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Occupational Noise Exposure, Noise-Related Health Outcomes, And Hearing Protection Practices Among Small-Scale Industrial Workers in Southwestern Nigeria

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Occupational Noise Exposure, Noise-Related Health Outcomes, And Hearing Protection Practices Among Small-Scale Industrial Workers in Southwestern Nigeria

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Abstract

Background: Small-scale industries account for a large proportion of employment and contribute significantly to economic development. Occupational noise is a major workplace hazard in developing countries, particularly in small-scale industries where engineering controls and personal protective equipment (PPE) are often inadequate. This study assessed PPE availability and utilization and examined associations between selected occupational risk factors and self-reported health outcomes among workers in small-scale industries in Abeokuta.

Methods: A descriptive cross-sectional study was conducted among 300 workers: 105 block moulders (BMF), 98 aluminium fabricators (AFF), and 97 iron welders (IWF). Data on socio-demographic characteristics, occupational exposures, and PPE utilisation were collected using

structured questionnaires. Descriptive and inferential statistics, including chi-square tests, were conducted at $p < 0.05$.

Results: Commonly reported ailments included fatigue (88%), speech interference (74.6%), headache (73.7%), tinnitus (66.7%), and increased heart rate (57.3%). Working hours were significantly associated with tinnitus, hearing loss, increased heart rate, stress, speech interference, insomnia, and elevated blood pressure ($p < 0.05$). PPE use varied across occupational groups, with safety shoes most commonly reported (60.0% BMF, 48.0% AFF, 31.6% IWF), while hearing protection devices (earplugs/earmuffs) were not used by any participant. Major barriers included discomfort (57.7%), non-availability (34.7%), excessive heat (26.3%), inadequate employer provision, poor awareness, and unfavourable workplace conditions.

Conclusions: Workers demonstrated poor perceptions and low acceptance of hearing protection, alongside substantial noise exposure and prevalent noise-related health effects. Comprehensive interventions, including hearing conservation programmes, audiometric screening, mandatory PPE provision and enforcement, and worker education, are urgently required.

Keyword: Occupational noise exposure; Personal protective equipment; Small-scale industries, Safety and Health.

1. Introduction

Due to the very low use of personal protective equipment (PPEs), employees of small-scale industries (machine operators) are exposed to numerous physical, chemical and accidental hazards (Ahmad et al., 2017; Balkhyour et al., 2019; Agu et al., 2022). Occupational noise remains one of the most prevalent physical hazards in workplaces worldwide and continues to pose a major public health challenge, particularly in low- and middle-income countries where occupational safety and health (OSH) regulations are often inadequately enforced (WHO, 2021; Khoza-Shangase, 2026).

The World Health Organization (WHO, 2021) estimates that approximately 16% of adult hearing loss results from exposure to excessive noise in the workplace, accounting for over 4 million disability-adjusted life years (DALYs) annually. Recent global burden analyses further confirm that regions with lower socio-demographic development most notably Sub-Saharan Africa bear the greatest age-standardized rates of occupational noise-induced hearing loss (ONIHL), with the burden continuing to rise through 2040 (Gong et al., 2025). Excessive exposure to workplace noise has been identified as a significant contributor to occupational morbidity, reducing workers' productivity, quality of life, and overall well-being. The World Health Organization (WHO, 2022) and the International Labour Organization (ILO, 2024) recognize occupational noise as a major environmental and occupational risk factor associated with both auditory and non-auditory health outcomes. Despite advances in engineering controls and workplace safety policies, millions of workers continue to experience hazardous noise exposure, especially within the informal and small-scale industrial sectors. Exposure to excessive occupational noise can cause hearing loss which may be partial or complete hearing loss in one or both ears as a result of exposure (OSHA, 2020; Zaw et al., 2020). Non-use of PPE by workers exposes them to noise hazard in the work place. Most workers in the small-medium enterprises/informal sector hardly use PPE and are not

under supervisory functions of relevant agencies. Similarly, while the formal large-scale factories are under the supervision of regulatory agencies, the small-scale factories are largely unregulated. Hence, most of their workers do not wear any PPE for hearing protection.

In Nigeria, studies among informal-sector welders have documented that although awareness of general PPE is high, regular use remains alarmingly low (49.8%), with specific hearing protection devices such as earmuffs and earplugs among the least known and least utilized forms of PPE (Agu et al., 2022). Comparable findings from small-scale metal industries in Tanzania report average noise exposure levels of 90.9–106.9 dBA with complete absence of hearing protection or noise reduction strategies (Axwesso et al., 2025). Recent longitudinal evidence from manufacturing settings further demonstrates that workers in small and micro-enterprises exhibit significantly higher prevalence of high-frequency hearing loss than those in large enterprises, underscoring the disproportionate vulnerability of informal-sector workers (Zhou & Zhang, 2024). Emerging evidence indicates that prolonged exposure to excessive noise contributes to tinnitus, sleep disturbance, annoyance, impaired communication, reduced cognitive performance, psychological stress, hypertension, cardiovascular disorders, fatigue, and decreased work efficiency (Basner & McGuire, 2018; Zaw et al., 2020; WHO, 2022). A recent Nigerian pilot study among informal generator technicians, an occupational cohort previously neglected in hearing health research reported a tinnitus prevalence of 45.2%, with prolonged exposure (≥10 years) increasing the odds of tinnitus by more than fourfold; notably, all participants reported zero use of hearing protection devices (Tsiga-Ahmed et al., 2025). In addition to noise alone, combined exposure to noise and industrial dust may exert a synergistic effect on cochlear oxidative stress, further accelerating high-frequency hearing loss among manufacturing workers (Zhou & Zhang, 2024). Exposure to noise has been observed to have deleterious effect on the health status of individuals working within the

noisy environment. Continuous exposure to high and unwarranted sound remains a major cause of hearing disorder all over the world (Aliyu et al., 2020). In most small-medium scale industries, there are certainly no protective measures in use to reduce the impact of noise on the health of the workers and; meanwhile the alteration of hearing impairment is being triggered by a definite critical duration and level of noise exposure. Due to lack of education and adequate supervision from relevant agencies, the use of PPE is almost absent among the workers hence, nearby population exposed themselves as well as people around them to the risk of hearing problems. Also, there is poor attitude towards the use of PPE against the impact of noise and lack of awareness of NIHL among small-scale factory workers. These issues constitute the core hurdle in preventing NIHL in the Nigeria population (Khoza-Shangase, 2026). In Nigeria, occupations such as welding, aluminium fabrication, and block moulding provide livelihoods for thousands of artisans and skilled workers. Nevertheless, these enterprises are frequently characterized by inadequate occupational safety practices, obsolete machinery, limited regulatory oversight, and poor compliance with workplace health and safety standards (Balkhyour et al., 2019; ILO, 2024; Ayinde et al., 2025).

A recent ergonomic review of Nigeria's block-making industry documented noise emissions from diesel-powered compactors and generators routinely exceeding 90-100 dB(A) far above the WHO-recommended occupational limit of 85 dB(A) within a regulatory environment marked by weak institutional enforcement and minimal safety inspections (Ayinde et al., 2025). Consequently, workers are routinely exposed to excessive occupational noise and other hazardous agents without adequate preventive measures (Balkhyour et al., 2019; ILO, 2024). Elevated noise pollution from these small-scale factories has become worrisome due to the proximity of residential buildings and shops to these factories, where the vulnerable groups such as children, the elderly and adults with

varying health conditions are exposed (Onoyom-Ita et al., 2016; Axwesso et al., 2025). International occupational safety guidelines recommend that workers exposed to hazardous noise levels should be provided with appropriate hearing protection alongside comprehensive hearing conservation programmes, including regular audiometric surveillance, workplace noise monitoring, worker education, and enforcement of occupational safety regulations (WHO, 2021, 2022; OSHA, 2024). Nevertheless, compliance with PPE use remains low in many informal industrial settings because of inadequate awareness, poor safety culture, discomfort associated with PPE, limited employer commitment, financial constraints, and weak enforcement of occupational safety legislation (Siwela & Moroe, 2026; Khoza-Shangase, 2026). Even in comparatively better-resourced formal manufacturing environments on the continent, consistent use of hearing protection devices is sub-optimal; a recent South African study found that only 51% of aluminium workers reported always using provided HPDs, with discomfort and communication interference cited as primary barriers (Siwela & Moroe, 2026). Research has shown that hearing problem can be remediated by the use of hearing protective gadgets but it is not clear how fast this can be done. The fact that noise emission in the monitored small-scale factories are well above the levels monitored in formal large scale factories is of concern. The study critically assessed and monitored the noise level that the small-scale workers are been exposed to. The study also provided PPE to small scale workers in a bit to reduce the impact of the exposure of noise from the machines at the workplace. While the formal large-scale factories are under the supervision of regulatory agencies, the small-scale factories are largely unregulated. Hence, while some workers in the former use PPE, most workers in the later do not wear any PPE for hearing protection so it's of concern. The occupational health burden associated with inadequate PPE utilization is particularly evident in low-resource settings where informal industries dominate economic activities. Studies

conducted across Africa have consistently reported poor utilization of hearing protective devices among welders, metal fabricators, construction workers, and other artisans despite high levels of occupational noise exposure (Nyarubeli et al., 2019; Mutangala et al., 2021; Khoza-Shangase, 2026). Similar findings have been reported in Nigeria, where occupational hazards among welders and other small-scale industrial workers include hearing impairment, eye injuries, musculoskeletal disorders, burns, cuts, respiratory problems, and psychological stress resulting from inadequate workplace safety practices (Nwafor et al., 2019; Aremu et al., 2020; Agu et al., 2022). Consequently, excessive noise generated from block-moulding machines, welding operations, metal fabrication equipment, power generators, and other industrial activities affects not only workers but also surrounding communities, increasing the risk of chronic noise exposure among vulnerable populations such as children, older adults, and individuals with pre-existing health conditions (Oguntoke et al., 2018; WHO, 2022; Gong et al., 2025). Against this background, the present study investigated the association between reported occupational risk factors, noise-related health effects, and the utilization of personal protective equipment among workers in selected small-scale industries in Ogun State, Nigeria. Specifically, the study evaluated the occurrence of self-reported auditory and non-auditory health outcomes associated with occupational noise exposure, assessed workers' awareness and utilization of personal protective equipment, and examined the influence of exposure characteristics on reported health effects. The findings are expected to provide evidence that will support occupational health policy development, strengthen workplace hearing conservation programmes, and improve the implementation of preventive interventions aimed at reducing occupational noise exposure among small-scale industrial workers in Nigeria.

2. Materials and Methods

2.1 Study Design and Study Area

A descriptive cross-sectional study was conducted among workers employed in selected small-scale industries. The study targeted three common occupational groups characterized by high occupational noise exposure: iron welders, aluminium fabricators, and block-moulding machine operators. These occupations were selected because they rely heavily on powered machinery and equipment capable of generating hazardous workplace noise levels. The study was designed to investigate the association between occupational noise exposure, self-reported noise-related health effects, and the utilization of personal protective equipment (PPE).

