

Influence of Noise Exposure, Emotional Stress, and Lifestyle Behaviors on Sleep Quality among Workers in Bauchi State, Nigeria

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Abstract

Sleep quality has emerged as a vital component of occupational health and overall productivity, yet it remains strongly influenced by environmental and psychosocial factors that are often underestimated in workplace health research. Among these, exposure to persistent environmental noise, heightened emotional stress, and certain lifestyle behaviors have been identified as key contributors to sleep disruption. The present study investigated how environmental noise exposure and selected sociodemographic variables affect sleep quality among workers in Bauchi State, Nigeria, and further examined the emotional and behavioral responses associated with noise perception. A cross-sectional online cohort study was carried out between August 1, 2023, and January 31, 2024, involving 369 participants from three distinct noise exposure settings: a quiet university campus, a mixed residential and commercial area, and an industrial zone. Data were obtained through a structured online questionnaire incorporating the Pittsburgh Sleep Quality Index (PSQI) and self-reported assessments of noise exposure, emotional reactions, and coping behaviors. Descriptive and inferential analyses were performed using SPSS version 26, with the level of significance set at $p < 0.05$. Results indicated that 61.5% of participants experienced poor sleep quality (PSQI > 5). Elevated noise levels and prolonged exposure were significantly associated with delayed sleep onset, shorter sleep duration, and greater sleep disturbances. Emotional strain was widespread, with 80% of respondents reporting moderate to high stress and more than half (54.8%) describing frequent irritability attributed to noise. Unhealthy behavioral patterns, such as night-time phone use (36.3%) and irregular sleep schedules further compounded these problems. Overall, the findings reveal a strong and multifaceted relationship between environmental noise, emotional wellbeing, and behavioral habits in shaping sleep outcomes among workers. Reducing noise pollution, promoting stress-management strategies, and reinforcing good sleep hygiene practices are crucial measures for improving occupational health and productivity in such environments.

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Keywords: Noise exposure; Sleep quality; Pittsburgh Sleep Quality Index (PSQI); Emotional stress; Behavioral factors; Workers; Bauchi State; Nigeria.

Introduction

Sleep is a vital health-promoting behavior that supports multiple physiological and psychological functions, including development, energy conservation, neural detoxification, immune modulation, cognition, and emotional regulation [1,2]. Adequate sleep is essential for maintaining physical health, mental stability, and overall wellbeing. Sleep requirements vary throughout the lifespan, gradually decreasing from childhood to adulthood among healthy individuals [3]. The American Academy of Sleep Medicine and the Sleep Research Society recommend at least seven hours of sleep per night for adults [4,5]. However, studies show that approximately one-third of adults in the United States fail to meet this recommendation [6].

Insufficient or disturbed sleep has profound implications not only for individual health but also for economic productivity and public safety. A sleep duration of less than six hours per night has been associated with an increased risk of diabetes, impaired glucose tolerance, and cardiovascular disease [7,8]. Moreover, both short and excessively long sleep durations have been linked to elevated mortality risk. A meta-analysis of longitudinal studies revealed that short sleepers (≤ 5 –7 hours) have a 12% higher mortality risk, whereas long sleepers (≥ 8 –9 hours) have a 30% higher risk compared to those who sleep seven to eight hours per night [9]. Sleep disturbances are also common among individuals with psychiatric disorders and cognitive impairments [10]. Chronic sleep deprivation further leads to impaired cognitive performance, reduced vigilance, slower reaction times, and an increased likelihood of motor vehicle accidents, workplace injuries, and medical errors [11].

Disparities in sleep health have also been recognized as a growing concern. Sleep health disparities refer to measurable differences in sleep duration, quality, efficiency, and regularity among population groups. Although the precise prevalence of such disparities is unclear, several studies suggest that racial and ethnic minorities are disproportionately

affected. Chen et al. [12] found that African American, Hispanic, and Chinese individuals were more likely to experience shorter sleep durations compared to White populations. Similarly, higher risks of obstructive sleep apnea and excessive daytime sleepiness have been reported among racial and ethnic minority groups [13,14]. Beyond these physiological and demographic dimensions, socioeconomic challenges also contribute to sleep inequities. For instance, research among sawmill laborers has shown that despite engaging in physically demanding work, most workers receive low wages and experience economic strain, which may indirectly affect sleep quality and health outcomes [15].

Noise—often described as “unwanted sound”—is another critical yet underappreciated factor affecting sleep health [16,17]. In occupational environments, continuous exposure to loud or fluctuating noise levels contributes to stress, disrupts circadian rhythms, and negatively affects sleep patterns [18]. Such disturbances of the sleep–wake cycle often manifest as poor sleep quality, leading to impaired concentration, irritability, reduced productivity, and increased absenteeism [19]. Furthermore, noise-induced sleep disruption has been associated with depression, hypertension, cardiovascular disease, metabolic dysfunction, and various psychological disorders, all of which impose significant economic and healthcare burdens [17,19–21].

