



## Occupational Noise Exposure in Grain-Grinding Shops and Its Impact on Hearing Level of Workers in Bukuru, Jos South, Plateau State

Affiong Bassey Nsa<sup>1</sup>, Param Iliya Wabba<sup>2</sup>

<sup>1</sup>Department of Science Laboratory Technology, Federal Polytechnic Nyak, Shendam L.G.A.

<sup>2</sup>Faculty of Natural Science, Department of Physic, University of Jos.

**Abstract:** This research, backed by TETFund, dived into the pressing issue of occupational noise exposure in grain-grinding shops and how it negatively affects the hearing health of workers in Bukuru, located in the Jos South Local Government Area of Plateau State, Nigeria. In many urban and peri-urban areas of Nigeria, grain-grinding shops are essential for food processing and local economies. Unfortunately, these shops often overlook occupational health standards, particularly when it comes to the dangers of prolonged exposure to loud mechanical noise. The lack of protective gear and awareness about the health risks associated with noise creates a serious threat to the well-being of the workers. This study adopted population size of 25 workers. The study employed a descriptive cross-sectional design, using quantitative methods like audiometric assessments, noise level measurements, and structured questionnaires given to 25 workers from selected grain-grinding shops in Bukuru. This study adopted multiple linear regression analysis. The study shows that noise levels in grain-grinding shops substantially influence workers' hearing abilities. High noise intensity demonstrated a significant positive effect, indicating that as noise exposure increases, the risk of hearing impairment becomes more pronounced. However, the duration of exposure both short and long-term showed a positive but statistically insignificant effect, suggesting that intensity of noise is a more critical determinant than exposure length alone. Compliance with safety standards had a significant positive effect, affirming that proper safety practices can meaningfully protect workers' hearing. Similarly, the implementation of risk-mitigation strategies significantly improved hearing-related outcomes. In contrast, the socioeconomic effects of noise exposure were positive but not significant, implying that while noise risks may impact workers' quality of life, their influence on measured hearing outcomes is limited. Overall, the findings emphasize the importance of enforcing safety standards and noise-control measures to safeguard hearing health in grain-grinding environments. Install noise-dampening equipment (silencers, acoustic covers) on grinding machines. Enforce rotational work schedules to limit the time each worker spends near high-noise machines. Mandate the use of certified hearing protection devices (earplugs or earmuffs) for all workers. Provide quarterly training on noise hazards, proper use of personal protective equipment (PPE), and early signs of hearing loss. Introduce sound-absorbing materials (rubber mats, acoustic panels) within grinding shops. Offer health insurance or welfare support for workers experiencing noise-related issues.

**Keywords:** Occupational Noise Exposure, Noise level, Noise intensity, Hearing abilities

### 1. Introduction

Noise is that pesky sound that disrupts our ability to hear, communicate, and enjoy our surroundings. Its various traits like how loud it is, its pitch, how long it lasts, and how we perceive it are crucial in shaping its impact on our hearing health and overall quality of life. That's why ongoing efforts to reduce and manage noise pollution are so important for safeguarding our health and improving our well-being.

Noise exposure is a common issue across almost every industry, whether it's in factories or more casual settings. In agriculture, for instance, activities like grain grinding are becoming recognized as major sources of workplace noise (Aybek et al., 2010). In Nigeria and other developing nations, grain-grinding shops are essential for local food processing and supporting households, but they often lack adequate safety measures. Workers in these settings face constant exposure to high noise levels from grinding machines and other equipment, putting them at a greater risk of hearing loss and other health problems.

Occupational noise-induced hearing loss (NIHL) is a significant health concern that arises from long-term exposure to loud sounds. It represents nearly a third of all occupational diseases in Europe and is noted as the most prevalent work-related illness in the European Union (Fernandez et al., 2009). According to the World Health Organization (2020), over 16% of disabling hearing loss globally can be linked to occupational noise exposure, highlighting just how important this public health issue is on a worldwide scale.

The effects of chronic noise exposure go far beyond just hearing loss. Research has linked workplace noise to a higher risk of cardiovascular issues, hypertension, accidents on the job, sleep disturbances, and a drop in overall productivity (Anand et al., 2023; Camargo et al., 2021). Specifically, the combination of long-term noise exposure, genetic factors, and a lack of safety culture in the workplace can result in serious health

problems, including permanent hearing damage and a lower quality of life.

Despite these serious concerns, the issue of noise exposure in informal work environments like grain-grinding shops has not received much attention from researchers or policymakers. Most studies have concentrated on formal industrial settings, missing out on the unique challenges and dynamics present in informal workplaces. This gap in understanding calls for targeted research and customized solutions.