2.2 Study Population and Eligibility Criteria

The study population comprised workers actively engaged in welding, aluminium fabrication, and block-moulding activities during the study period. Eligible participants were workers aged 18 years and above who had worked continuously in their current occupation for at least one year and voluntarily agreed to participate. Apprentices, temporary workers with less than one year of occupational exposure, and individuals with documented hearing impairment unrelated to occupational noise exposure were excluded.

2.3 Sample Size Determination

The minimum sample size was determined using the Yamane (1967) formula at a 95% confidence level and a precision level of 5% are assumed (1) to ascertain the total number of factory sites needed from each of the three groups activity types.

$$n = \frac{N}{1+N(e^2)} \quad \text{.....(1)}$$

Where;

n = required sample size,

N = study population,

e = level of precision (p = 0.05).

Based on the estimated population of eligible workers, a total sample of 300 participants was obtained, comprising 97 iron welders, 98 aluminium fabricators, and 105 block moulders.

2.4 Sampling Procedure

A comprehensive inventory of registered and operating small-scale industries within the study area was first undertaken. Eligible workshops were identified through field mapping and preliminary visits. Simple random sampling was subsequently employed to select participating factories from each occupational category. Within each selected workplace, workers who satisfied the inclusion criteria were randomly selected for questionnaire administration and occupational health assessment.

2.5 Data Collection

Data were collected using a structured interviewer-administered questionnaire (Table S1 in Supplementary Information). Prior to the main survey, pre-sampling analysis and validating test for questionnaire data were conducted among approximately 10% of the intended sample in similar workplaces outside the selected study sites to assess clarity, reliability, and suitability.

The questionnaire was used to elicit information on:

- Socio-demographic characteristics of the respondents;
- Workers' perception of workplace noise and duration of employment;
- daily working hours and duration of occupational noise exposure;

- awareness and utilization of personal protective equipment;
- self-reported physiological and psychological health effects associated with occupational noise exposure.

2.6 Assessment of Personal Protective Equipment Utilization

The survey specifically assessed the use of hearing protection devices (earplugs and earmuffs), eye protection, respiratory protection, gloves, safety footwear, protective clothing, and face shields. Participants were further asked to identify factors limiting PPE compliance, including discomfort, inadequate supply, poor awareness, workplace culture, and employer support.

2.7 Outcome Measures

The primary outcome variables included: self-reported auditory health outcomes (hearing loss, tinnitus, communication difficulties); non-auditory health outcomes (headache, fatigue, stress, insomnia, irritation, elevated heart rate, dizziness and hypertension); and utilization of personal protective equipment. Independent variables included age, occupation, duration of employment, daily working hours, and duration of occupational noise exposure.

2.8 Statistical Analysis

Data were analysed using IBM SPSS Statistics version 22.0 (IBM Corp., Armonk, NY, USA). Descriptive and inferential statistics. Associations between occupational risk factors and reported noise-related health outcomes were assessed using the Chi-square (χ^2) test. Statistical significance was established at $p < 0.05$ with a 95% confidence interval.

3. Results and Discussion

3.1 Association Between Reported Risk Factors and Noise-Related Health Effects

The associations between occupational risk factors (age, daily exposure and duration of working hours) and self-reported noise-related health effects were evaluated using a chi-square (χ^2) test (Figures 1 – 3). The results demonstrated that occupational noise exposure was significantly associated with several auditory and non-auditory health outcomes among workers employed in the three categories of small-scale industries.

The occurrence of headache ($\chi^2 = 65.734$, $p = 0.001$), speech interference ($\chi^2 = 54.052$, $p = 0.001$), stress ($\chi^2 = 157.888$, $p = 0.001$), sleeplessness ($\chi^2 = 88.303$, $p = 0.001$), irritation ($\chi^2 = 26.084$, $p = 0.001$), elevated blood pressure ($\chi^2 = 61.693$, $p = 0.001$), ringing in ears ($\chi^2 = 45.296$, $p = 0.001$), increased heart rate ($\chi^2 = 80.258$, $p = 0.001$) and annoyance ($\chi^2 = 13.219$, $p = 0.001$) showed significant associations with workers' age (Figures 1 and 2).

In contrast, hearing loss ($\chi^2 = 4.349$, $p = 0.361$) and fatigue ($\chi^2 = 1.765$, $p = 0.779$) were not significantly associated with age (Figures 1 and 2). The significant association between age and

