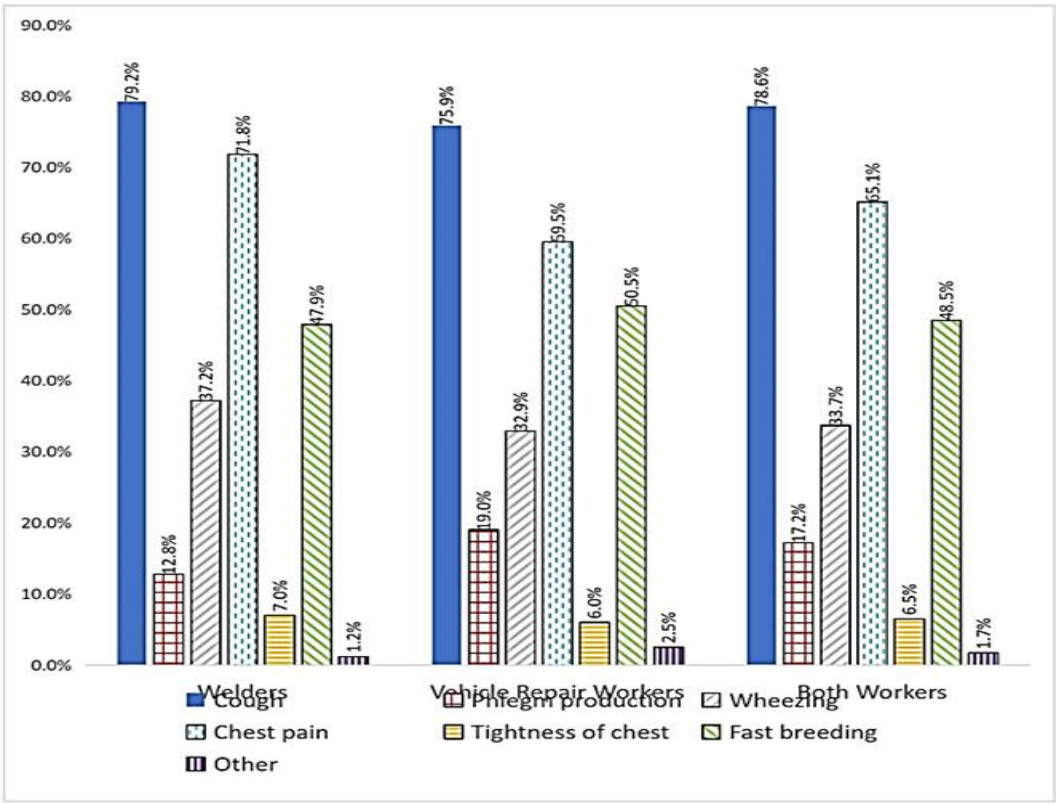

Figure 1. Compound Bar Chart representing the distribution of symptoms of Respiratory conditions reported among Welders and Vehicle Repair Workers studied