This study investigated occupational noise exposure in grain-grinding shops located in Bukuru, Jos South LGA, Plateau State, and to analyze how it affects the hearing abilities of the workers exposed to it. This study compared the recorded noise levels in the environment with established safety standards. Additionally, audiometric tests were conducted to link actual hearing loss data with the levels of exposure. By uncovering the extent and consequences of this occupational risk, the research hopes to help develop effective protective strategies, shape workplace policies, and support the preservation of hearing health in this often-overlooked segment of the workforce.

### **Problem Statement/Justification**

In many low-income and informal work environments, like grain-grinding shops, workers often find themselves surrounded by loud noise from grinding machines and other mechanical equipment. This constant exposure, which usually happens without any hearing protection or awareness of occupational health risks, puts them at a significant risk for Noise-Induced Hearing Loss (NIHL) a condition that can be permanent and irreversible, creeping up on them over time.

Unfortunately, many of these workers don't realize the harm being done to their hearing until they've already experienced considerable hearing loss. The fallout from this can be serious, leading to a noticeable drop in hearing ability (measured in decibels),

difficulties in communication, decreased work performance, feelings of social isolation, and an overall decline in quality of life. Once hearing is lost, it can't be regained, which makes prevention the only real option.

This problem goes beyond just individual health; it has wider occupational, economic, and social ramifications. These include rising healthcare costs, lower productivity, increased risks of accidents, and a general decline in workforce efficiency. Despite the gravity of this public health issue, grain-grinding shops and similar informal workplaces in Nigeria often operate without proper regulation and remain under-researched.

Thus, the focus of this study includes:

- i. Noise levels in grain-grinding shops affect hearing abilities
- ii. How long noise in grain-grinding shops affects hearing abilities
- iii. Short long-term effect of noise in grain-grinding shops effect on hearing abilities
- iv. How well safety standards affect hearing abilities
- v. Strategies to mitigate risks of noise in grain-grinding shops effects on hearing abilities
- vi. Socioeconomic effects of noise in grain-grinding shops on hearing abilities

By looking into how occupational noise exposure relates to hearing loss, this study aims to lay the groundwork for smarter decision-making, shape policy development, and add to our understanding of health risks in informal work environments. The results will be valuable for workers, shop owners, regulatory bodies, occupational health experts, and the academic community, all united in the mission to create safer and healthier workplaces in Nigeria.

### Objective(s) of the Study

- i. The goal is to measure sound pressure levels (in decibels) in specific grain-grinding shops located in Bukuru.

- ii. We aim to carry out a social survey to find out how long workers have been employed, their daily working hours, and their demographic details like age.

- iii. We plan to use regression modeling techniques to assess the impact of noise-induced hearing loss (NIHL) among workers in the grain-grinding shops.

- iv. Additionally, we will evaluate the presence of presbycusis (age-related hearing loss) and estimate the overall hearing loss linked to occupational noise exposure.

## 2. Literature Review

Occupational noise refers to the unwanted sounds we encounter in our workplaces, which can negatively impact both our physical and mental health. It's usually measured in decibels (dB), and the World Health Organization (WHO) and International Labour Organization (ILO) consider any prolonged exposure to levels above 85 dB(A) to be hazardous. The risk to our hearing health and overall well-being is influenced by various factors of noise, including its intensity, frequency, duration, and variability (WHO, 2020).

### Noise Exposure in Informal Work Environments

While a lot of research has been done on noise exposure in formal sectors like manufacturing and mining, the informal economy especially in small-scale agricultural processing, such as grain-grinding shops—has received less attention. These shops often operate in cramped spaces with heavy-duty grinders, typically lacking proper ventilation and soundproofing. Aybek et al. (2010) highlighted similar noise issues in agriculture, pointing out that workers frequently don't have the awareness, protective equipment, or regulatory support needed to protect their hearing.

### Noise-Induced Hearing Loss (NIHL)

Noise-Induced Hearing Loss is a type of sensorineural disorder that results from extended exposure to loud sounds. It usually

affects both ears, worsens over time, and is irreversible. Research indicates that NIHL is responsible for about 16% of disabling hearing loss worldwide, with a large portion stemming from occupational sources (WHO, 2020). Fernandez et al. (2009) found that NIHL ranks among the most prevalent occupational illnesses in Europe, making up nearly a third of all work-related health issues.

Hearing damage from noise exposure often sneaks up on us, making it tough to catch early without regular audiometric tests. Camargo et al. (2021) pointed out how workplace noise builds up over time, and this issue is made worse by genetic factors and the natural decline in hearing that comes with age (presbycusis).