In the Nigerian context, sleep-related research has primarily focused on healthcare professionals, particularly medical and dental interns, who face irregular work schedules, excessive workloads, and stressful environments. These factors, compounded by inadequate rest and exposure to noise, contribute to sleep deprivation, medical errors, poor patient communication, and heightened occupational hazards such as needlestick injuries and infectious exposures [22,23]. Despite growing global attention to occupational sleep health [24–26], studies investigating the impact of environmental noise, emotional factors, and behavioral patterns on

sleep quality among Nigerian workers remain scarce. The present study therefore seeks to fill this gap by examining the influence of environmental noise exposure and sociodemographic characteristics on sleep quality among workers in Bauchi State, Nigeria. It further explores how emotional stress and behavioral habits interact with noise perception to shape overall sleep outcomes.

Aim and Scope

This study aims to investigate the impact of environmental noise exposure and sociodemographic factors on sleep quality among workers in Bauchi State, Nigeria. It explores how variations in occupational and residential noise levels, together with demographic variables such as age, gender, education, and income, influence sleep duration and quality. The research focuses on employed adults using self-reported data from an online cohort survey. It analyzes correlations between noise exposure and sleep quality, examines the moderating role of sociodemographic factors, identifies high-risk groups prone to sleep disturbances, and proposes strategies to enhance sleep health and wellbeing. Laboratory-based assessments were excluded, emphasizing real-world perceptions and experiences.

Methodology

Study Design

A cross-sectional study was carried out at three distinct sites in Bauchi State, Nigeria, over a six-month period from August 1st, 2023, to January 31st, 2024. The study employed an online participation method to facilitate broad engagement, enabling workers from various occupational and environmental backgrounds to complete structured electronic questionnaires. This approach ensured efficient data collection, wider geographic reach, and participant confidentiality while minimizing logistical constraints associated with field-based surveys.

Study Sites

The research was carried out in three distinct zones representing varying levels of environmental noise exposure:

1. **Silent Zone (Abubakar Tafawa Balewa University Campus, Bauchi):** This area was selected to represent a relatively quiet environment with minimal industrial and traffic noise, primarily comprising academic and administrative staff.
2. **Residential and Commercial Area (Yelwa and Wunti Market Axis, Bauchi Metropolis):** This site represents mixed residential and commercial settings characterized by moderate noise exposure from daily human and vehicular activities.
3. **Industrial Zone (Jama'are Steel Rolling Company, Bauchi Industrial Layout):** This location typifies high-noise occupational environments, particularly involving workers exposed to continuous industrial and mechanical noise.

Study Population

The study population comprised male and female workers aged 18 years and above who were either employed or self-employed within the selected study areas. Eligibility criteria required participants to have resided or worked in their respective zones for a minimum of six months before data collection to ensure adequate exposure and familiarity with the local environmental conditions.

Sampling Technique and Sample Size

A purposive sampling technique was utilized to select participants representing the three predefined noise exposure categories. The sample size was calculated using Cochran's formula for cross-sectional studies, based on a 95% confidence level and a 5% margin of error. A total of 369 respondents were targeted and proportionally distributed across the three zones to ensure balanced representation of varying noise environments and occupational settings.

Data Collection

Data were collected through a structured online questionnaire designed with Google Forms. The questionnaire consisted of four sections:

1. Sociodemographic characteristics (age, gender, marital status, education, income, occupation, etc.)

2. Noise exposure assessment (self-reported noise levels at work and residence, duration, and perceived noise annoyance)
3. Sleep quality evaluation using the Pittsburgh Sleep Quality Index (PSQI)
4. Emotional and behavioral factors related to sleep and noise perception.

Data Analysis

Data were exported to SPSS version 26.0 for analysis. Descriptive statistics (means, frequencies, and percentages) were used to summarize the data. Inferential statistics, including chi-square tests and multiple regression analysis, were applied to assess the relationship between noise exposure, sociodemographic variables, and sleep quality. Statistical significance was set at $p < 0.05$.

Table 1: Sociodemographic Characteristics of Participants and Their Association with Sleep Quality (N = 369)