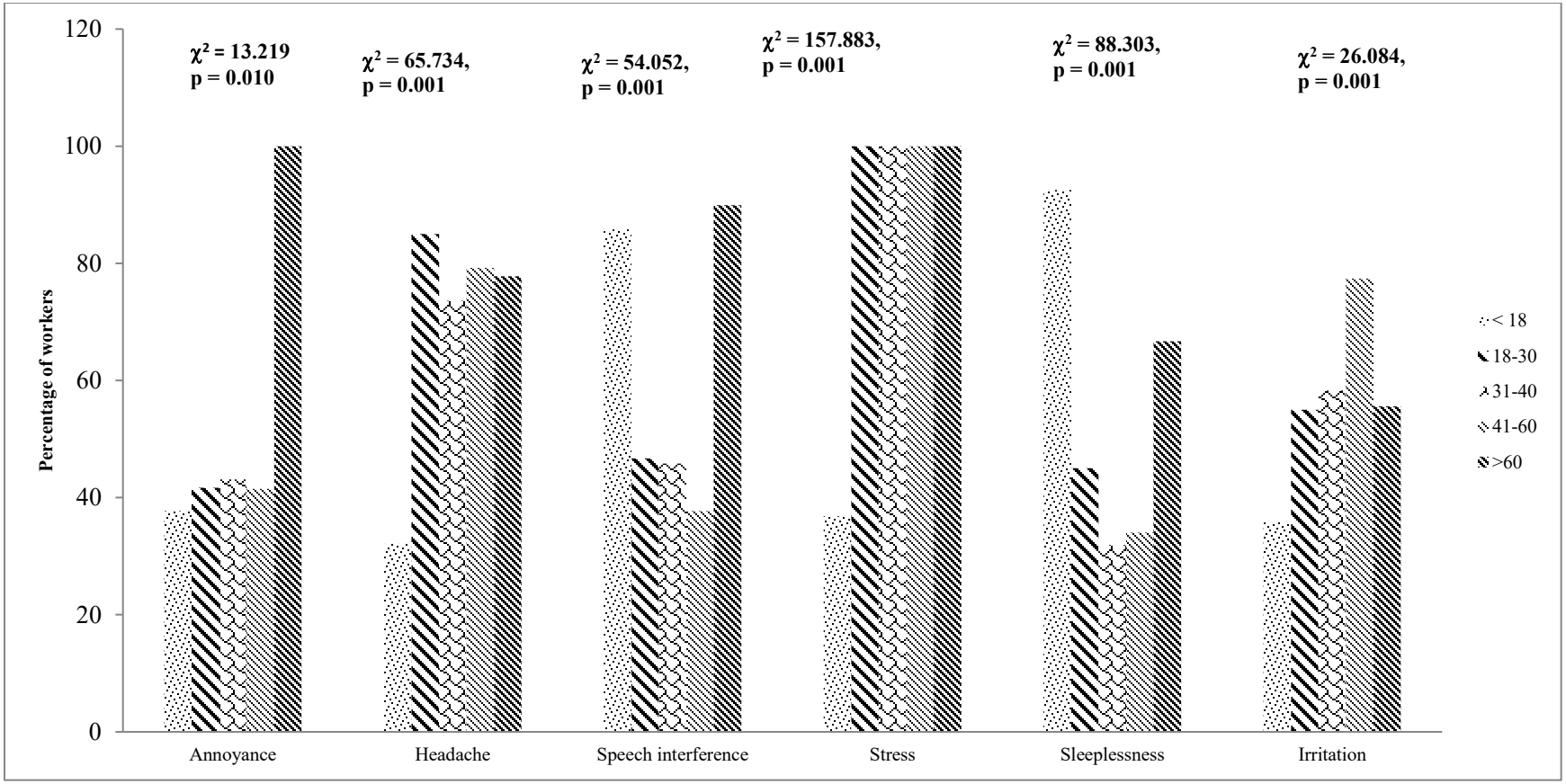


Figure 1: Association of related noise effects by age groups of workers

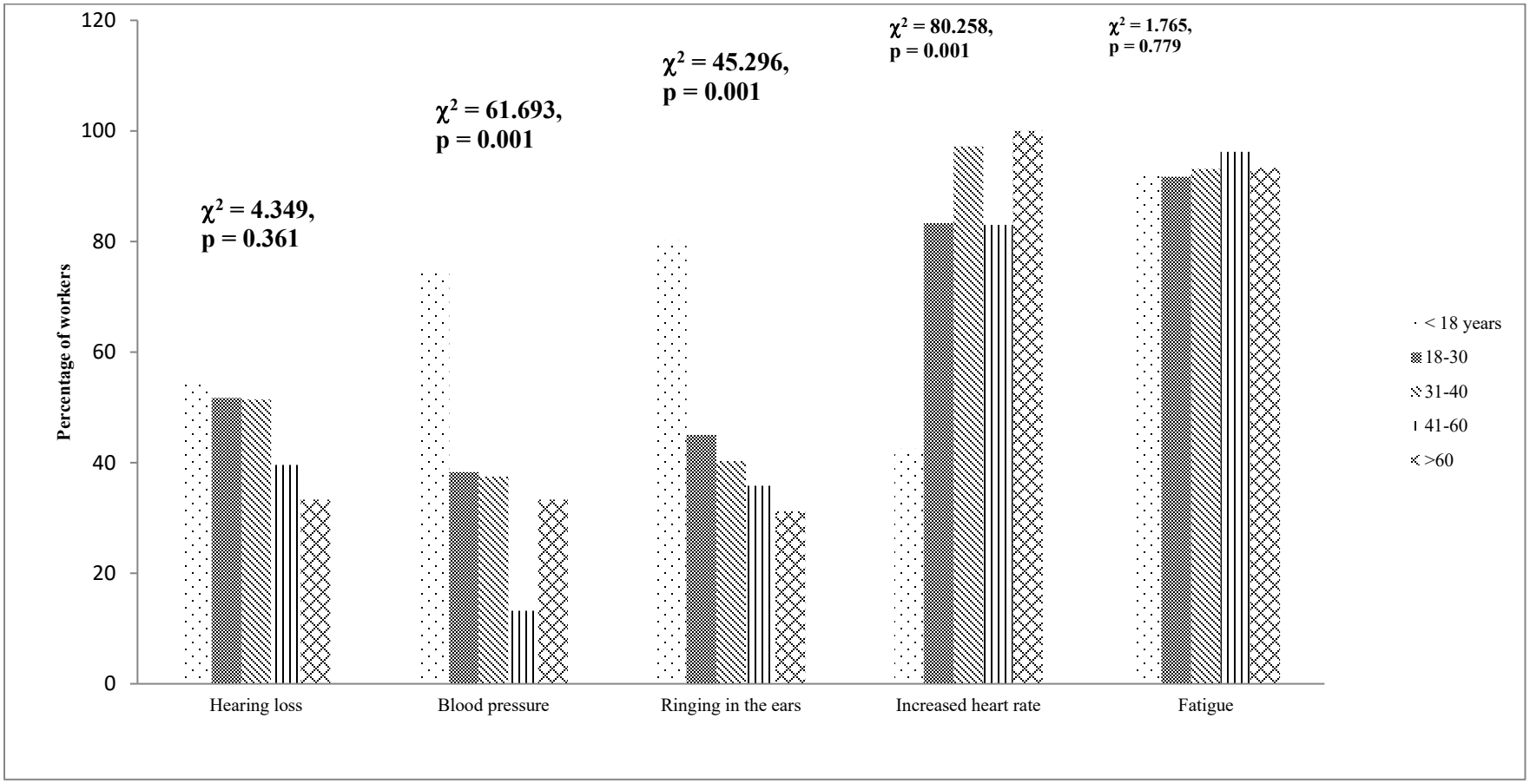


Figure 2: Association of related noise effects by age groups of workers

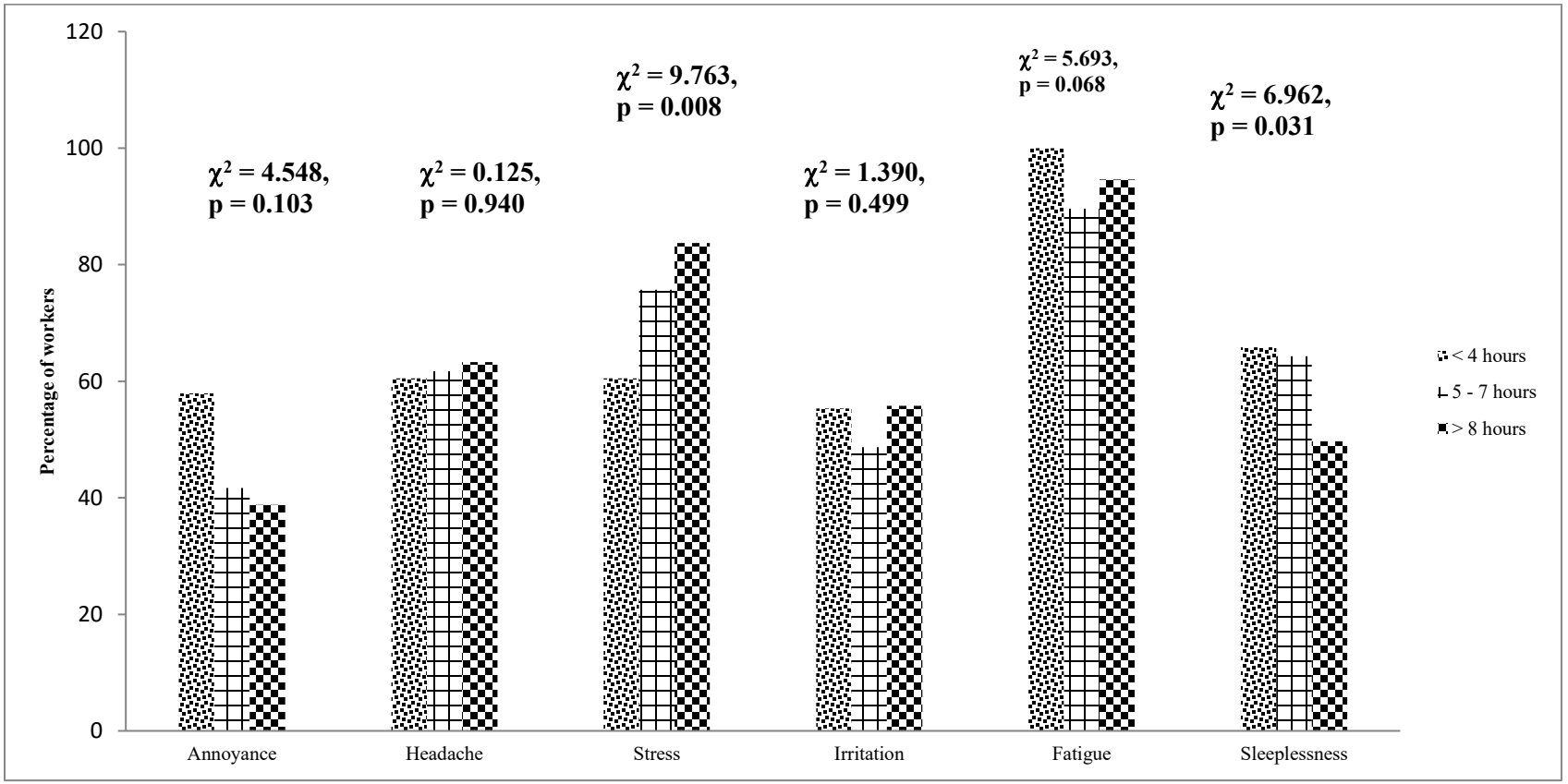


Figure 3: Association of related noise effects by duration of working hours of workers

most non-auditory health outcomes suggest that increasing age may increase workers' susceptibility to the physiological and psychological effects of chronic occupational noise exposure. Ageing is associated with cumulative occupational exposure and gradual deterioration of physiological resilience, thereby increasing vulnerability to stress-related disorders, cardiovascular responses, sleep disturbances, and communication difficulties. Although hearing loss was not significantly associated with age in this study, this finding may reflect the influence of multiple interacting factors, including duration of exposure, individual susceptibility, genetic predisposition, recreational noise exposure, and previous ear diseases. Recent studies have similarly reported that prolonged occupational noise exposure contributes substantially to cardiovascular dysfunction, psychological distress, and impaired quality of life irrespective of chronological age (Zaw et al., 2020; WHO, 2022; Cai et al., 2023).

Workers aged between 18 and 60 years ($\chi^2 = 157.888$, $p < 0.001$) reported the highest prevalence of stress, headache, sleep disturbance, and increased heart rate. This finding is expected because these economically active age groups undertake physically demanding activities for prolonged periods, frequently operating noisy equipment with limited engineering controls and inadequate use of hearing protective devices. Similar observations have been reported among industrial workers in Nigeria and other developing countries, where cumulative occupational exposure has been linked with increased prevalence of non-auditory health effects among middle-aged workers (Aremu et al., 2020; Mutangala et al., 2021).

Daily working duration 4 – 8 hours also showed important relationships with occupational health outcomes. Workers who spent longer periods operating machinery reported significantly higher frequencies of tinnitus ($\chi^2 = 32.884$, $p < 0.05$), hearing loss ($\chi^2 = 28.212$, $p = 0.001$), increased heart rate ($\chi^2 = 11.743$, $p = 0.003$), stress ($\chi^2 = 9.763$, $p < 0.05$), speech interference ($\chi^2 = 7.744$, p

= $p < 0.05$), insomnia ($\chi^2 = 6.962$, $p = 0.031$), and elevated blood pressure ($\chi^2 = 6.852$, $p = 0.032$). Conversely, headache, fatigue, irritation, and annoyance were not significantly associated with the duration of daily working hours (Figures 3 and 4).

These findings indicate that prolonged occupational exposure rather than merely the presence of workplace noise substantially increases the likelihood of developing both auditory and systemic health effects. Simultaneously, chronic activation of the sympathetic nervous system contributes to elevated blood pressure, increased heart rate, psychological stress, and sleep disorders. These mechanisms have been widely documented in occupational health literature and support recommendations for limiting exposure duration alongside engineering noise control measures (WHO, 2022; OSHA, 2024).

Workers with longer daily exposure reported significantly greater occurrence of annoyance ($\chi^2 = 23.306$, $p = 0.001$), headache ($\chi^2 = 23.906$, $p = 0.001$), stress ($\chi^2 = 52.508$, $p = 0.001$), irritation ($\chi^2 = 13.937$, $p = 0.001$), fatigue ($\chi^2 = 14.682$, $p = 0.001$), insomnia ($\chi^2 = 35.320$, $p = 0.001$), elevated blood pressure ($\chi^2 = 14.403$, $p = 0.001$), tinnitus ($\chi^2 = 29.142$, $p = 0.001$), speech interference ($\chi^2 = 11.896$, $p = 0.003$), and increased heart rate ($\chi^2 = 28.989$, $p = 0.001$). However, no statistically significant association was observed between daily occupational noise exposure and hearing loss ($\chi^2 = 4.134$, $p = 0.127$) (Figures 5 and 6). The results in this study is similar to the study of Sriopas *et al.* (2016) on auto part factory workers in welding units which showed a non-significant association with working duration and noise-related health challenges.

Similar findings have been reported in occupational studies where tinnitus and auditory discomfort were more strongly associated with exposure duration than self-reported hearing loss among iron and steel workers which is similar to the finding of this study (Nyarubeli et al., 2019;