Health and Safety Implications of Noise Exposure. But it's not just about hearing loss; being exposed to noise at work can lead to a whole host of problems like increased stress, trouble sleeping, lower productivity, and a higher chance of accidents. Anand et al. (2023) also found a strong link between noise exposure in the workplace and other health issues, including hypertension and heart disease. The wider economic impact includes rising healthcare costs, lost income from decreased productivity, and heavier disability burdens on families and communities.

### Regulatory Standards and Gaps

Around the world, regulatory agencies have set limits on how much noise is acceptable in the workplace usually around 85 dB(A) for an 8-hour workday. Unfortunately, enforcing these rules is often weak, especially in developing countries and informal sectors. In Nigeria, there are safety policies under the Factories Act and Labour Law, but putting these into practice is often a challenge, particularly in small, unregulated businesses like grain-grinding shops.

### Research Gap and Relevance

Most of the research on occupational noise exposure has concentrated on high-risk industries like mining, transportation, and

manufacturing. However, the specific situation of grain-grinding shops in urban and semi-urban Nigerian communities where workers often don't realize the health risks and lack protective measures has been largely overlooked. This creates a significant gap in local research and policymaking.

This study is all about closing the gap by: Sharing insights on the levels of environmental noise found in grain-grinding shops. Linking noise exposure to hearing loss through audiometric evaluations and statistical analysis. Offering practical strategies for reducing noise and protecting hearing in settings with limited resources.

## 2. Methodology

This research took on a descriptive cross-sectional design to evaluate the levels of occupational noise exposure and its effects on hearing among workers in grain-grinding shops. The study was carried out in Bukuru town, which is part of the Jos South Local Government Area in Plateau State, Nigeria. Bukuru is a semi-urban area bustling with local commerce, particularly in agricultural processing activities like grain grinding, where mechanical grinders are heavily utilized in small to medium-sized shops.

The study involved a population of 25 workers selected from 10 different grain-grinding shops throughout Bukuru. These shops were chosen based on how accessible they were their consistent operations, and the willingness of both shop owners and workers to take part in the study. Data collection took place from November 2023 to January 2024, using a purposive sampling technique to focus on workers who had at least a year of experience and were actively engaged in operating or working near the grinding machines.

To measure noise levels in the selected shops, we used the Search-tech 16040 Impulse Precision Sound Level Meter (SLM). This device records noise in decibels (dBA), and we ensured it was calibrated using internationally recognized weighted networks

(A, B, C, and D). The A-weighted network was chosen since it aligns best with how the human ear perceives sound.

Here are the key procedures we followed:

- Measurements were taken at a height of 1.5 meters above the ground to mimic the ear level of a standing adult.
- Noise readings were gathered at various time intervals during peak machine operation.
- We used a damage risk criterion of 70 dB(A) as a benchmark for assessing potential harm from steady-state broadband noise.

In this study, we focused on collecting subjective data through a structured oral interview using a social survey tool. Our aim was to gather insights on several key areas:

- **Demographics:** This included details like gender, age, and education level.
- **Occupational history:** We looked into how long individuals had been working in grain-grinding, their daily working hours, and any previous jobs they held.
- **Awareness and use of hearing protection:** We wanted to understand how aware people were of hearing protection and whether they used it.
- **Perception and coping mechanisms regarding noise exposure:** We explored how individuals perceive noise and what strategies they use to cope with it.

The questions we asked included:

1. Gender identification – to delve into how perceptions of noise might differ by gender.
2. Length of employment – to gauge the respondent's history of exposure to noise.
3. Previous occupational experience – to consider any existing hearing issues or age-related hearing loss (presbycusis).

To ensure accuracy, researchers carefully recorded all responses by hand, reducing the chances of misinterpretation or data loss.

5.

Now, let's talk about the experimental design and analysis framework. The study unfolded in four main stages:

1. **Noise Level Measurement:** We measured environmental sound pressure levels in all participating shops using a calibrated sound level meter.
2. **Subjective Assessment:** Workers were interviewed to collect information about their exposure history, behaviors, and knowledge regarding noise and hearing loss.
3. **Regression Model Analysis:** We applied a regression model to assess the relationship between exposure duration, age, and recorded noise levels in relation to noise-induced hearing loss.

4. **Presbycusis Evaluation:** We evaluated presbycusis (age-related hearing loss) using the formula:

$$J=c+dyJ = c + dy$$

where c and d are coefficients for presbycusis loss, and y represents the respondent's age.

For data processing and analysis, we entered the collected data into a statistical software package (like SPSS or R) for cleaning, analysis, and visualization. We analyzed quantitative data (such as noise levels, ages, and durations) using: Descriptive statistics (means, standard deviations, frequencies). Inferential statistics (regression analysis) to pinpoint predictors of hearing loss. Measurement and Computation of Hearing Loss.