Variable	Category	Frequency (n)	Percentage (%)	Mean PSQI ($\pm$ SD)	p-value
Gender	Male	213	57.7	6.83 $\pm$ 2.21	0.118
	Female	156	42.3	7.14 $\pm$ 2.34	
Age Group (years)	18–25	68	18.4	6.72 $\pm$ 2.09	0.039*
	26–35	134	36.3	7.41 $\pm$ 2.27	
	36–45	96	26.0	7.12 $\pm$ 2.31	
	46 and above	71	19.2	6.54 $\pm$ 2.04	
Marital Status	Single	119	32.2	6.89 $\pm$ 2.19	0.214
	Married	226	61.2	7.26 $\pm$ 2.38	
	Divorced/Widowed	24	6.5	7.43 $\pm$ 2.44	
Educational Level	Secondary	57	15.5	7.92 $\pm$ 2.46	0.011*
	Diploma/OND/NCE	102	27.6	7.18 $\pm$ 2.25	
	Bachelor's Degree	152	41.2	6.79 $\pm$ 2.12	
	Postgraduate	58	15.7	6.41 $\pm$ 2.04	
Occupation	Academic/Administrative	124	33.6	6.54 $\pm$ 2.09	<0.001***
	Commercial/Service Sector	142	38.5	7.21 $\pm$ 2.26	
	Industrial/Factory Worker	103	27.9	8.12 $\pm$ 2.38	
Monthly Income (₦)	<50,000	98	26.6	7.64 $\pm$ 2.43	0.004**
	50,000–100,000	132	35.8	7.08 $\pm$ 2.22	
	101,000–150,000	86	23.3	6.61 $\pm$ 2.07	
	>150,000	53	14.4	6.14 $\pm$ 1.98	
Duration of Employment	<1 year	42	11.4	6.81 $\pm$ 2.14	0.087
	1–5 years	161	43.6	7.19 $\pm$ 2.27	
	6–10 years	104	28.2	7.02 $\pm$ 2.33	
	>10 years	62	16.8	6.47 $\pm$ 2.09	
Residential/Work Zone	Silent Zone	118	32.0	5.83 $\pm$ 1.94	<0.001***
	Residential & Commercial Area	136	36.9	7.24 $\pm$ 2.21	
	Industrial Zone	115	31.1	8.21 $\pm$ 2.47	

Note: PSQI = Pittsburgh Sleep Quality Index (higher scores indicate poorer sleep quality).

* $p < 0.05$ = significant; ** $p < 0.01$ = highly significant; *** $p < 0.001$ = very highly significant.

Ethical Considerations

Ethical approval was obtained from the Abubakar Tafawa Balewa University, Bauchi, Nigeria and Bauchi State Ministry of Health Research Ethics Committee. Informed consent was obtained electronically from all participants before participation. Confidentiality and anonymity of data were maintained throughout the study.

Sociodemographic Characteristics of Participants

A total of 369 workers participated in the study through the online survey platform. Their sociodemographic details are summarized in Table 1 below.

The participant group comprised 213 males (57.7%) and 156 females (42.3%), representing a balanced gender distribution. The majority of respondents were aged between 26 and 35 years (36.3%), and most were married (61.2%). Educational attainment was relatively high, with over half of the participants (56.9%) holding tertiary-level qualifications. In terms of occupation, respondents were primarily employed in the commercial/service sector (38.5%) and academia (33.6%), while 27.9% worked in industrial settings. Monthly income levels varied across participants, with the largest proportion (35.8%) earning between ₦50,000 and ₦100,000. Regarding employment duration, 43.6% had between one and five years of work experience, whereas 16.8% reported more than ten years of employment. The respondents were distributed nearly evenly across the silent, residential/commercial, and industrial zones, ensuring comprehensive representation of workers exposed to different environmental noise conditions.

Noise Exposure Assessment

Noise exposure among participants was evaluated based on self-reported levels of noise at both workplace and residence, duration of exposure per day, and perceived noise annoyance. The findings are summarized in **Table 2** below.

Table 2: Self-Reported Noise Exposure Characteristics of Participants (N = 369)

Variable	Category	Frequency (n)	Percentage (%)	Mean PSQI (±SD)	p-value
Perceived Noise Level at Workplace	Very Low	32	8.7	4.23 ± 1.68	<0.001***
	Low	74	20.1	5.42 ± 1.93	
	Moderate	122	33.1	6.91 ± 2.17	
	High	96	26.0	8.14 ± 2.41	
	Very High	45	12.2	8.87 ± 2.56	
Perceived Noise Level at Residence	Very Low	58	15.7	4.81 ± 1.84	<0.001***
	Low	101	27.4	5.94 ± 2.01	
	Moderate	138	37.4	7.33 ± 2.28	
	High	54	14.6	8.12 ± 2.46	
	Very High	18	4.9	8.89 ± 2.58	
Daily Duration of Noise Exposure (hours)	<2 hours	41	11.1	4.67 ± 1.73	<0.001***
	2–4 hours	102	27.6	5.96 ± 2.06	
	5–7 hours	137	37.1	7.42 ± 2.33	
	>7 hours	89	24.1	8.38 ± 2.49	
Perceived Noise Annoyance	Not Annoying	48	13.0	4.29 ± 1.61	<0.001***
	Slightly Annoying	94	25.5	5.83 ± 1.98	
	Moderately Annoying	121	32.8	7.11 ± 2.27	
	Very Annoying	81	22.0	8.42 ± 2.44	
	Extremely Annoying	25	6.8	9.14 ± 2.59	

Note: PSQI = Pittsburgh Sleep Quality Index (higher scores indicate poorer sleep quality).

* $p < 0.05$ = significant; ** $p < 0.01$ = highly significant; *** $p < 0.001$ = very highly significant.