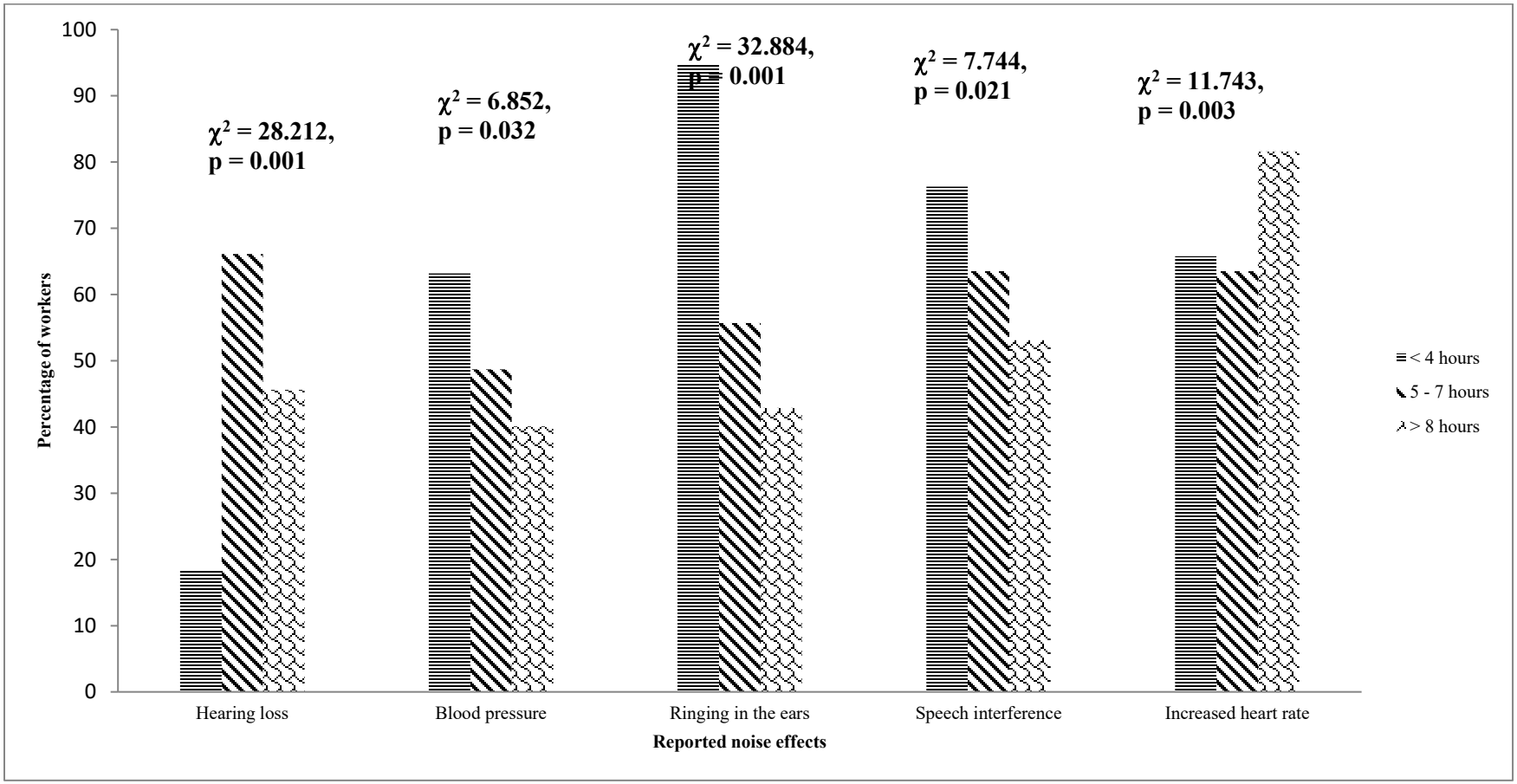


Figure 4: Association of related noise effects and duration of working hours

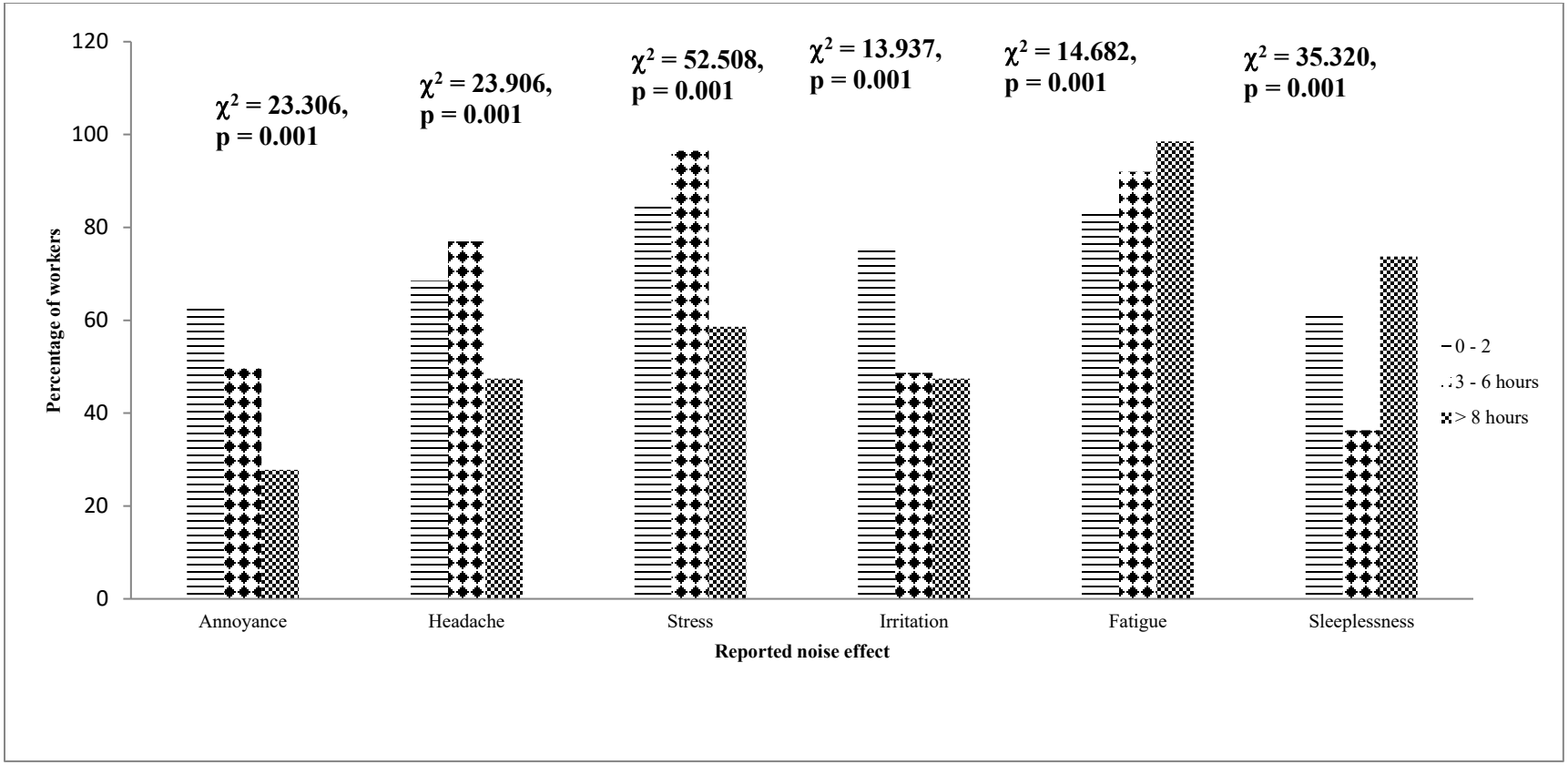


Figure 5: Association of related noise effects by daily exposure of workers

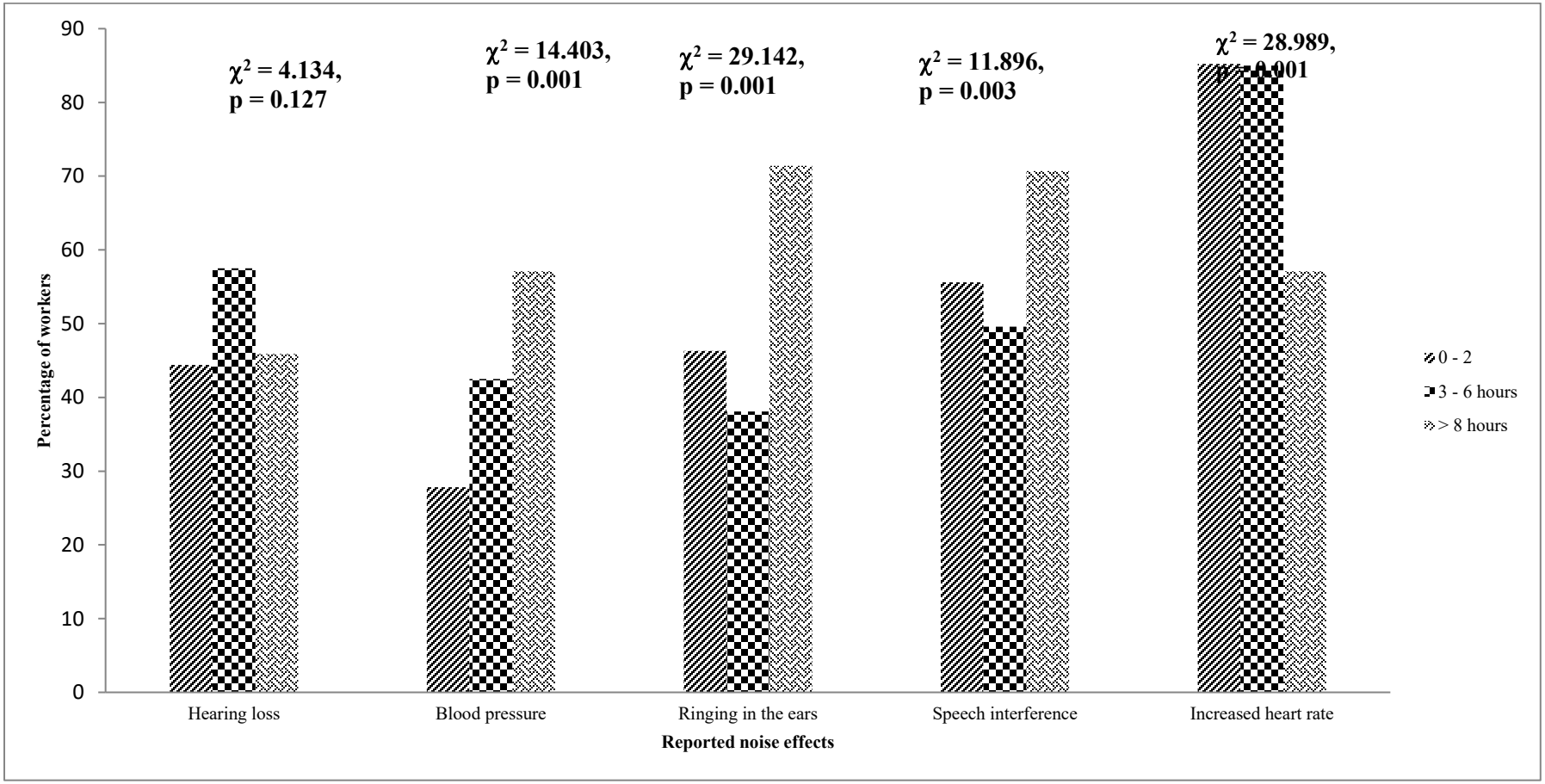


Figure 6: Association of related noise effects by daily exposure of workers

Zaw et al., 2020).

The significant associations observed for stress, cardiovascular responses, sleep disturbance, speech interference, and tinnitus reinforce growing evidence that occupational noise should be recognized not only as an auditory hazard but also as an important environmental determinant of workers' physical and psychological health.

This is similar to the study of Agarwal *et al.* (2015) on reported incidence on health-related issue such as hearing loss on steel factory workers with daily exposure or working period in India. Ringing in the ear is a considerable problem for noise-exposed workers and it can adversely affect sleep, lead to stress, irritation and annoyance (Zaw *et al.,* 2020) long duration and exposure to noisy workplace can develop ringing in the ear which may progress to hearing loss.

3.2 Socio-Demographic Characteristics, Occupational Noise Perception, and Duration of Exposure

The respondents' information is presented in Table 1. A total of 300 workers comprising 97 iron welders, 98 aluminum fabricators and 105 block moulders participated in the study. All respondents were male, reflecting the male-dominated nature of these occupations within the informal industrial sector. This is due to gender bias towards the block moulders, iron welders and aluminum fabricators, especially in developing country such as Nigeria.

The majority of workers across the three occupational groups were between 31 and 40 years of age, had attained at least secondary education, were married, and had accumulated between 5 and 10 years of occupational experience. Educational attainment plays a critical role in occupational health because it influences workers' awareness of workplace hazards, understanding of safety procedures, and willingness to adopt preventive measures.

Table 1: Socio-demographic characteristic of workers/respondents (n=300)

Characteristic	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Age in years	**Welder**		**Block**		**Aluminum**	
Below 18	20	20.6	28	26.7	17	17.3
18-30	19	19.6	22	21	28	28.6
31-40 years	41	42.3	30	28.6	35	35.7
41 and Above	17	17.5	25	23.8	18	18.4
Educational status						
Informal Education	28	28.9	23	21.9	-	-
Primary	33	34.0	30	28.6	35	35.7
Secondary	36	37.1	42	39	60	61.2
Tertiary	-	-	11	10.5	3	3.1
Marital Status						
Married	69	71.1	81	77.1	69	70.4
Single	28	28.9	24	22.9	29	29.6
Ethnicity of Workers						
Yoruba	73	75.3	84	80.0	98	100.0
Years of exposure on the job						
0-4	26	26.8	26	24.8	34	34.7
5-10	36	37.1	45	42.9	47	48
11-20	24	24.7	24	22.9	9	9.2
Above 20 years	11	11.3	10	9.5	8	8.2
Daily working hour						
1-4 hours	17	17.5	6	5.7	-	-
5-8 hours	42	43.3	30	28.6	33	33.7
More than 8 hours	38	39.2	69	65.7	65	66.3

Nevertheless, literacy alone does not necessarily translate into safe workplace behaviour.