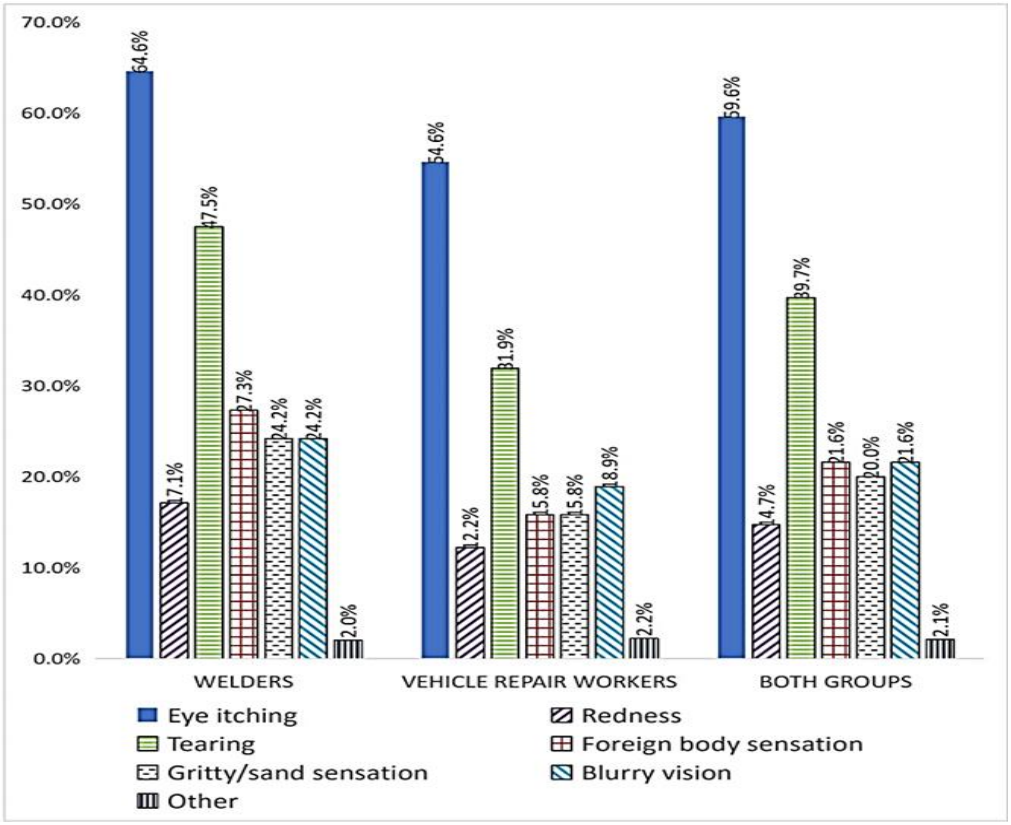

Figure 2. Compound Bar Chart representing the distribution of commonly reported Ocular issues among Welders and Vehicle Repair Workers studied

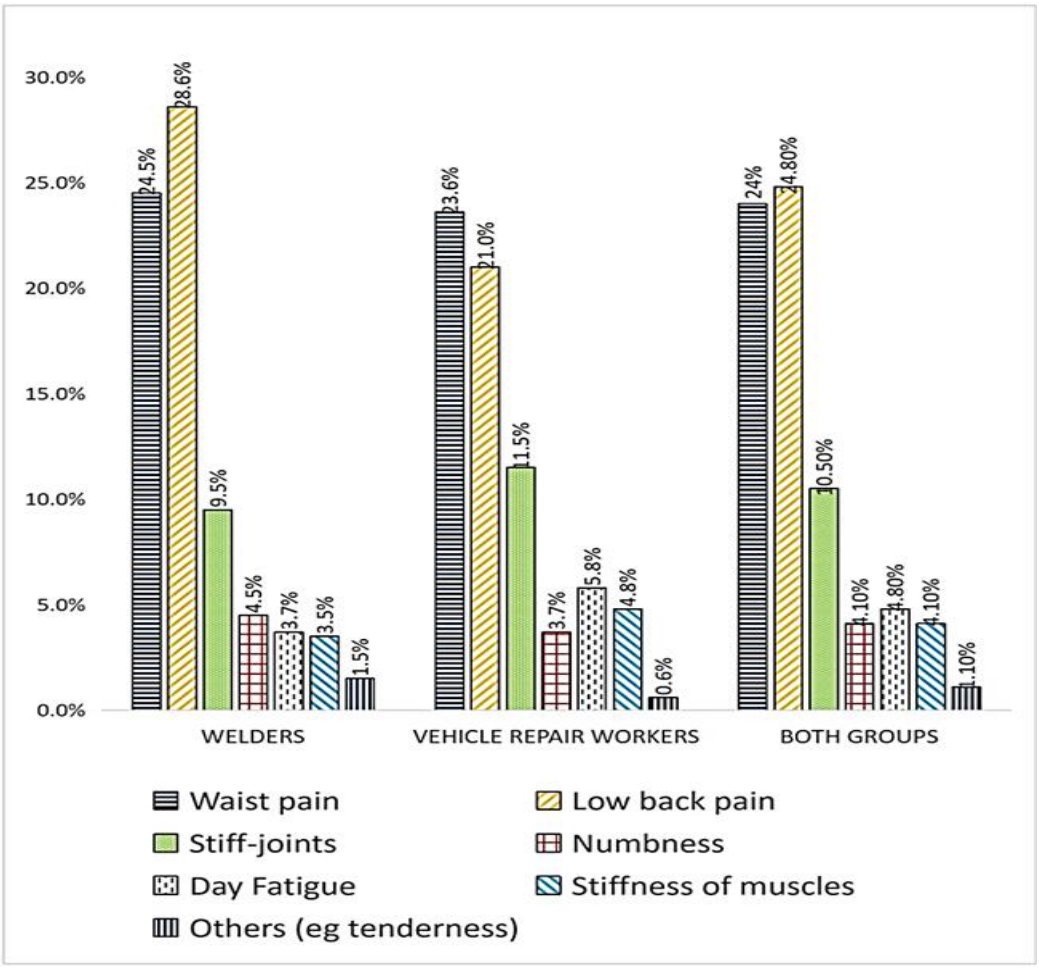

Figure 3. Compound Bar Chart representing the distribution of commonly reported Musculoskeletal issues among Welders and Vehicle Repair Workers studied