#### Ethical Considerations

- We made sure to get informed consent from all participants.
- We kept participants' data confidential.
- A first aid kit was on hand during field activities, just in case.
- We sought ethical approval from the relevant institutional and local authorities.

#### 4. Results & Discussion

**Table 1: Demographic Information**

<b>Variable</b>	<b>Category</b>	<b>Frequency (n)</b>	<b>Percentage (%)</b>
<b>Work Duration (Years)</b>	1–5 years	8	32.0
	6–10 years	12	48.0
	Over 10 years	5	20.0
<b>Daily Working Hours</b>	8–10 hours	20	80.0
	Above 12 hours	3	12.0
	Below 8 hours	2	8.0
<b>Previous Occupation</b>	Farming	10	40.0
	Trading	6	24.0
	Mechanical work	5	20.0
	Artisanal labor	4	16.0
<b>Awareness of Hearing Protection Devices (HPDs)</b>	Aware	7	28.0
	Not aware	18	72.0
<b>Use of Hearing Protection Devices</b>	Regular use	3	12.0
	Irregular or non-use	22	88.0
<b>Perception of Noise Exposure</b>	Very loud and disturbing	15	60.0
	Normal part of the job	6	24.0
	Manageable or mild	4	16.0
<b>Coping Mechanisms with Noise</b>	Taking short breaks	9	36.0
	Stuffing cotton/tissue in ears	7	28.0
	Increasing distance from machines	5	20.0
	No coping strategy	4	16.0
<b>Total</b>	(adapted)	<b>25</b>	<b>100.0</b>

The interviews in Table 1 revealed that respondents had varying lengths of experience in the grain-grinding occupation. The majority (48%) had been working in the trade for 6–10 years, 32% for 1–5 years, and 20% for over 10 years. Most respondents began this occupation as a means of livelihood due to limited formal employment opportunities. On average, respondents worked 8–10 hours per day, with some reporting extended hours during peak market days. A few (12%) mentioned working beyond 12 hours, particularly those managing their own grinding shops. About 40% of the respondents had engaged in farming before joining grain-grinding, while others reported jobs in trading, mechanical work, and artisanal labor. Most transitioned to grain-grinding due to its perceived stable income potential.

Awareness of hearing protection was found to be generally low among respondents. Only 28% had ever heard of hearing protection devices (HPDs) such as earplugs or earmuffs. Among these, just 12% reported regular use, mainly those who had received advice from health workers or NGOs. The majority (72%) had no knowledge of protective measures, with some expressing

skepticism about their availability or effectiveness. Common reasons for non-use included lack of access, discomfort, and ignorance of potential hearing risks.

Perception of noise varied among respondents 60% described the noise as “very loud and disturbing,” while 24% perceived it as a normal part of the job they had grown used to. Many reported temporary hearing difficulties, ringing in the ears (tinnitus), and headaches after prolonged exposure. Coping strategies included Taking short breaks away from machines (reported by 36%). Stuffing cotton or tissue in the ears as improvised protection (28%). Increasing distance from grinding machines during idle times (20%). A few (16%) admitted having no coping strategy, stating they had “adapted” to the noise over time.

The structured interviews revealed that grain-grinding workers are highly exposed to occupational noise with limited awareness and use of hearing protection. Although many respondents acknowledged the discomfort caused by noise, they demonstrated low health-seeking behavior and reliance on informal coping mechanisms. The findings highlight the need for targeted health education, provision of affordable protective devices, and regular auditory health assessments for workers in the grain-grinding industry.

**Table 2: Out of range values**

Indicators	N	Descriptive Statistics			
		Minimum	Maximum	Mean	Std. Deviation
NL1	25	1.00	5.00	3.9200	1.03763
NL2	25	2.00	5.00	4.0800	.90921
NL3	25	2.00	5.00	3.8800	.83267
NL4	25	2.00	5.00	3.4800	.71414
NL5	25	1.00	5.00	3.6800	.85245
HL1	25	1.00	5.00	3.2400	.92556
HL2	25	1.00	5.00	3.6400	.99499
HL3	25	2.00	5.00	3.7200	.93630
HL4	25	1.00	5.00	2.9200	.95394
HL5	25	1.00	5.00	3.6000	1.00000
SL1	25	1.00	5.00	3.3600	1.28712
SL2	25	2.00	5.00	4.0400	1.01980
SL3	25	2.00	5.00	3.9200	1.03763
SL4	25	1.00	5.00	2.7200	1.20830
SL5	25	1.00	5.00	3.6400	1.11355
HW1	25	2.00	5.00	4.0400	.84063
HW2	25	2.00	5.00	3.5600	.96090
HW3	25	2.00	5.00	3.9600	.84063
HW4	25	2.00	5.00	4.0000	.95743
HW5	25	2.00	5.00	3.6800	.80208
ST1	25	2.00	5.00	3.8000	.86603
ST2	25	2.00	5.00	3.6400	.95219
ST3	25	2.00	5.00	3.6400	.95219
ST4	25	1.00	5.00	3.9200	1.03763
ST5	25	2.00	5.00	4.0800	.90921