Furthermore, a substantial proportion of block moulders (66.3%) and aluminium fabricators (65.7%) reported working more than eight hours per day, indicating prolonged occupational exposure to workplace hazards, particularly excessive noise.

The predominance of male workers observed in this study is consistent with the occupational structure of welding, metal fabrication, and block-moulding industries across many developing countries, where physically demanding manual labour remains largely undertaken by men.

Similar workforce characteristics have been reported among informal-sector welders in the Democratic Republic of Congo and Nigeria, where males constitute the overwhelming majority of workers because of cultural norms, apprenticeship systems, and the physically intensive nature of these occupations (Mutangala et al., 2021; Nwafor et al., 2019)

The age distribution (31 – 40 years) in the order iron welders> aluminum fabricators> block moulders. This is a clear indication that an increasingly great number of youths are attracted by this job. This finding is similar to a study conducted by Kumar (2013), where the majority of the workers were within 20 and 40 years of age.

This finding was confirmed by Mutangala *et al.* (2021) in their study among informal sector welders from Lubumbashi, Democratic Republic of Congo. The proportion of respondents capable of reading and writing with a secondary education accounted for 61.2% (aluminum fabricators), 39.0% (block moulders) and 37.1% (iron welders). Education level is vital in any discipline as it provides basis of creating understanding and awareness among those involved.

Furthermore, 66% block moulders and 64% iron welders and 48.0% of aluminum workers have spent between 5 – 20 years on the job. The fact that many of the workers have spent several years on the job indicates the three activities constitute occupation not just pastime engagements (Table 1).

More than two-thirds of block moulders and aluminium fabricators reported working beyond the conventional eight-hour workday, thereby exceeding the duration recommended for continuous exposure to hazardous occupational noise without adequate hearing protection.

Long-term employment in noisy environments increases cumulative noise dose, thereby elevating the risk of both auditory and non-auditory effects. Previous epidemiological studies have demonstrated that cumulative occupational exposure, rather than exposure intensity alone, is an important determinant of tinnitus, cardiovascular responses, sleep disturbance, and progressive hearing impairment among industrial workers (WHO, 2022; Zaw et al., 2020).

3.2 Workers' Perception of noise and duration of exposure

Workers' perception of occupational noise exposure is presented in Figures 7–11. The majority of the block moulders (85.7%) and iron welders (73.0%) reported being exposed to machine-generated noise for seven (7) hours and more each daily working day, whereas approximately half (50.0%) of the aluminum fabricators reported daily exposure of between 1 – 4 hours (Figure 7). This implies that more than half of the workers spent an average of eight hours in the sampled factories being exposed to high noise levels.

Furthermore, above 80% respondents had worked continuously within these occupations for several years, indicating prolonged cumulative occupational exposure to excessive workplace noise (Figure 8). Consequently, the accumulated noise dose received over many years may