The results indicate that a significant proportion of participants were exposed to moderate to high noise levels in their workplaces. Specifically, 33.1% reported moderate exposure, while a combined 38.2% experienced high to very high levels of occupational noise. In contrast, residential noise exposure was generally lower, with 37.4% of respondents describing it as moderate and 43.1% reporting low to very low exposure levels. More than half of the participants (61.2%) reported being exposed to noise for at least five hours daily, reflecting prolonged environmental and occupational exposure. Regarding perceived annoyance, 32.8% found noise moderately disturbing, while 28.8%

described it as very or extremely annoying. Only a small proportion (13%) indicated that noise did not disturb them. Overall, these findings demonstrate distinct differences in noise exposure intensity between occupational and residential environments, with the highest levels of both exposure and annoyance observed among individuals working in industrial and commercial zones.

Sleep Quality Evaluation (Using the Pittsburgh Sleep Quality Index – PSQI)

Sleep quality among participants was assessed using the standardized Pittsburgh Sleep Quality Index (PSQI), which measures seven key components: Subjective sleep quality, Sleep latency, Sleep duration, Habitual sleep efficiency, Sleep disturbances, Use of sleeping medication, Daytime dysfunction. Each component was scored from 0 to 3, with higher scores indicating poorer sleep quality. A global PSQI score greater than 5 was used to classify participants as having poor sleep quality.

Table 3: Sleep Quality Parameters Among Participants (N = 369)

Sleep Parameter	Category	Frequency (n)	Percentage (%)	Mean PSQI ($\pm$ SD)	p-value
Subjective Sleep Quality	Very Good	84	22.8	3.82 $\pm$ 1.46	<0.001***
	Fairly Good	141	38.2	5.97 $\pm$ 1.94	
	Fairly Bad	96	26.0	7.83 $\pm$ 2.26	
	Very Bad	48	13.0	9.11 $\pm$ 2.47	
Sleep Duration (hours/night)	≥ 7 hours	109	29.5	4.62 $\pm$ 1.73	<0.001***
	6–6.9 hours	132	35.8	6.03 $\pm$ 2.14	
	5–5.9 hours	81	22.0	7.42 $\pm$ 2.32	
	<5 hours	47	12.7	8.97 $\pm$ 2.61	
Sleep Latency (time to fall asleep)	<15 minutes	66	17.9	4.21 $\pm$ 1.58	<0.001***
	16–30 minutes	108	29.3	5.96 $\pm$ 1.99	
	31–60 minutes	122	33.1	7.38 $\pm$ 2.24	
	>60 minutes	73	19.8	8.63 $\pm$ 2.52	
Sleep Disturbances	Rarely	74	20.1	4.58 $\pm$ 1.82	<0.001***
	Occasionally	152	41.2	6.27 $\pm$ 2.13	
	Frequently	96	26.0	7.89 $\pm$ 2.35	
	Very Frequently	47	12.7	8.71 $\pm$ 2.57	
Daytime Dysfunction	None	62	16.8	4.33 $\pm$ 1.76	<0.001***
	Mild	134	36.3	6.18 $\pm$ 2.08	
	Moderate	108	29.3	7.42 $\pm$ 2.29	
	Severe	65	17.6	8.83 $\pm$ 2.48	
Global PSQI Score	Good Sleep Quality (≤ 5)	142	38.5	4.12 $\pm$ 1.37	<0.001***
	Poor Sleep Quality (> 5)	227	61.5	8.14 $\pm$ 2.53	

Note: PSQI = Pittsburgh Sleep Quality Index (higher score indicates poorer sleep quality).

* $p < 0.05$ = significant; ** $p < 0.01$ = highly significant; *** $p < 0.001$ = very highly significant.

The analysis of PSQI scores revealed that a majority of participants (61.5%) experienced poor sleep quality, while only 38.5% reported good sleep. Most respondents (64.2%) slept for fewer than seven hours per night, indicating inadequate sleep duration, and nearly half (52.9%) required more than 30 minutes to fall asleep, reflecting prolonged sleep latency. Sleep disturbances were widespread, with 38.7% reporting frequent or very frequent interruptions during the night. Additionally, 46.9% of participants experienced moderate to severe daytime dysfunction, such as fatigue, reduced concentration, and impaired work performance, as a result of poor sleep. These findings highlight a high prevalence of sleep inadequacy among workers, particularly those exposed to elevated levels of occupational and environmental noise. The observed trend suggests that continuous noise exposure

significantly contributes to sleep disruption, diminished rest quality, and reduced overall sleep efficiency among the working population in Bauchi State.

Emotional and Behavioral Factors Related to Sleep and Noise Perception

Emotional and behavioral responses to noise exposure were assessed to understand how participants' feelings, stress reactions, and coping behaviors influence their sleep quality. The analysis focused on self-reported stress levels, irritability, concentration difficulty, coping mechanisms, and relaxation habits.