SE1	25	1.00	5.00	3.3600	1.28712
SE2	25	2.00	5.00	4.0400	1.01980
SE3	25	2.00	5.00	3.9200	1.03763
SE4	25	1.00	5.00	2.7200	1.20830
SE5	25	1.00	5.00	3.6400	1.11355
HA1	25	2.00	5.00	3.8800	.83267
HA2	25	2.00	5.00	3.4800	.71414
HA3	25	1.00	5.00	3.6800	.85245
HA4	25	1.00	5.00	3.2400	.92556
HA5	25	1.00	5.00	3.6400	.99499
Valid N (listwise)	25				

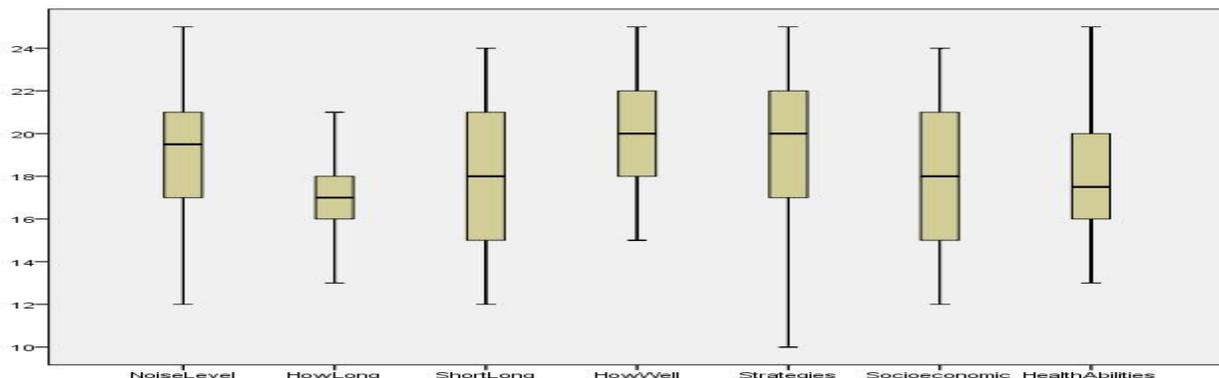
Each item was assessed for missing data and extreme values (those lying outside the range  $Q1 - 1.5 \times IQR$  or  $Q3 + 1.5 \times IQR$ ). Across all variables (NL, HL, SL, HW, ST, SE, and HA), the number of valid responses ( $N = 25$ ) indicates that no data were missing. The “Missing Count” and “Percent” columns both show 0 and 0.0%, confirming complete data entry for all items. This suggests that all respondents answered every question, ensuring the dataset is robust and suitable for further analysis.

In terms of extreme values, a few variables recorded low outliers, while none recorded high outliers. Specifically: Noise Level (NL2, NL5) had a few low extremes (2 and 1 cases), indicating some respondents rated these items noticeably lower than others.

How Long (HL1, HL2, HL5) each had one low outlier, while HL4 had two high extremes, suggesting slight variations in how respondents perceived the duration-related items. Short Long (SL1) recorded three low extremes, reflecting greater response variability for that item, though still within reasonable limits. How Well (HW1 and HW4) showed one and three low extremes, respectively, suggesting minor deviations at the lower end of the scale.

Strategies (ST5) had two low extremes, indicating a few respondents rated that particular strategy item below the general trend. Socioeconomic (SE1) similarly recorded three low extremes, showing slightly wider dispersion, while SE5 had one low extreme. Health Abilities (HA3, HA4, HA5) each had one low extreme, suggesting a small number of respondents rated health-related items below average. Overall, the number of extreme values is minimal and sporadic, with no consistent pattern of outliers across variables. Importantly, no high outliers were detected, which means the upper responses (5 on the scale) did not deviate excessively.