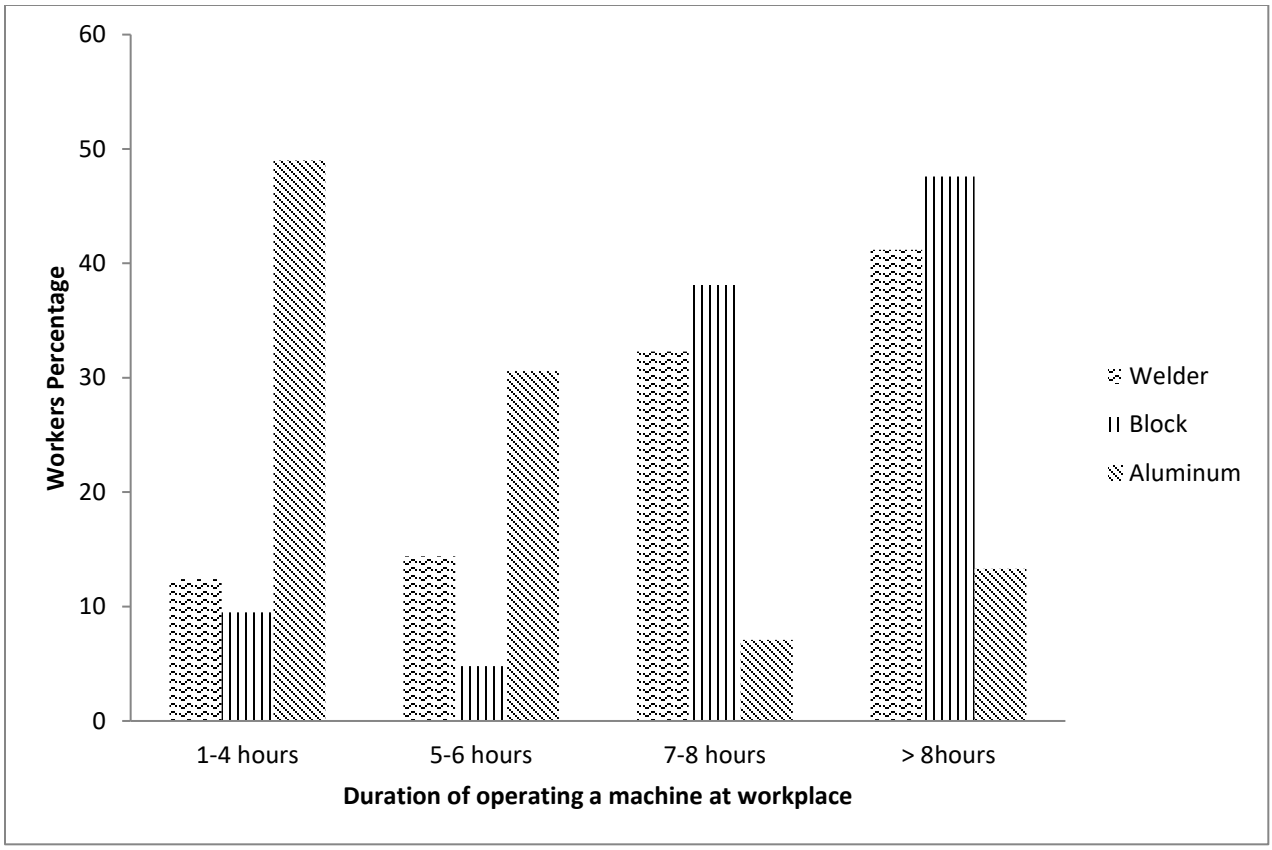


Figure 7: Duration of exposure to a machine noise at workplace

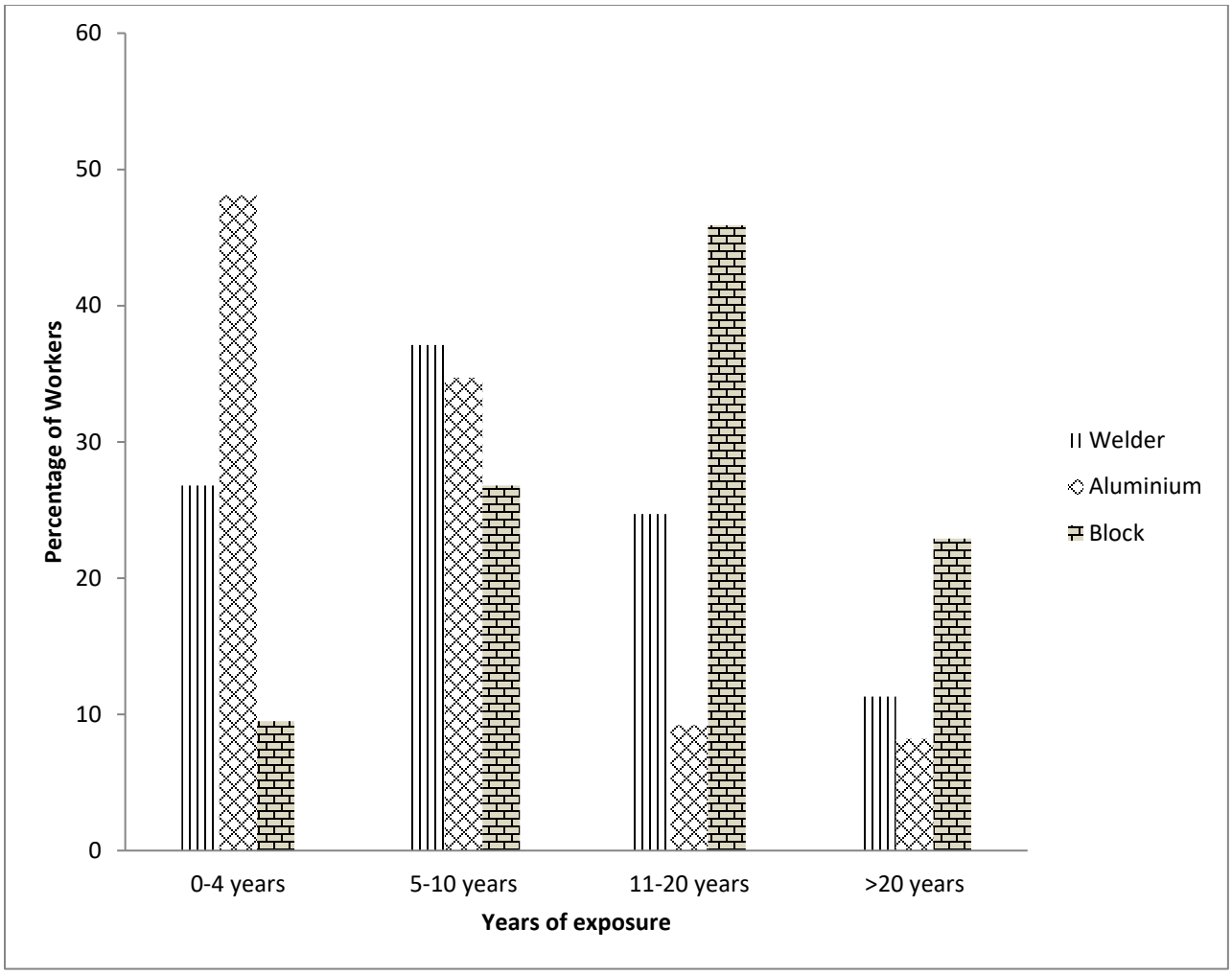


Figure 8: Years of exposure on the job

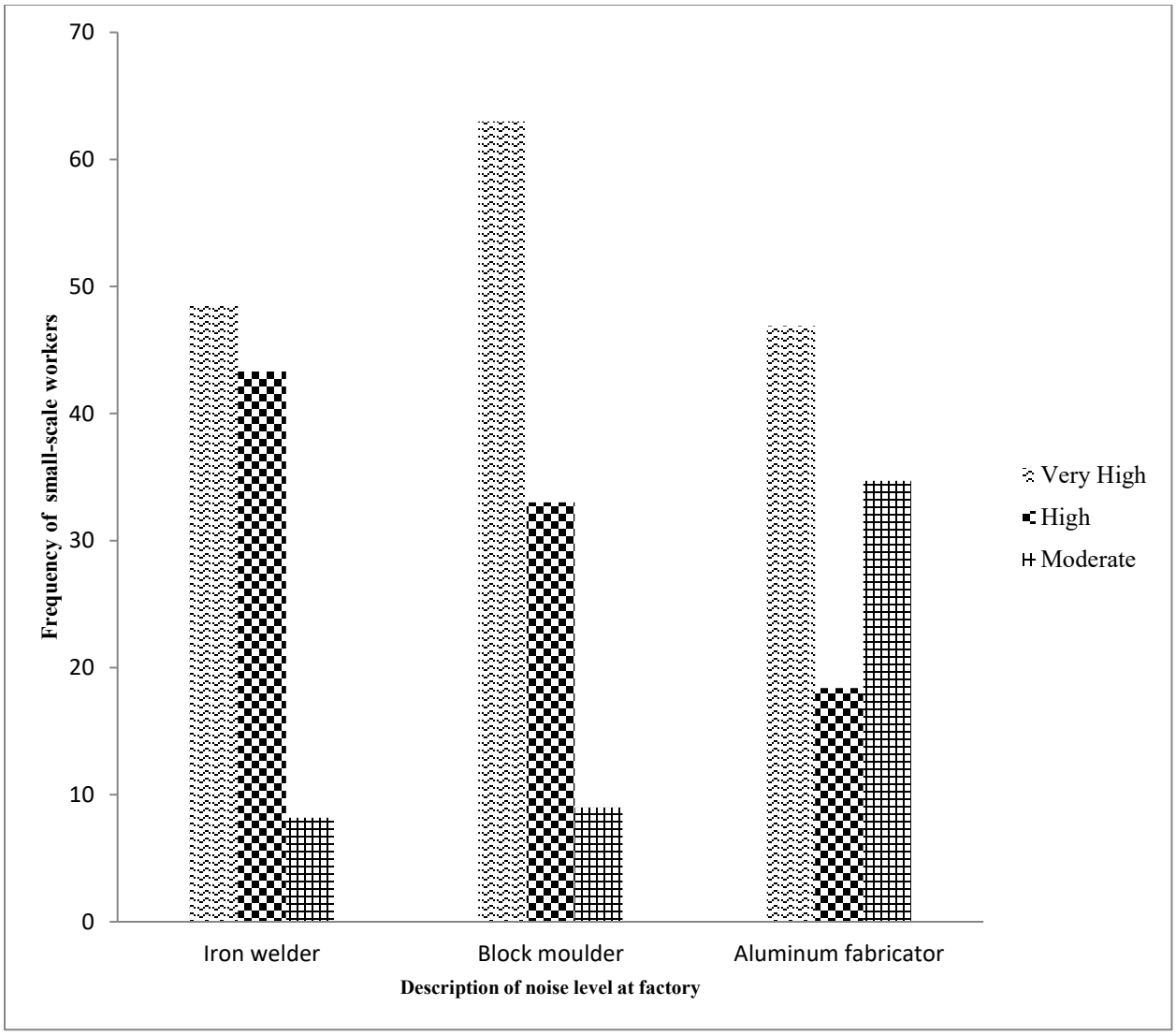


Figure 9: Perception of noise level at workplace

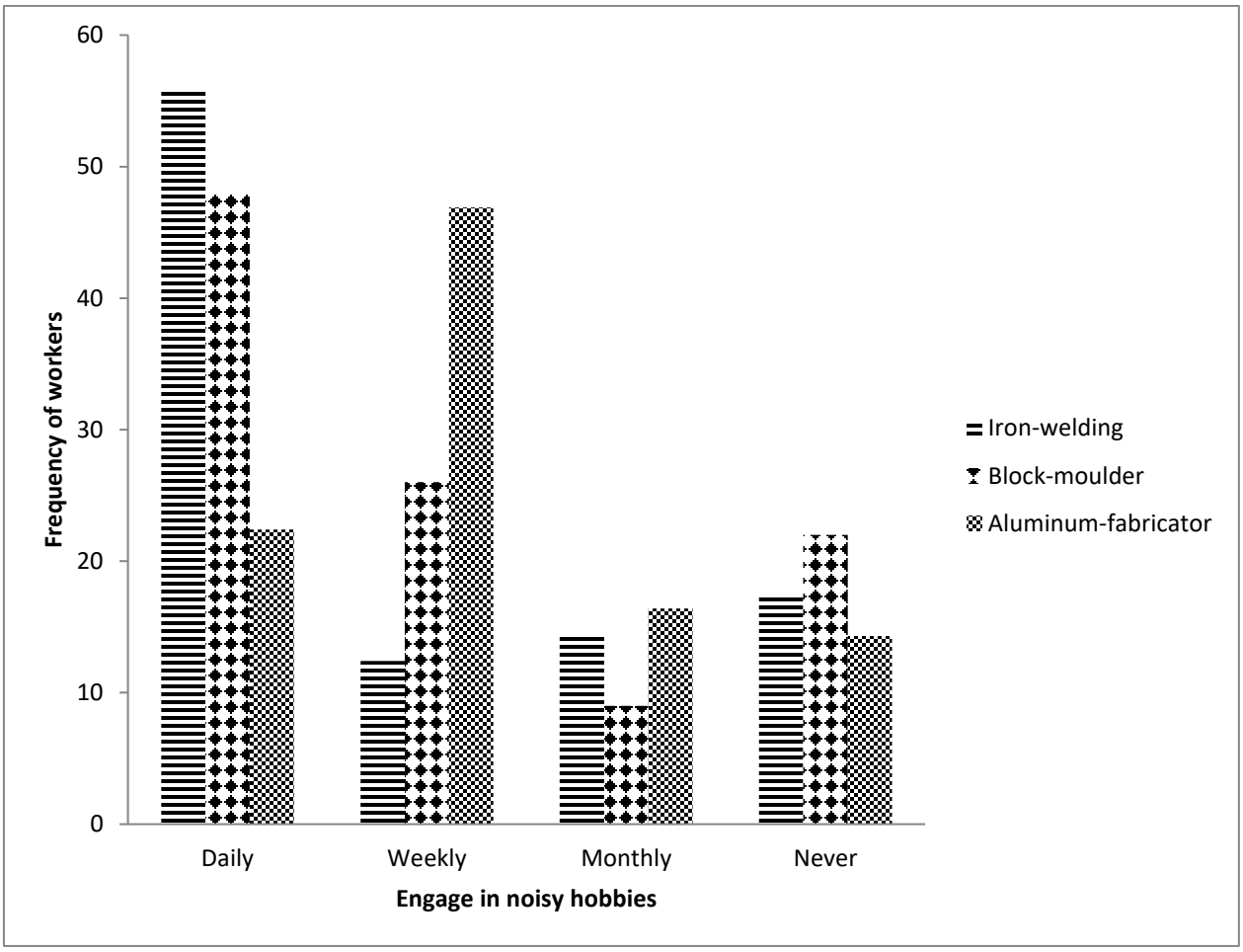
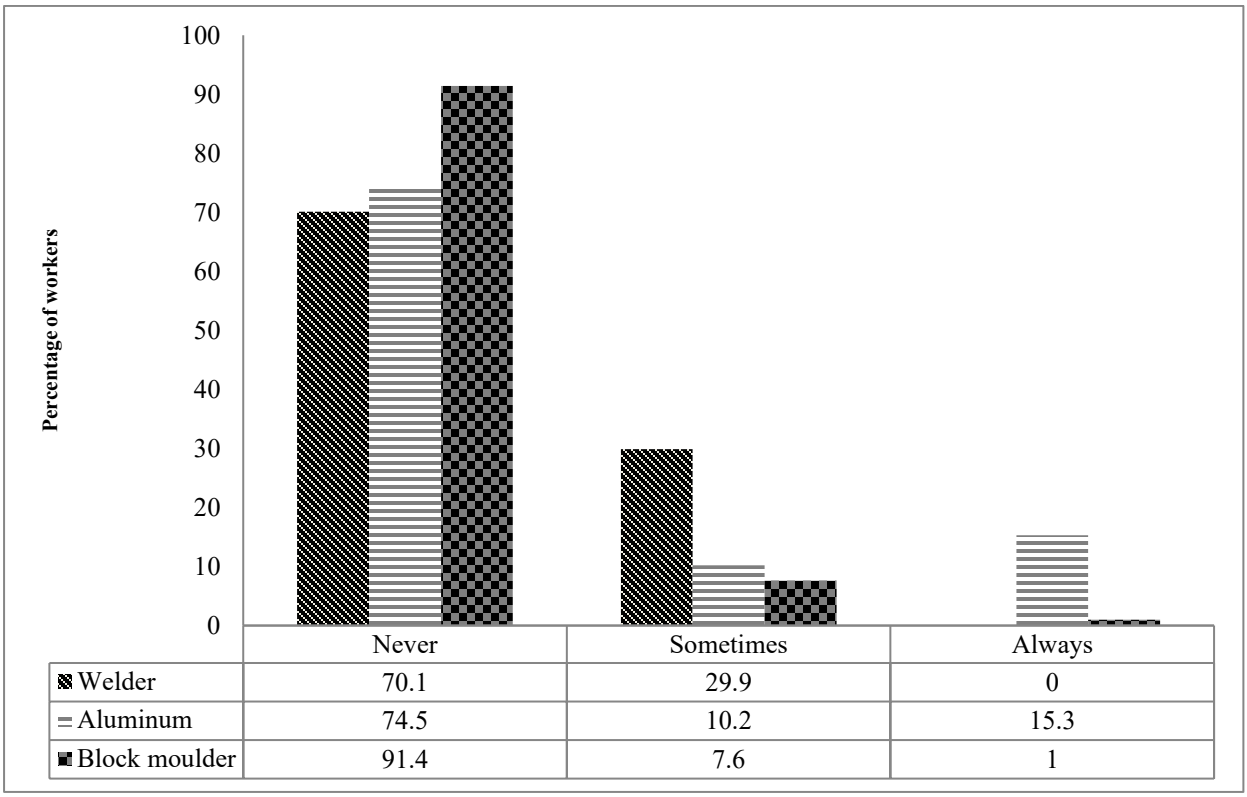


Figure 10: Duration of exposure of workers with noisy activities



	Never	Sometimes	Always
Welder	70.1	29.9	0
Aluminum	74.5	10.2	15.3
Block moulder	91.4	7.6	1

Figure 11: Workers with earplug/earmuff during activity

exceed internationally recommended occupational exposure limits, increasing the likelihood of permanent auditory damage and chronic physiological stress.

Nearly all block moulders (96%) described workplace noise as very high, while 82.0% of iron welders and almost half of aluminum fabricators expressed similar perceptions regarding excessive machine-generated noise (Figure 9). The high level of awareness among respondents indicates that excessive occupational noise is readily recognized by exposed workers.

Exposure to noise above 85 dB (A) for 8 hours in the workplace has been linked to serious health effects in exposed humans (WHO, 2022). The exposure of a quarter of the machine operators to high noise levels for many years portends severe negative health implications for the machine operators and their apprentices. This assertion was corroborated by the study of Oguntoke *et al.* (2018).

