



**ADDIS ABABA UNIVERSITY**

**COLLEGE OF HEALTH SCIENCE**

**SCHOOL OF PUBLIC HEALTH**

**ASSESSMENT OF OCCUPATIONAL NOISE EXPOSURE, TEMPORARY  
HEARING LOSS, AND ASSOCIATED FACTORS AMONG SECONDARY  
ALUMINUM PRODUCTION FACTORY WORKERS IN DEBRE BERHAN  
TOWN, ETHIOPIA**

**BY:**

**MESERET NIGUSSIE (BEd in Chem.)**

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By: MESERET NIGUSSIE (BEd) Signature \_\_\_\_\_ Date \_\_\_\_\_

**Approved by the examining board**

Signature Date

**Chairperson, Department Graduate Committee** \_\_\_\_\_

**Advisors;**

Dr. Samson wakuma (PhD.) \_\_\_\_\_

**Dr. Yifokire Tefera ( PhD)** \_\_\_\_\_

**Internal examiner**

\_\_\_\_\_

**External examiner**

\_\_\_\_\_

**DECEMBER, 2023**

**ADDISABAB, ETHIOPIA**

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### ***List of Acronyms and Abbreviation***

AOR	Adjusted Odd Ratio
COR	Crude Odd Ratio
LAeq 8	Equivalent Sound Levels measured over exposure time of 8h
dB (A)	Decibel A
ETB	Ethiopian Birr
HPDs	Hearing Protective devices
KHz	kilohertz
MLS	Ministry of Labor and Skill
MOLSA	Minister of Labor and Social Affairs
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
REL	Recommended Exposure Limit
SPSS	Statistical Package for Social Science
TWA	Time Weighted Average
ERC	Ethics Review Committee
WHO	World Health Organization WHO
SEGs	Similar Exposure Groups
TTS	Temporary Threshold Shift
PTS	Permanent Threshold Shift
NIHL	Noise Induced Hearing Loss

## Abstract

**Introduction:** Occupational noise is a widespread risk factor with a strong evidence base linking it to an important health outcome (hearing loss). Beside the fact that hearing loss brought on by industrialization is currently a significant public health issue in sub-Saharan Africa, including Ethiopia,

**Objective:** To assess occupational noise exposure, temporary hearing loss, and associated factors among secondary aluminum production factory workers in DebreBerhan Town. Ethiopia

**Methods:** An institutional-based cross-sectional study design was employed from April 1, 2023, to June 30, 2023. The data collection methods were observational checklists, face-to-face interviews, aerial and personal noise level measurements. Trained data collectors participated in the data collection. A total of 458 production workers from the six departments were directly interviewed for the questionnaires, and again, 30 individuals from those production workers, five from each six departments, were selected randomly based on the similar exposure group (SEG) technique for personal noise dosimeter measurements. The data were entered into Epi info version 7 and exported to SPSS version 21 for analysis. Bivariate and multivariable logistic analyses were used to identify the associated factors. Statistical significance was declared using a 95% confidence interval and a p-value of  $< 0.05$ .

**Results:** A total of 458 workers participated in this study, making the response rate 100%. Among the participants, 276 (60.1%) were males, with a mean age of 25.3 (+3.64) years. The prevalence of temporary hearing loss among workers was 69%, 95% (CI, 64.5-73.2%). Working departments and working hours were significantly associated with temporary hearing loss.

The maximum average noise exposure levels for an 8 hours working day were recorded in the cold rolling mill ( $96.2 \pm 0.82$  dB (A)) and sizing ( $94.6 \pm 2.88$  dB (A)) work sections.

**Conclusion:** - This study indicated that workers in a secondary aluminum production factory are exposed to a very high noise level with a high prevalence of hearing loss. Working departments and duration of exposure (length of working hours) were the determinant factors to hearing loss.

**Recommendation:** - The factory should implement noise control methods, such as engineering or administration with providing hearing protective devices to reduce the noise exposure of workers.

# 1. INTRODUCTION

## 1.1. Background of the study

Noise is one of the physical factors in industries, and more attention is being paid to its negative impact these days. Sound is defined as vibrations that travel through air or another medium and can be heard when they reach a person's or animal's ears. While Noise is an unwanted sound that doesn't occur naturally. Noise can include sounds coming from machinery, highway traffic, industrial, and residential sources (1). Overexposure to loud noises at or above 85 dB (A) can result in tinnitus, hearing loss, and trouble understanding speech in noisy environments (2). Additionally, it is linked to poorer income, depression, cardiovascular disease, and balance issues. For instance, the study conducted among industrial workers showed that of 5205 workers exposed to a high noise level, 13.64% had hypertension, 13.74% had cardiovascular conditions, and 25.74% had hearing difficulty (3). Another study done in USA showed that from 25% occupational noise exposed workers, 12% had hearing difficulty, 24% had hypertension and 28% had elevated cholesterol(4), A systematic review indicated that occupational noise exposure causes between 7 and 21% of hearing loss among workers, with the lowest incidence in industrialized countries, where the incidence is going down, and the highest in developing countries. (5)