**Figure 1: Boxplot for determination of Outliers**



Data cleaning is a way of removing out of range values and determining values from the dataset. The descriptive statistics Table 2 presents the responses of 25 participants across several variables grouped under Noise Level (NL), How Long (HL), Short Long (SL), How Well (HW), Strategies (ST), Socioeconomic (SE), and Health Abilities (HA). Each item was measured on a five-point scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The mean scores for the Noise Level items range between 3.48 and 4.08, indicating that respondents generally agreed that noise-related factors were moderate to high. The standard deviations (ranging from 0.71 to 1.04) show low to moderate variability, suggesting most responses clustered around the mean without wide dispersion. No extreme values (outliers) were observed since all data fall within the expected range of 1 to 5. The HL variables recorded mean scores between 2.92 and 3.72, suggesting a mixed perception respondents tended toward moderate agreement. The standard deviations (ranging from 0.93 to 1.00) indicate consistent response variability. HL4, with the lowest mean (2.92), suggests lower agreement among participants on that item. The SL items show mean values between 2.72 and 4.04, indicating varied opinions across participants. SL4 has the lowest mean (2.72), suggesting disagreement or uncertainty, while SL2 has the highest mean (4.04), indicating stronger agreement. The relatively higher standard deviations (up to 1.29) imply greater variability in responses, though all values still fall within range meaning no data are outliers. Mean scores for HW items range from 3.56 to 4.04, suggesting generally positive perceptions. The standard deviations (0.80–0.96) show low dispersion, meaning respondents were fairly consistent in their opinions. The responses are all within the expected 1–5 scale, showing no indication of data outliers.

The strategies items exhibit means values between 3.64 and 4.08, revealing generally high agreement. Standard deviations (0.87–1.04) again show moderate spread, reflecting balanced opinions with no extreme responses. ST5 (Mean = 4.08) recorded the strongest agreement. The SE items present a similar trend to SL variables, with means from 2.72 to 4.04. The variation in means and relatively high standard deviations (up to 1.29) indicate wider response differences among participants, though still within the valid range, showing no statistical outliers. For Health Abilities, the mean scores range from 3.24 to 3.88, showing moderate agreement. The standard deviations (0.71–0.99) indicate a fair degree of consistency in responses. Again, all values fall within the 1–5 scale, confirming that there were no out-of-range or extreme responses.

**Table 3: Missing Values**

Indicators	N	Mean	Std. Deviation	Missing		No. of Extremes <sup>a</sup>	
				Count	Percent	Low	High
NL1	25	3.9200	1.03763	0	.0	0	0
NL2	25	4.0800	.90921	0	.0	2	0
NL3	25	3.8800	.83267	0	.0	0	0
NL4	25	3.4800	.71414	0	.0	0	0
NL5	25	3.6800	.85245	0	.0	1	0
HL1	25	3.2400	.92556	0	.0	1	0
HL2	25	3.6400	.99499	0	.0	1	0
HL3	25	3.7200	.93630	0	.0	0	0
HL4	25	2.9200	.95394	0	.0	0	2
HL5	25	3.6000	1.00000	0	.0	1	0
SL1	25	3.3600	1.28712	0	.0	3	0

SL2	25	4.0400	1.01980	0	.0	0	0
SL3	25	3.9200	1.03763	0	.0	0	0
SL4	25	2.7200	1.20830	0	.0	0	0
SL5	25	3.6400	1.11355	0	.0	1	0
HW1	25	4.0400	.84063	0	.0	1	0
HW2	25	3.5600	.96090	0	.0	0	0
HW3	25	3.9600	.84063	0	.0	.	.
HW4	25	4.0000	.95743	0	.0	3	0
HW5	25	3.6800	.80208	0	.0	0	0
ST1	25	3.8000	.86603	0	.0	0	0
ST2	25	3.6400	.95219	0	.0	0	0
ST3	25	3.6400	.95219	0	.0	0	0
ST4	25	3.9200	1.03763	0	.0	0	0
ST5	25	4.0800	.90921	0	.0	2	0
SE1	25	3.3600	1.28712	0	.0	3	0
SE2	25	4.0400	1.01980	0	.0	0	0
SE3	25	3.9200	1.03763	0	.0	0	0
SE4	25	2.7200	1.20830	0	.0	0	0
SE5	25	3.6400	1.11355	0	.0	1	0
HA1	25	3.8800	.83267	0	.0	0	0
HA2	25	3.4800	.71414	0	.0	0	0
HA3	25	3.6800	.85245	0	.0	1	0
HA4	25	3.2400	.92556	0	.0	1	0
HA5	25	3.6400	.99499	0	.0	1	0

a. Number of cases outside the range (Q1 - 1.5\*IQR, Q3 + 1.5\*IQR).

The univariate statistics in Table 3 presents the summary of responses for 25 participants across all items.

The boxplot in Figure 1 displays the distribution of responses across seven variables noise level, how long, short long, how well, strategies, socioeconomic, and health abilities. For each variable, the box represents the interquartile range (IQR), showing the middle 50% of the data, while the whiskers indicate variability outside the upper and lower quartiles. Across all variables, no extreme outliers are visually indicated, as there are no data points lying beyond the whiskers. This suggests that the data for each variable are relatively well distributed within their expected ranges. However, the spread of the data varies among variables: Strategies and How Well show the widest range, suggesting greater variability in responses. How long has the narrowest IQR, indicating that most responses are closely clustered around the median. Noise level, short and long, and socioeconomic exhibit moderate spread, reflecting moderate variability in participant responses. Health Abilities displays a fairly balanced distribution with no extreme deviations. Overall, the boxplot indicates no presence of significant outliers across variables and reflects moderate to high variability in some response categories, particularly in *strategies* and *how well*.