Similarly, majority of the aluminum fabricator are regularly engaged with different noise hobbies such as the use of power tools on weekly basis (Figure 10). More than 70% of the workers that used heavy equipment and noisy power tools did not wear earplugs or earmuffs during these activities to minimize the high sound intensity from the tools (Figure 11).

3.3 Perceived noise exposure and hearing status among small-scale industrial workers

The perception of noise by machine operators and their hearing evaluation are presented in Table 12. A substantial proportion of the workers (79.3%) acknowledged that excessive noise exposure can cause permanent hearing loss while 65% believed that workplace noise adversely affected their hearing. Despite this relatively high level of awareness, only 38.6% reported being disturbed by the noise generated within their workplaces.

Table 12: Self-evaluation of hearing status and noise exposure by workers

Characteristic	No. of Respondents	Percent
Machine operators on noise assessment		
Excessive exposure to noise can cause permanent deafness	238	79.3
Exposure to noise at workplace would affect hearing?	195	65.0
Bothered by noise at workplace	116	38.6
Trouble following conversation with 2 or more people talking at the same time	137	45.6
Highlighting communication and hearing abilities of machine operators		
Problem of hearing over telephone	110	36.7
Hear better from one ear than other when on telephone	133	44.3
Straining of ear to understand conversation	187	62.3
Trouble hearing in noisy background	205	68.3
Asking people to repeat their statement due to noise from the machine	147	49.0
Machine operation serve as source of noise	179	59.7
Other sources of disturbing noise at workplace		
Vehicular traffic	221	73.7
Commercial activities/ Block industries	199	66.4
Use of powered generators	217	72.3

Furthermore, nearly half (45.6%) of the workers experienced difficulty following conversations involving two or more speakers, 68.3% reported difficulty hearing in noise environment, 62.3% strained to understand conversations. Approximately one-third (36.7%) experienced difficulty hearing during telephone conversations whereas 44.3% heard better from one ear than the other.

The majority of respondents also identified vehicular traffic (73.7%), power generators (72.3%), and commercial activities (66.4%) as additional sources of environmental noise surrounding their workplaces.

Similar observations have been recognized among industrial workers exposed to continuous machine-generated noise, where reduced speech discrimination and impaired communication were among the initial symptoms of occupational auditory dysfunction (Nyarubeli et al., 2019; Zaw et al., 2020). These communication challenges not only reduce productivity but also increase the likelihood of workplace hazards due to misunderstanding of verbal instructions and warning signals.

The identification of vehicular traffic, power generators, and surrounding commercial activities as major contributors to workplace noise indicates that workers are simultaneously exposed to occupational and environmental noise sources.

The fact that most of the respondents attested to urban traffic as a source of noise pollution was in line with Oyedepo (2012) that vehicular noise, industrial machines and generators are major sources of noise pollution in cities. Also, revelation that generators constituted a major factor in noise pollution corroborated the findings of Olokooba *et al*. (2010) and Anomoharan and Osemeikhan (2005).

3.3.1 Noise-related physiological and psychological health effects

The prevalence of self-reported ailment frequently among workers is presented in Figure 12. Stress and fatigue constituted the most frequently reported symptoms (88.0%); speech interference (74.6%); headache (73.7%); ringing in the ear (66.7%); and increased heart rate (57.3%).

In addition, approximately half of the respondents experienced insomnia (51.0%), dizziness (48.0%), and impaired hearing (43.7%), while irritation (38.0%), anxiety and annoyance were commonly reported (Figure 12).

The predominance of stress and fatigue among the respondents demonstrates that occupational noise exerts substantial non-auditory health effects in addition to its well-established impact on hearing. These physiological responses may persist even when workers become accustomed to noisy environments, thereby increasing long-term risks of cardiovascular disease, reduced work performance, and diminished quality of life (WHO, 2022). The high prevalence of tinnitus observed in this study deserves particular attention because tinnitus is widely recognized as one of the earliest indicators of excessive occupational noise exposure.

The high frequency of speech interference further highlights the adverse consequences of occupational noise on workplace communication. Ineffective communication may compromise operational efficiency and significantly increase occupational injury risk because workers may fail to hear instructions, machinery alarms, or hazard warnings.

These common ailments suffered by the machine operators are similar to those identified by Oguntoke *et al.* (2012) in their study.

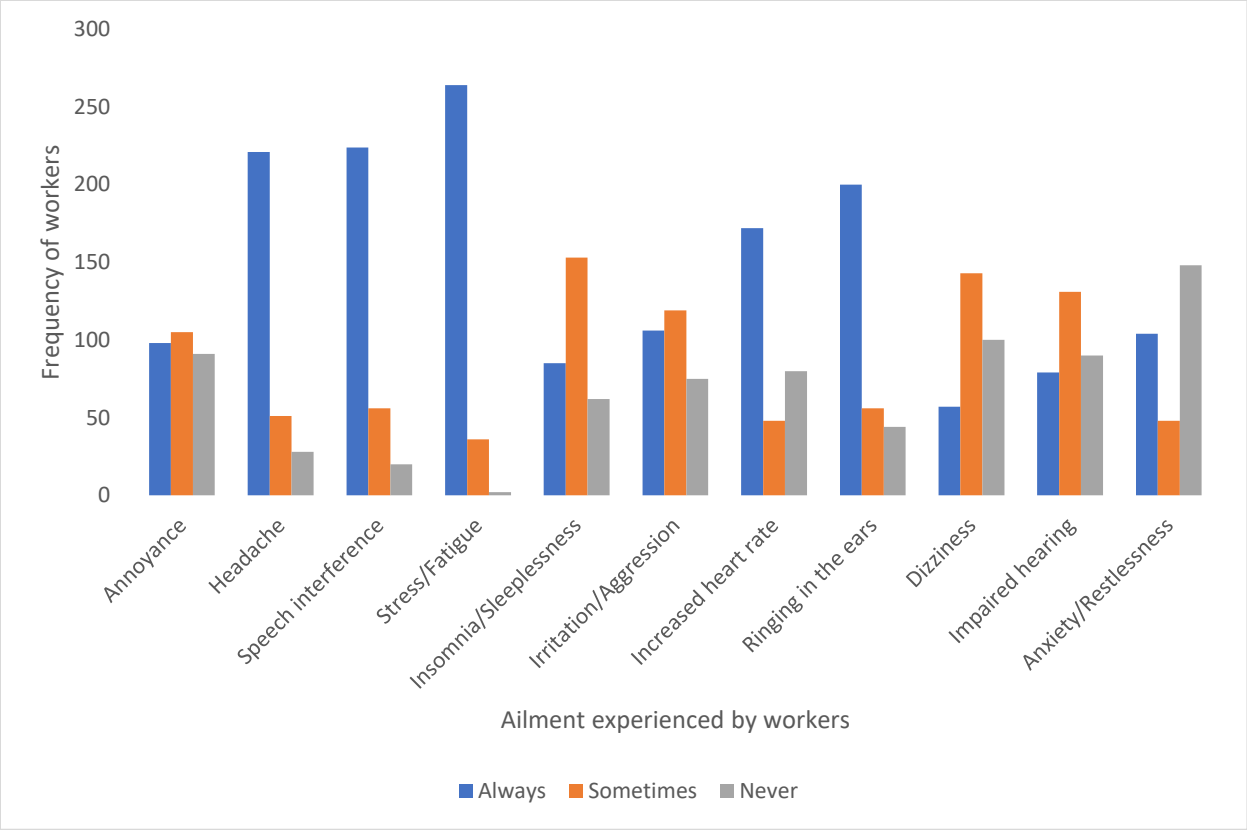


Figure 12: Ailment suffered by small-scale workers

Frequent occurrence of these noise pollution-induced health impacts points to the hazardous nature of these small-scale factories in this study and other areas in Nigeria (Oguntoke *et al.,* 2018). In this study only few of the workers revealed that noise pollution disturbed them from sleeping and affected their hearing which was in agreement with the findings of Olokooba *et al*. (2010). Also, Olaosun *et al*. (2009) showed that noise can disturb people's rest, sleep, work and communication and it can damage hearing and manifest psychological, physiological and possible pathological reactions.

Headache is one of the most common neurological problems which cause a substantial health and social burden on the human populations (NICE, 2012). In order to prevent human discomforts (annoyance) and hearing impairment especially in a residential environment, noise level should not exceed 70 dB (A) over 24 hours of exposure and 85 dB over a 1-hour during daytime (WHO, 2022).

3.3.2 Other Occupational Health Challenges

Respondents identified additional occupational health challenges associated with their work environment as shown in Figure 13. Bone and back pain represented the most frequently reported complaint (72.0%), cuts (68.0%) eye irritation (60.3%), burns (52.3%), foreign bodies in the eye (49.3%), catarrh (34.3%), and electric shock (28.6%). Foreign object in the eyes can lead to eye injury if the eye is not protected with either a safety goggle or welding shields. Likewise, burns and electric shocks remain common hazards where electrical safety procedures are poorly implemented.

Similar work-related health profiles have been reported among welders and fabrication workers in Nigeria and other African countries, highlighting persistent deficiencies in workplace safety management within informal industrial enterprises (Nwafor et al., 2019; Aremu et al., 2020).

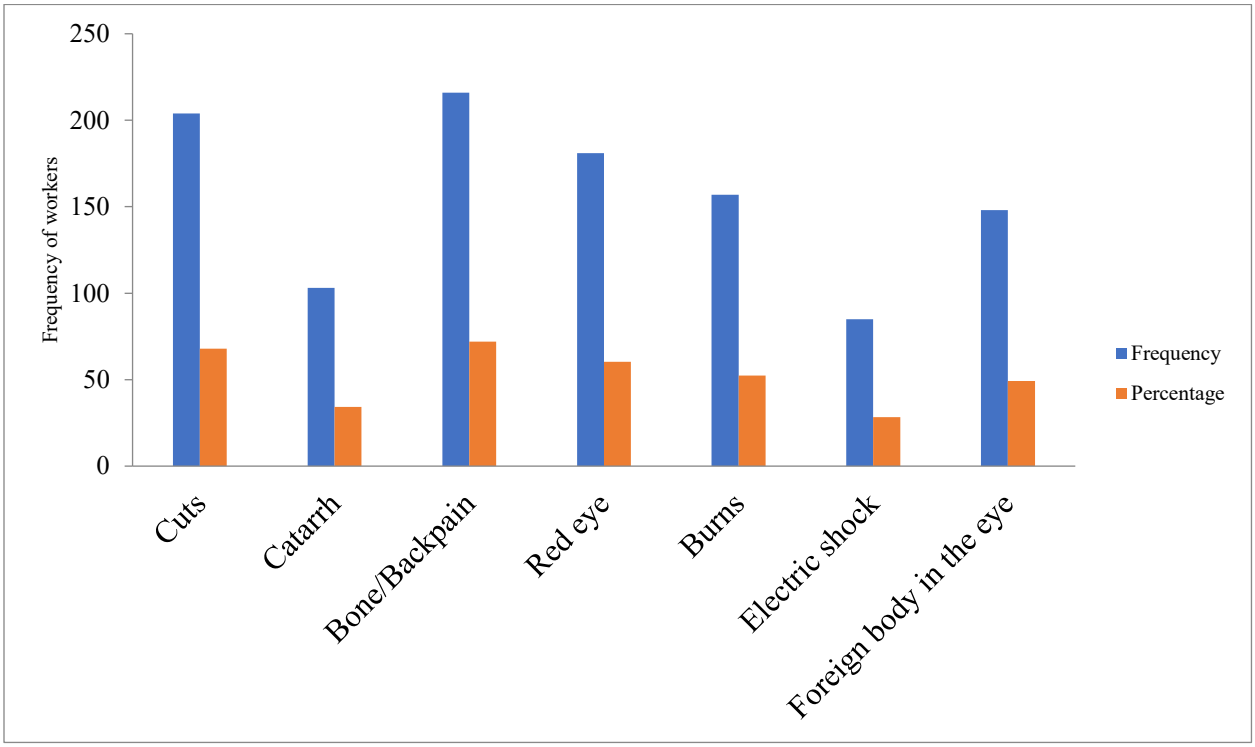


Figure 13: Other occupational ailments identified by workers

The study is in agreement with the work of Illiyasu and Lawan (2010) which showed that occupational hazards mentioned by welders in Kano city were burns, cuts, foreign body in the eyes, electric shock, red eyes among others.