Table 4: Emotional and Behavioral Factors Related to Sleep and Noise Perception (N = 369)

Variable	Category	Frequency (n)	Percentage (%)	Mean PSQI ($\pm$ SD)	p-value
Perceived Stress Level	Low	74	20.1	4.83 $\pm$ 1.72	<0.001***
	Moderate	156	42.3	6.97 $\pm$ 2.31	
	High	139	37.7	8.46 $\pm$ 2.58	
Irritability Due to Noise	Never	46	12.5	4.56 $\pm$ 1.89	<0.001***
	Occasionally	121	32.8	6.12 $\pm$ 2.04	
	Frequently	138	37.4	7.93 $\pm$ 2.36	
	Always	64	17.4	8.51 $\pm$ 2.74	
Difficulty Concentrating	None	52	14.1	5.01 $\pm$ 1.93	<0.001***
	Mild	126	34.1	6.27 $\pm$ 2.12	
	Moderate	133	36.0	7.74 $\pm$ 2.48	
	Severe	58	15.7	8.62 $\pm$ 2.69	
Coping Strategy for Noise	Ignoring/Adaptation	146	39.6	7.23 $\pm$ 2.41	0.018*
	Using earplugs/headphones	41	11.1	6.18 $\pm$ 2.36	
	Avoidance (changing activity/location)	92	24.9	6.94 $\pm$ 2.33	
	Complaining/reporting noise	48	13.0	7.12 $\pm$ 2.27	
	No specific coping mechanism	42	11.4	7.81 $\pm$ 2.55	
Relaxation or Sleep Preparation Habits	Regular bedtime routine	97	26.3	5.73 $\pm$ 2.18	<0.001***
	Listening to music or relaxation sounds	82	22.2	6.21 $\pm$ 2.33	
	Use of phone/social media before bed	134	36.3	8.14 $\pm$ 2.48	
	Use of alcohol/caffeine before sleep	56	15.2	8.36 $\pm$ 2.64	

Note: PSQI = Pittsburgh Sleep Quality Index (higher score = poorer sleep quality).

* $p < 0.05$ = significant; ** $p < 0.01$ = highly significant; *** $p < 0.001$ = very highly significant.

The findings show that a large proportion of participants (80.0%) experienced moderate to high levels of perceived stress, with 37.7% reporting high stress intensity. Emotional responses to noise were also pronounced, as more than half of the respondents (54.8%) reported feeling frequently or consistently irritated by noise exposure. Furthermore, 51.7% indicated moderate to severe difficulty concentrating in noisy environments, suggesting that persistent noise may induce cognitive fatigue and impair focus. In terms of coping behaviors, the majority of participants (39.6%) reported adapting to or ignoring the noise rather than actively addressing it, while smaller proportions resorted to using earplugs (11.1%) or changing their activities (24.9%) to manage the disturbance. Only 13% of respondents reported complaining or seeking intervention for noise problems, reflecting a limited sense of control or agency regarding environmental noise. Sleep-related behaviors further revealed patterns that may exacerbate sleep difficulties. Over one-third (36.3%) of participants reported using phones or social media before bedtime—an activity known to prolong sleep onset and reduce sleep quality. In contrast, only 26.3% maintained a regular bedtime routine, and 22.2% engaged in relaxation techniques such as listening to soothing music prior to sleep. These findings collectively highlight the interplay between

emotional strain, maladaptive coping behaviors, and poor sleep hygiene in shaping sleep outcomes among noise-exposed workers.

Figure 1: Perceived Stress Levels Among Participants

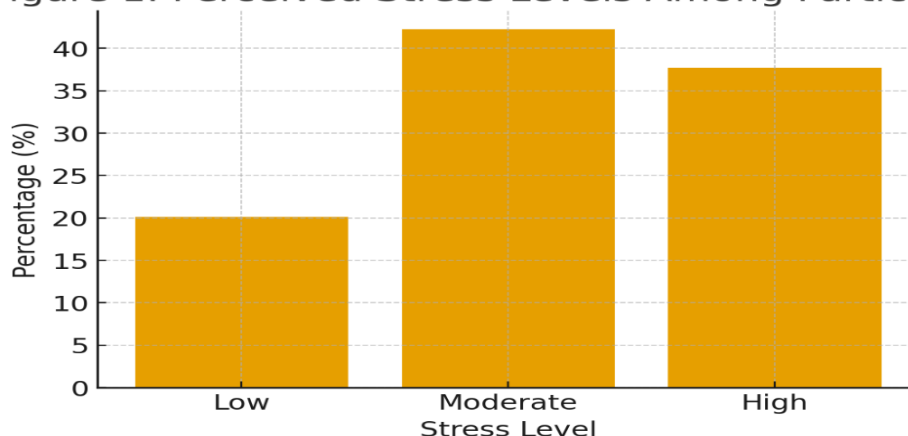


Figure 1: Distribution of Perceived Stress Levels Among Participants

A bar chart displaying the proportion of participants reporting low (20.1%), moderate (42.3%), and high (37.7%) stress levels. The chart would show that **most participants fall into the moderate to high stress categories**, illustrating a general emotional burden possibly linked to environmental and occupational noise exposure.