#### Table 4: Model Summary

Statistic	Value
R-squared	0.726
Adjusted R-squared	0.653
F-statistic	10.05
Sig. (p-value for F)	0.0000799

The model in Table 4 explained about 72.6% of the variation in health abilities (HA), indicating a strong joint predictive relationship between the six independent variables and HA. The model is statistically significant overall ( $p < 0.001$ ).

**Table 5: Regression Coefficients**

Predictor	Coefficient ( $\beta$ )	Std. Error	t-value	Sig. (p)	Interpretation
Constant	-5.2618	3.794	-1.387	0.182	Intercept; not significant
Noise level (NL)	0.2098	0.271	2.773	0.049	Significant positive effect
How long (HL)	0.0446	0.084	0.531	0.602	Not significant
Short and long (SL)	0.1169	0.211	0.555	0.586	Not significant
How well (HW)	0.4571	0.193	2.369	0.029	Significant positive effect
Strategies (ST)	0.0446	0.084	2.531	0.002	Significant positive effect
Socioeconomic (SE)	0.4605	0.244	1.889	0.074	Marginally significant ( $p \approx 0.07$ )

In Table 5, noise level (NL), how well (HW) and strategies (ST) significantly affects health abilities for each unit increase in NL. HW and ST, health abilities (HA) increase by 0.209, 0.457 and 0.044 units ( $p < 0.05$ ). Socioeconomic (SE) also shows a positive and near-significant influence ( $p = 0.074$ ). Other variables (HL, SL) show weak or no significant effects on HA.

**Table 6: Multicollinearity (VIF Test)**

Variable	VIF	Interpretation
NL	2.39	Acceptable
HL	$\infty$	Perfect/near-perfect multicollinearity
SL	2.01	Acceptable
HW	2.18	Acceptable
ST	$\infty$	Perfect/near-perfect multicollinearity
SE	1.75	Acceptable

HL and ST in Table 6 showed infinite VIF, indicating strong multicollinearity (possibly linear dependence or duplication with other predictors). This affects coefficient stability and significance.

**Table 7: Residual Diagnostics**

Test	Statistic	Interpretation
Durbin–Watson	2.64	No autocorrelation (good)
Jarque–Bera (JB)	3.71 ( $p = 0.156$ )	Residuals are approximately normal ( $p > 0.05$ )
Omnibus Test	$p = 0.062$	Acceptable normality

The regression model in Table 7 fits well overall ( $R^2 = 0.726$ ). How well (HW) is the strongest and significant predictor of health abilities (HA). Socioeconomic (SE) also contributes positively but marginally. There is multicollinearity between HL and ST, which should be addressed by removing one or combining related variables. The model residuals are normal and independent, supporting model validity.

Noise levels in grain-grinding shops had a significant positive effect on hearing abilities. This study is in tandem with the study conducted by Zhang et al. (2025). Findings from the study highlight the need for increasing the awareness of occupational noise hazards among dental professionals and the importance of routine audiological monitoring.

How long noise in grain-grinding shops had a positive but insignificant effect on hearing abilities. This is consistent with the study conducted by Ritzel and McCrary-Quarles (2008). A workplace can help conserve hearing and reduce noise by conducting initial and annual hearing tests, incorporating administrative and engineering controls, providing personal hearing devices to workers, and educating workers about hearing conservation.

Short long-term effect of noise in grain-grinding shops had a positive but no significant effect on hearing abilities. This study agreed with the study by Ibrahim et al. (2016). The result of the study shows that the highest noise of 99.4 dBA was recorded at a pressure blower when compared to other machines. WHO Class-4 hearing protector is recommended for workers on the shop floor and room acoustics should be upgraded to absorb some sounds transmitted to offices.

How well safety standards had a significant positive effect on hearing abilities. This study aligned with the study conducted by Taofeek (2025). The findings reveal a strong correlation between prolonged exposure to high noise levels and early onset of hearing

loss, along with an increased risk of developing other chronic health issues.

Strategies to mitigate risks of noise in grain-grinding shops had a significant positive effect on hearing abilities. Adeyemi et al. (2018). The findings emphasized the need for government and relevant authorities to carry out occupational safety awareness among workers in the non-formal sector of the society.