Collectively, these findings demonstrate that workers in small-scale industries are exposed to multiple interacting occupational hazards that extend far beyond excessive noise.

The occupational health challenges identified in this study by the machine operators could be due to the poor nature of workshop design and the absence of hydraulic lifts which assists in lifting heavy materials in the iron welding and aluminum fabricator process in developed countries.

Moreover, work overload, carelessness and non-use of protective equipment could also be responsible for health complaints of small-scale industrial workers in Abeokuta.

3.4 Personal protective equipment awareness and healthcare measures behaviour

The awareness and utilization of PPE among the workers are presented in Table 14 while the distribution of specific PPE used across the three occupational groups is shown in Table 15.

Overall, less than half of the respondents demonstrated adequate awareness and utilization of hearing protection measures. Approximately 46.3% of the workers were aware of hearing protection devices, 52.7% had received information regarding the benefits of PPE, and only 44.0% reported using any form of personal protective equipment during work. Furthermore, only 37.3% indicated that PPE use was enforced by workshop owners or managers.

Among respondents who did not use PPE, the most frequently reported barriers were discomfort while wearing the equipment (57.7%), non-availability of PPE (34.7%), excessive heat and stuffiness (26.3%), the perception that work could be completed before PPE became necessary

Table 14: Awareness and use of personal protective equipment

Characteristic	Frequency	Percent
Aware of gadgets that protect ear from excessive noise	139	46.3
Information on benefit of using PPE	158	52.7
Use of Hearing protective devices at work	132	44.0
Manager/head of factory impose the use of PPE	112	37.3
Reasons for not using PPE		
Employer did not provide	104	34.7
Not comfortable with the equipment	173	57.7
Feeling stuffy/hot weather	79	26.3
Job get finish quickly	70	23.3
Negligence/No benefit of using PPE	40	13.3
Use PPE when expose to excessive noise	41	13.6
Use of medication	144	45.0
Method of medication used		
Herbal	87	29.0
Orthodox	95	31.6
Self-medication	118	39.3
Total	300	100.0

Table 15: Utilization of specific personal protective equipment

Specific PPE used	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Eyes and face	**Welder (n=97)**		**Block (n=105)**		**Aluminum (n=98)**	
Safety goggle	38	39.2	0	0	10	10.2
Mask shield/Helmet	6	6.2	14	13.3	5	5.1
Sunglasses	44	45.4	9	8.6	13	13.3
None	9	9.3	82	78.1	70	71.4
Ear						
Ear muffs	0	0	0	0	0	0
Ear plugs	0	0	0	0	0	0
None	97	100	105	100	98	100.0
Lungs						
Facemasks/cotton mask	49	50.5	66	62.9	56	57.1
Respirators	0	0	0	0	0	0
None	48	49.5	39	37.1	42	42.9
Feet						
Safety boot	47	48.5	63	60	31	31.6
Ordinary shoes	29	29.9	24	22.9	44	44.9
Bathroom slippers	21	21.6	18	17.1	23	24.5
Hand						
Ordinary gloves	36	37.1	11	10.5	12	12.2
Insulated safety glove	41	42.3	73	69.5	48	49
None	20	20.6	21	20	38	38.8
Body trunk						
Ordinary cloth	57	58.8	20	19	66	67.3
Work suit/Overall	33	34	62	59	23	23.5
Leather apron	7	7.2	23	21.9	5	5.1

(23.3%), and negligence or lack of perceived benefit (13.3%). Only 13.6% reported using hearing protection devices whenever exposed to excessive occupational noise. Regarding healthcare practices, 39.3% relied on self-medication, 31.6% sought orthodox medical care, while 29.0% reported using traditional herbal remedies.

Despite moderate awareness of occupational hazards, the overall utilization of PPE among the respondents remained unsatisfactory. This finding suggests that awareness alone is insufficient to promote behavioural change without adequate institutional support, regular safety training, employer commitment, and enforcement of occupational safety regulations (OSHA, 2008).

The most ascribed reasons for non-use of hearing protection devices in this study were non-availability and discomfort. Others reported stuffiness and negligence as barriers for not using hearing protection devices. Similar concerns have been reported among industrial workers in Saudi Arabia, Myanmar, Tanzania, and other developing countries, where discomfort substantially reduced compliance despite awareness of occupational hazards (Balkhyour et al., 2019; Zaw et al., 2020). The relatively high proportion of workers relying on self-medication for occupational health complaints also deserves attention. Nearly two-fifths of respondents reported treating work-related symptoms independently rather than seeking professional healthcare. Self-medication may delay diagnosis of occupational diseases, leading to hearing impairment, hypertension, and chronic musculoskeletal disorders, thereby reducing chances for early intervention.

3.4.1 Utilization of specific personal protective equipment

The distribution of specific PPE across the three occupational groups is summarized in Table 15. Eye protection varied considerably between occupations. Safety goggles and sunglasses were commonly used by iron welders (84.6% combined), whereas more than 70% of block moulders

and aluminium fabricators reported using no eye protection during work. For respiratory protection, approximately 50–63% of respondents used facemasks or cotton masks, while none reported using certified respirators. Safety boots were used by 60.0% of block moulders and 48.5% of welders, whereas ordinary shoes or slippers remained common among aluminium fabricators.

Insulated safety gloves constituted the most frequently used hand protection, particularly among block moulders (69.5%), while coveralls were primarily used by block moulders (59.0%). Most notably, none of the respondents across the three occupational groups reported using earplugs or earmuffs, indicating complete absence of hearing protection despite continuous occupational noise exposure.

International hearing conservation guidelines recommend mandatory use of hearing protection whenever occupational noise exceeds recommended exposure limits, particularly where engineering controls cannot adequately reduce noise at the source (WHO, 2022; OSHA, 2024). The findings therefore suggest that hearing conservation practices remain largely absent within the surveyed industries.

The relatively higher utilization of eye protection among welders compared with block moulders and aluminium fabricators probably reflects greater awareness of immediate ocular hazards such as welding arc radiation, flying sparks, and molten metal particles.

The widespread use of ordinary shoes, slippers, and non-certified face coverings also indicates incomplete compliance with occupational safety standards (OSHA, 2008). Although some workers reported using cotton masks, these provide minimal protection against respirable dust and airborne contaminants generated during welding, grinding, and block production.

The utilization of PPE in this study among small-scale enterprise in Abeokuta is similar to the observation of Chukwu *et al.* (2019) on occupational hazards and use of PPE among small-scale welders in Owerri North, Imo State (Nigeria). The least utilized PPE reported by the three occupational groups in this study were respiratory and ear protectors.

Majority of workers that do not make use of a safety shield for eye and face protection were prone to high rate of eye injury or accidents. AlMahmoud *et al*. (2020) reported a high percentage of eye injury incidents among workers in small-scale factories.

3.5 Strengths of the Study

A major strength of this study lies in its inclusion of three important categories of small-scale industries (iron welding, aluminium fabrication, and block moulding) by providing a comprehensive assessment of occupational noise exposure within Nigeria's informal manufacturing sector. The relatively large sample size also enhanced the reliability of the findings and enabled meaningful comparisons across occupational groups. Furthermore, the study simultaneously evaluated auditory health outcomes, non-auditory effects, occupational risk factors, and PPE utilization, providing a broader understanding of the occupational health burden associated with excessive workplace noise.

3.6 Study Limitations and implications

Hearing status and several health outcomes were assessed primarily through self-report rather than objective audiometric evaluation. Also, the study was conducted within one geographical area of Ogun State, which may limit generalizability to other regions of Nigeria. Future longitudinal studies incorporating personal noise dosimetry, pure-tone audiometry are recommended to strengthen evidence regarding the long-term health consequences of occupational noise exposure.

The findings demonstrate an urgent need to strengthen occupational health services within Nigeria's informal industrial sector. Policymakers should enforce industry-specific hearing conservation programmes, while employers should ensure continuous availability of certified PPE, periodic occupational health training, and regular audiometric surveillance.

Conclusion

The present study provides comprehensive evidence that workers employed in small-scale industries in Abeokuta, Ogun State, are exposed to hazardous occupational noise levels and experience a high burden of both auditory and non-auditory health effects.

There is significant association between occupational risk factors, including age, duration of daily exposure, and working hours, and the occurrence of several noise-related health outcomes such as ringing ear, hearing loss, increased heart rate, stress, speech interference, sleeplessness and elevated blood pressure.

Prolonged occupational exposure and extended working hours were significantly associated with tinnitus, headache, annoyance, speech interference, stress, sleep, insomnia, elevated heart rate, cardiovascular responses, and other adverse health outcomes.

The findings highlighted the urgent need for comprehensive hearing conservation programmes, noise control measures, strengthened occupational health policies, mandatory provision and enforcement of appropriate PPE, reduce the burden of occupational disease and improve the health, safety, and productivity of small-scale industrial workers in Abeokuta.

Declarations

Ethics approval and consent to participate

The study followed the core principles of research ethics outlined in the Declaration of Helsinki. Ethical approval for the study was obtained from the departmental research committee of the Federal University of Agriculture Abeokuta, Ogun State, Nigeria before commencement of data collection. Verbal consent from the Association of iron welders, block moulders and aluminium workers in Abeokuta was taken. Permission was also obtained from workshop owners and supervisors. The objectives of the study were clearly explained to all participants, and written informed consent was obtained prior to enrolment. Participation was entirely voluntary, confidentiality of respondents' information was maintained throughout the study, and participants were informed of their right to withdraw from the study at any stage without penalty.

Consent for publication

Not Applicable

Availability of data and materials

All data generated or analysed during this study are included in this published article and its supplementary information file.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Tijani, Y. A.: Conceptualization, Writing – original draft, Visualization, Resources, Investigation, Methodology, Formal analysis, Data curation **Oguntoke, O**.: Validation, Supervision, Resources, Project administration, Conceptualization **Dimowo, B. O.**: Writing – review & editing, Visualization, Resources, Investigation, Formal analysis

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