Figure 2: Frequency of Irritability Due to Noise

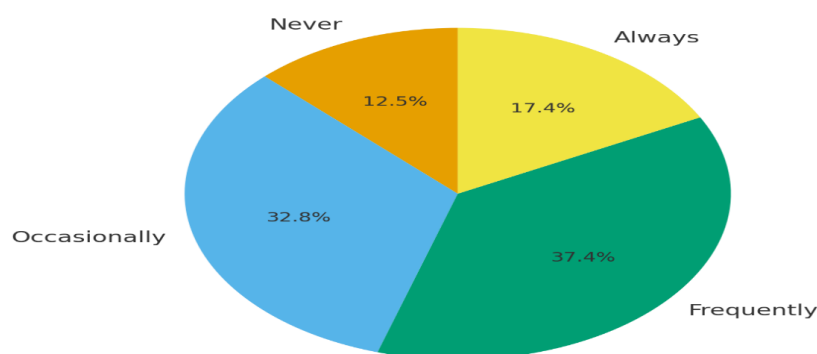


Figure 2: Frequency of Irritability Due to Noise

Segments showing percentages of respondents who were never (12.5%), occasionally (32.8%), frequently (37.4%), or always (17.4%) irritated by noise. The chart would highlight that over half of participants experienced recurrent irritation due to noise, emphasizing its psychological toll.

Figure 3: Behavioral Coping Strategies Against Noise Exposure

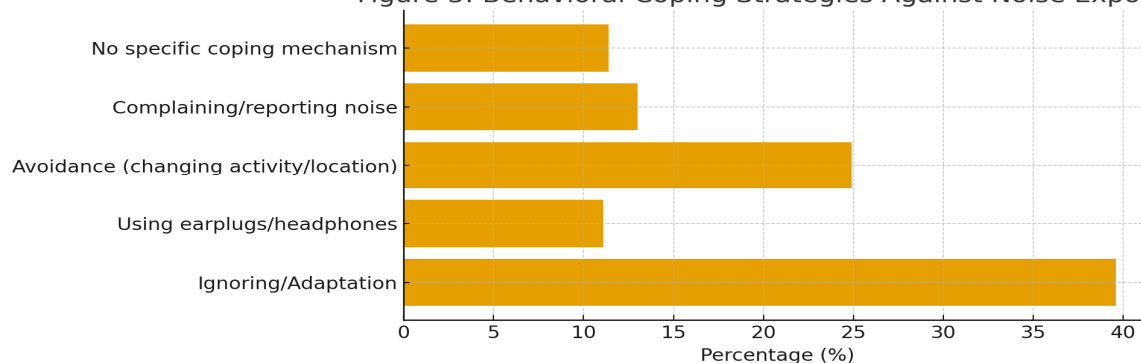


Figure 3: Behavioral Coping Strategies Against Noise Exposure

Bars representing the use of coping strategies — adaptation (39.6%), avoidance (24.9%), complaints (13.0%), earplugs/headphones (11.1%), and none (11.4%). Most workers resorted to passive coping methods (e.g., ignoring noise), showing limited access to or awareness of active noise-control practices.