Socioeconomic effects of noise in grain-grinding shops had no significant but positive effect on hearing abilities. This is consistent with Zhang et al. (2025). Findings from the study highlight the need for increasing the awareness of occupational noise hazards among dental professionals and the importance of routine audiological monitoring.

## 5. Conclusion and Recommendation

The study shows that noise levels in grain-grinding shops substantially influence workers' hearing abilities. High noise intensity demonstrated a significant positive effect, indicating that as noise exposure increases, the risk of hearing impairment becomes more pronounced. However, the duration of exposure both short and long-term showed a positive but statistically insignificant effect, suggesting that intensity of noise is a more critical determinant than exposure length alone. Compliance with safety standards had a significant positive effect, affirming that proper safety practices can meaningfully protect workers' hearing. Similarly, the implementation of risk-mitigation strategies significantly improved hearing-related outcomes. In contrast, the socioeconomic effects of noise exposure were positive but not significant, implying that while noise risks may impact workers' quality of life, their influence on measured hearing outcomes is limited. Overall, the findings emphasize the importance of enforcing safety standards and noise-control measures to safeguard hearing health in grain-grinding environments.

---

**The following recommendations were made:**

1. Install noise-dampening equipment (silencers, acoustic covers) on grinding machines.
2. Enforce rotational work schedules to limit the time each worker spends near high-noise machines.
3. Mandate the use of certified hearing protection devices (earplugs or earmuffs) for all workers.
4. Provide quarterly training on noise hazards, proper use of personal protective equipment (PPE), and early signs of hearing loss.
5. Introduce sound-absorbing materials (rubber mats, acoustic panels) within grinding shops.
6. Offer health insurance or welfare support for workers experiencing noise-related issues.

**References**

- Anand, S., Kumar, P., & Joshi, R. (2023). Effects of Occupational Noise on Non-Auditory Health Outcomes. *Journal of Environmental Health*.
- Aybek, A., Kamer, H. S., & Arslan, S. (2010). Determination of Noise Level of Some Agricultural Machines. *Applied Ergonomics*.
- Basner, M., Babisch, W., Davis, A., Brink, M., Clark, C., Janssen, S., & Stansfeld, S. (2014). Auditory and non-auditory effects of noise on health. *The Lancet*, 383(9925), 1325–1332. [https://doi.org/10.1016/S0140-6736\(13\)61613-X](https://doi.org/10.1016/S0140-6736(13)61613-X)
- Camargo, L. A., Marques, R. C., & Ribeiro, A. M. (2021). The Combined Effect of Noise Exposure and Aging on Hearing Loss. *Occupational Medicine & Health Affairs*.
- Fernandez, M. D., Quintana, S., Chavarría, N., & Ballesteros, J. A. (2009). Noise Exposure in the Workplace and Hearing Loss: A European Perspective. *International Archives of Occupational and Environmental Health*.
- Ising, H., & Kruppa, B. (2004). Health effects caused by noise: Evidence in the literature from the past 25 years. *Noise and Health*, 6(22), 5–13.
- Kerns, E., Masterson, E. A., Themann, C. L., Calvert, G. M., & Centers for Disease Control and Prevention (CDC). (2018). Hearing difficulty and tinnitus among U.S. workers and non-workers in 2007. *American Journal of Industrial Medicine*, 61(1), 4–15. <https://doi.org/10.1002/ajim.22734>
- Lie, A., Skogstad, M., Johannessen, H. A., Tynes, T., Mehlum, I. S., Nordby, K. C., ... & Bratveit, M. (2016). Occupational noise exposure and hearing: A systematic review. *International Archives of Occupational and Environmental Health*, 89(3), 351–372. <https://doi.org/10.1007/s00420-015-1083-5>
- Neitzel, R., & Swinburn, T. K. (2015). Noise exposure, occupational hearing loss, and health equity: The need for improved standards and prevention strategies. *American Journal of Industrial Medicine*, 58(3), 255–265. <https://doi.org/10.1002/ajim.22397>
- Seixas, N. S., Goldman, B., Sheppard, L., Neitzel, R., Norton, S., & Kujawa, S. G. (2021). Predictors of hearing threshold levels and occupational noise exposure over time. *Journal of Occupational and Environmental Hygiene*, 18(2–3), 88–98. <https://doi.org/10.1080/15459624.2020.1845171>
- Stansfeld, S. A., & Matheson, M. P. (2003). Noise pollution: Non-auditory effects on health. *British Medical Bulletin*, 68(1), 243–257. <https://doi.org/10.1093/bmb/ldg033>
- World Health Organization (WHO). (2020). Hearing Loss Due to Occupational Noise Exposure. Geneva: WHO Press.
- Yang, Q., Lin, M., & Tan, Y. (2024). Global Burden of Occupational Noise Exposure: A Review. *International Journal of Environmental Research and Public Health*.