Discussions

Welders and vehicle repair workers are exposed to the risk of hazardous substances which endangers them to the risk of health morbidities including respiratory issues, ocular problems, musculoskeletal problems. Other morbidities are cancers and cardiovascular damage. The present study successfully assessed the morbidity patterns among welders and vehicular repair workers in Abia State, Nigeria. The commonly reported symptoms of respiratory conditions found among the study group included cough, chest pain and wheezing. Most of these symptoms have also been reported in other similar studies. For instance, it was reported in another Nigerian study that common respiratory conditions among saw-mill workers included cough and chest pain (Olarewaju et al., 2024). Another study also reported having more than half of the workers studied with poor respiratory conditions (Thomas et al., 2023). This study finding is therefore an indication for the possibility of respiratory related diseases among the study group. (Petersson Sjögren et al., 2023) also reported that the presence of the other respiratory symptoms diseases such as Asthma, Pneumonia and Chronic Obstructive Pulmonary Disease (COPD) were possible.

In terms of ocular issues, many of the study group especially welders reported having suspected ocular problems and this is not surprising considering that a good number of them do not protect their eyes while at work. Commonly reported ocular issues in this study included itching, tearing, foreign body sensation and blurry vision. Consistent to the present study finding, a study on welders in Port Harcourt Mechanic villages, Rivers State, Nigeria, found significant association between welders and ocular surface abnormalities (Oboh & Ofagbor, 2022).

Responses on the occurrence of musculoskeletal problems was also high among the study group, and commonly reported musculoskeletal issues include low back pain, waist pain, stiff joints, fatigue and others. According to Elenwo (2018), reported health issues reported included back pain (18.0%) and dizziness (13.0%). The possible causes of the musculoskeletal issues are the ergonomic occupational hazards associated with welding and vehicle mechanic work from repeated movements, and exertion of force in movement and lifting of heavy objects (Sattar, 2023). This study finding is consistent with the findings of (Odunola et al., 2022). Also, it is possible that both the welders and the vehicle repair workers are facing stress in their job. Constant occupational stress and bending are associated with low back pain (Terfe et al., 2023).

The findings of the present study show that all the mean air pollutants found in welding and vehicle repair environments in Abia State were above the WHO and FMoE (Nigeria) permissible limits and standards. Among other air pollutants, the environments were found to be significantly polluted beyond the recommended limits of SO_2, NO_2, CO, NH, $PM_{2.5}$ and PM_{10}. This is expected as vehicular exhaust alone is considered the worst type of exhaust due to its breathing-level emissions which enable maximum human exposure, as well as its content of different noxious oxides of sulphur (SO_2), nitrogen (NOx), carbon (CO), VOCs, and suspended particulates (Adeyanju, 2024). Additionally, long-term exposure to fumes and vapour constantly used in welding and vehicle repairs alters physiological functions and is associated with respiratory and cardiovascular damage in humans (Badima et al., 2024; Danes et al., 2025) . Thus, welding and vehicular repair environments are a health risk to the workers, visitors, and persons within the neighbouring sites.

Recommendations

Following the findings of this study, the following are recommended:

1. Health Education: There is need for increased awareness and sensitization concerning occupational hazard exposures among welders and vehicle repair workers, especially at their work locations. These public awareness activities should be made crucial with efforts to raise public awareness about the occupational health risks of air pollution in welding and vehicle repairs and the importance of implementing clean air policies for a healthier environment.

2. Policy interventions: There should be enforcement of occupational health and safety training and services among welders and vehicle repair workers. This aims to encourage welders and vehicle repair workers as well as others within that line of work to embrace protective precautionary measures against hazards associating exposure either through job performance or by air pollution. Policy interventions should also include enforcement of occupational safety regulations including the enforcement and subsidization of personal protective equipment.

3. Healthcare Access: There is a need for provision of regular health screenings for artisans, and establishment of accessible occupational health clinics. Welders and vehicle repair workers should be encouraged to visit health facilities and hospitals for proper check up whenever they notice any symptom of poor health conditions. Additionally, there is need for the assessment of health status of other persons doing business or other activities at closer locations to welders and vehicle repairs environment for public health advancement.

4. Environmental and Engineering Controls: There should be monitoring of welding and vehicle repairs premises and workshop environment against hazardous air pollution. Pollution control measures including improvement in ventilation in welding and vehicle repairs workshops are recommended.

5. Research: Support and sponsorship of quality technology driven research that will promote greener emissions and less pollution in mechanic and welding workshops are recommended.

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Conflict of interest

The authors declare no conflict of interest.

Consent for publication

All authors consented for the publication of the manuscript in this journal.

Data availability

Data will be made available upon reasonable request.

Author contribution

All authors contributed equally to this manuscript including the conceptualization, data management, and writing of the manuscript.

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