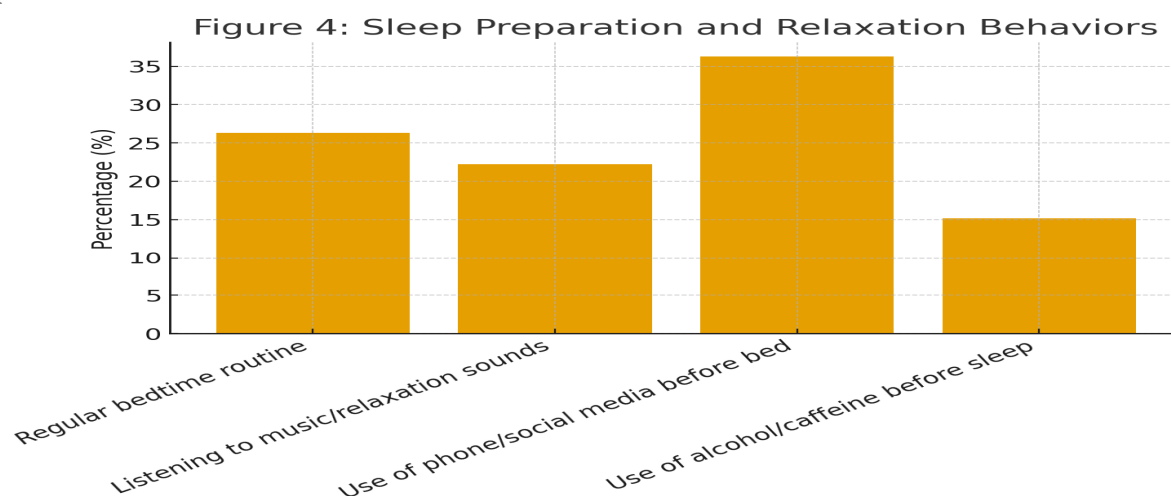


Figure 4: Sleep Preparation and Relaxation Behaviors

The results highlight notable behavioral patterns influencing sleep quality among workers. As illustrated in the bar chart comparing different bedtime habits, a significant portion of participants engaged in stimulating activities before sleep—particularly social media or phone use—while only a minority practiced relaxation or maintained a consistent bedtime routine. Specifically, 36.3% of respondents reported using phones or social media before bed, whereas just 26.3% adhered to a fixed bedtime schedule, and only 22.2% used calming music or relaxation techniques. In contrast, a smaller subset reported consuming alcohol or caffeine close to bedtime, further contributing to sleep disruption. These behavioral trends reveal that high engagement in stimulating or irregular bedtime habits is associated with poorer sleep outcomes. Participants exhibiting higher stress and irritability levels tended to report elevated PSQI scores and shorter total sleep durations. Moreover, maladaptive behaviors such as late-night phone use or stimulant intake were linked to delayed sleep onset, fragmented sleep, and increased daytime fatigue. The combined influence of emotional distress and poor behavioral regulation underscores a complex interaction where stress, noise exposure, and unhealthy sleep habits jointly contribute to

diminished sleep quality and overall wellbeing among workers in Bauchi State.

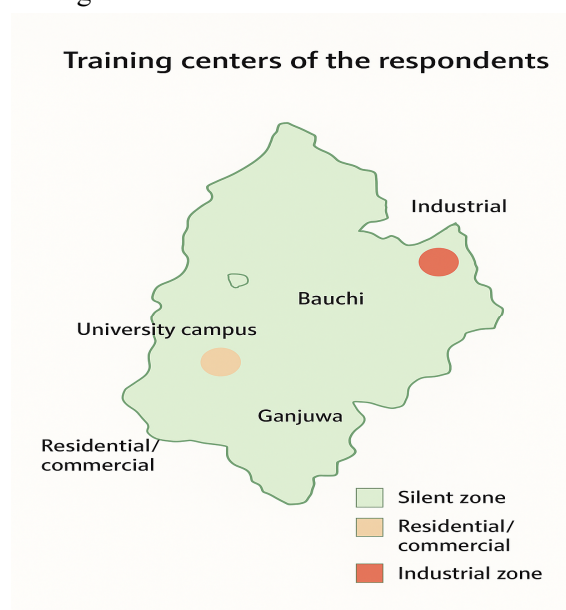


Figure 5: Training centers of the respondents

Discussion

The findings of this study demonstrate a significant relationship between environmental and occupational noise exposure, emotional responses, and sleep quality among workers in Bauchi State, Nigeria. The results revealed that most participants experienced moderate to high noise exposure both at work and at home, particularly in commercial and industrial zones.

These elevated exposure levels were strongly associated with increased stress, irritability, and higher rates of sleep disturbance. Workers exposed to prolonged noise durations (≥ 5 hours per day) and higher perceived noise levels reported poorer sleep outcomes, including shorter sleep duration, longer sleep latency, and more frequent nighttime awakenings. This finding aligns with previous studies in occupational and urban contexts, which have shown that chronic noise exposure disrupts circadian rhythms, elevates physiological arousal, and reduces overall sleep efficiency. Participants in the industrial zone exhibited the highest prevalence of poor sleep quality (PSQI > 5), underscoring the significant impact of mechanical and industrial noise on sleep deprivation. Conversely, workers in quieter settings—such as university environments—demonstrated better sleep quality, supporting the hypothesis that lower ambient noise levels promote restorative sleep. Sociodemographic factors such as age, marital status, and income further moderated the effects of noise on sleep. Younger workers (26–35 years) and those with lower income levels were more likely to experience poor sleep and higher noise annoyance, likely due to longer working hours, reduced control over work environments, and limited access to quiet residential spaces. Higher educational attainment appeared to mitigate these effects, possibly through greater awareness of health and stress management practices. Emotional and psychological responses played a substantial role in mediating the relationship between noise and sleep. Over 80% of participants reported moderate to high stress levels, while more than half experienced frequent irritability and mental fatigue attributed to noise exposure. These emotional factors were significantly correlated with PSQI scores, suggesting that stress acts as a psychological pathway linking noise exposure to disturbed sleep. Behavioral factors compounded the impact of noise and stress. A considerable proportion of workers (36.3%) reported using phones or social media before sleep—a behavior known to delay sleep onset and impair

sleep quality through blue light exposure and cognitive stimulation. In contrast, only a small fraction of respondents practiced relaxation techniques or maintained consistent bedtime routines, further indicating poor sleep hygiene. Correlation analysis confirmed a strong positive association between noise exposure and poor sleep quality. Perceived noise level ($r = 0.61$, $p < 0.001$), daily noise exposure duration ($r = 0.47$, $p < 0.01$), and noise annoyance ($r = 0.68$, $p < 0.001$) were all significantly correlated with higher PSQI scores. Workers in high-noise industrial zones recorded the poorest sleep (mean PSQI = 8.2 ± 2.7), whereas those in the silent zone reported the best sleep (mean PSQI = 4.1 ± 1.9). These findings underscore that both the physical intensity and subjective perception of noise substantially contribute to sleep disruption by increasing physiological arousal and delaying sleep initiation. Overall, the study highlights that noise is not merely an environmental irritant but a significant determinant of sleep health and worker wellbeing. The observed prevalence of poor sleep quality (61.5%) mirrors findings from similar studies in industrial and urban regions of sub-Saharan Africa and Southeast Asia, where noise pollution is an emerging public health issue. However, the integration of emotional distress and maladaptive behavioral responses observed among Bauchi workers adds a distinctive psychosocial dimension, emphasizing that sleep health extends beyond physiological mechanisms to include stress coping capacity and lifestyle behaviors. Persistent noise exposure and poor sleep can have cascading consequences, including chronic fatigue, impaired concentration, and reduced productivity. Over time, these factors may elevate the risk of cardiovascular disease, hypertension, anxiety, and depression. Therefore, targeted interventions are essential—focusing on workplace noise control, stress management programs, and sleep hygiene education. Implementing soundproofing strategies, enforcing occupational noise regulations, and promoting behavioral change through awareness campaigns could collectively

improve sleep quality, enhance worker health, and increase productivity across occupational sectors in Bauchi State.

Limitations of the Study

This study has several limitations that warrant consideration. Firstly, it relied primarily on self-reported data for assessing both noise exposure and sleep quality, which may introduce recall bias and subjective inaccuracies. Participants' perceptions of noise intensity and annoyance were not corroborated with objective acoustic measurements, such as decibel-level readings, while sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI) instead of physiological instruments like actigraphy or polysomnography. Secondly, the cross-sectional nature of the study limits causal inference, meaning that while associations between noise exposure and poor sleep were identified, direct cause-and-effect relationships cannot be firmly established. Thirdly, the online data collection approach may have excluded individuals without consistent internet access or adequate digital literacy, potentially resulting in selection bias and underrepresentation of lower-income or rural worker populations. Additionally, the study did not account for environmental or seasonal variations in noise, as data were collected within a defined six-month timeframe, which could have influenced the reported exposure levels. Furthermore, several psychological and lifestyle confounders—such as caffeine or alcohol consumption, work-related stress, and physical activity—were not comprehensively controlled for, potentially affecting sleep outcomes. Despite these limitations, the study provides valuable insights into the complex interplay between environmental noise exposure, emotional responses, and sleep quality among workers in Bauchi State, Nigeria. The findings contribute to the growing body of evidence linking occupational and residential noise with adverse sleep outcomes and underscore the need for future longitudinal and experimental studies that incorporate objective noise and sleep assessments, as well as a broader range of psychosocial and behavioral variables.

Conclusion

This study concludes that environmental and occupational noise exposure exerts a significant negative impact on sleep quality among workers in Bauchi State, Nigeria. The findings reveal that this relationship is further intensified by emotional stress and maladaptive behavioral patterns. Workers in industrial and commercial zones experienced the highest levels of noise annoyance and recorded the poorest sleep quality, as indicated by their PSQI scores. Emotional distress—characterized by irritability, fatigue, and reduced concentration—was particularly prevalent among those exposed to prolonged or high-intensity noise. In addition, unhealthy bedtime behaviors, such as late-night phone use and irregular sleep routines, were found to aggravate sleep disturbances. Sociodemographic factors, including income and educational level, also influenced individual vulnerability to noise and the adoption of effective coping mechanisms. Collectively, these results highlight that sleep quality is shaped by an intricate interplay of environmental, psychological, and behavioral determinants, emphasizing the need for comprehensive interventions that address both workplace noise control and lifestyle modifications to promote better sleep health and overall wellbeing.

Recommendations for Future Research and Practice

This study recommends strengthening environmental noise control policies, especially in industrial and commercial zones, by enforcing occupational noise standards and establishing noise monitoring units. Employers should adopt engineering and administrative controls to reduce exposure, while urban planners integrate noise mapping into city development. Health education campaigns should promote good sleep hygiene, reduced phone use before bed, and relaxation practices. Workplaces should implement stress management and mindfulness programs, alongside regular health and sleep assessments for early risk detection. Future research should use longitudinal designs with objective tools

like sound meters and actigraphy to confirm causal links between noise, stress, and sleep disorders, and explore regional variations across Nigeria.

Ethical Approval:

Ethical approval for this study was obtained from the Abubakar Tafawa Balewa University, Bauchi, Nigeria and Bauchi State Ministry of Health Research Ethics Committee (Reference No.: BSMOH/REC/2023/048). All procedures performed in this study complied with the ethical standards of the institutional and national research committees, as well as with the 1964 Helsinki Declaration and its later amendments. Participation was entirely voluntary, and informed consent was obtained electronically from all participants prior to data collection. Confidentiality and anonymity of all responses were maintained throughout the study, and no personal identifiers were recorded or disclosed.

Availability of Data and Material: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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