Work-related hearing impairment remains a problem as a result of excessive noise emissions from machinery, work processes, occupational tasks, or combinations of these if not effectively managed (6). Literature showed that the main factors associated with hearing loss were age, sex, education level, amount of noise exposure, alcohol usage, cigarette smoking, working department, length of employment, and use of hearing protective devices (7–10). Manufacturing industry is the central part of Ethiopia's growth and transformation, with several workers employed in different factories such as metals, textiles, agriculture, and so on. However, there is an extremely high labor turnover rate, and one of the three identified main causes of the problem is poor working conditions (11). Occupational noise is a workplace hazard that should be taken into account, particularly in manufacturing plants; however, working conditions in Ethiopia have received little attention, and appropriate noise control interventions are lacking. Furthermore, there is insufficient evidence about noise level and its health effect among workers in metal

industries such as aluminum factories. Therefore the purpose of this study is to determine noise exposure levels, temporary hearing loss, and associated factors among workers in a secondary aluminum production factory in DebreBerhan Town Ethiopia

## **1.2 Statement of the problem**

Occupational noise exposure is the second most common risk factor in the workplace behind working injuries (12). Globally, about 16% of disabling hearing loss in adults is due to occupational-related noise (13). A study conducted in the United States revealed that about 33% of workers are affected by occupational noise-induced hearing loss (14). 600 million workers globally are exposed to dangerous noise levels each year, with about 30 million workers exposed daily. About 1.7 million workers are exposed to >85 dB (A) of noise in Britain (15), and 12–15% of the workforce is subjected to high noise levels in Germany (16). The Centers for Disease Control and Prevention (CDC) report that approximately 46% of manufacturing workers have been exposed to hazardous noise. Around 18% of workers in this industry have hearing loss, and 11% have tinnitus (17).

According to a study conducted on Thailand steel industry workers, 60.2% of study participants were exposed to harmful noise levels ranging from 91 to 96 dB (A) (18). Noise pollution and hearing loss are public health issues in Sub-Saharan Africa, including Ethiopia (19). A study conducted at the Iron and Steel Factory in Tanzania showed that 85.5% of the workers experienced a temporary threshold shift during their work shift (20).

Another study on the Ayka Addis textile factory in Ethiopia revealed that 49% of the workers have temporary hearing loss (9). The noise level measurement in another study conducted at the Akaki basic metal business was a mean (SD) of 89 + 13 dB, and the audiometric measurement result of NIHL was 22% (7). However, data on hearing loss and its associated factors in Ethiopian metal industry workers is still lacking.

There has been no research on the prevalence of temporary hearing loss and the risk factors associated with it among metal industry workers. The few prior studies in the metals sector in Ethiopia were focused on noise-induced hearing loss, which is undetectable and irreversible once

it occurs, whereas temporary hearing loss provides a “proof of concept” for potential protection against permanent hearing loss.

### **1.3. Rationale of the study**

. Industries in Ethiopia are overgrowing to increase economic growth, but worker safety is being neglected in the process. The majority of workers in manufacturing are subject to several occupational dangers, such as noise pollution at their workplace. According to a review of situational analysis and need assessments conducted in Ethiopia, noise exposure was highly prevalent and had the potential to have a major negative impact on hearing in the manufacturing sector (21). To establish a strong workplace monitoring system, there is no adequate monitoring equipment. As a result, there is a lack of effective measurements, documentation, and reporting of occupational noise hazards.

### **1.4. Significance of the study**

The findings of the study will primarily help to protect employee safety and health by estimating workplace noise levels and assessing the health effects of prolonged noise exposure. It also promotes the use of hearing protection. This justifies accountable parties, such as factory managers, developing corporate-level prevention strategies such as modernizing or replacing inefficient processes with more efficient ones, designing machines that improve the working environment, and providing the necessary personal protective equipment.

Thus, assessing temporary hearing loss and noise levels among workers exposed to noise helps in the selection of an appropriate intervention.

In addition, the study will help other researchers carry out related studies and help policymakers take the appropriate measures to reduce occupational noise hazards.

## **2. LITRATURE REVIEW**

### **2.1 Occupational Noise**

Occupational noise is the amount of acoustic energy received by an employee's auditory system when they are working in the industry (22). Frequency and loudness are two key characteristics of noise. Noise can be categorized as tonal noise, which is continuous or fluctuating noise with one or two single frequencies; non-steady noise, which is fluctuating or intermittent noise; or impulsive noise, which is one or more bursts of sound energy lasting less than one second.

The impacts of occupational noise exposure cause a tremendous financial and disease burden on both individuals and society. In the USA, it is estimated that the annual compensation for occupational noise-induced hearing loss is approximately \$242.4 million (23). Noise exposure has serious negative effects on people's health and finances, as well as functional, social, and emotional effects on workers in a variety of professions (24). It may restrict one's ability to interact with people, increase social stress, lead to despair, low self-esteem, and a lack of self-identity, impair one's concentration and cognition, and worsen interpersonal relationships (25). It can also have a big effect on productivity, and being distracted by a coworker's conversation can lower productivity by up to 66% (26). Noise often has a negative physiological and psychological impact on people. The most frequent of these physiological effects are hearing loss (acoustic trauma), temporary hearing loss, and permanent hearing loss (14). Blood pressure increases, heart rate accelerations, the development of muscular reflexes, and trouble sleeping are some other physiological effects of noise. Noise's psychological effects are more common than its physical ones, and they include trouble falling asleep and perceiving (12).

### **2.2. Occupational noise Exposure levels**

#### **2.2.1 Noise Exposure limit and standards**

To avoid the negative effects of noise exposure, noise levels should be reduced to tolerable levels. Based on the most up-to-date research in both science and practice, the National Institute for Occupational Safety and Health (NIOSH) develops Recommended Exposure Limits (REL)

to noise. Noise exposure at or above the NIOSH (REL) of 85 dB (A) for an 8-hour time-weighted average (TWA) is deemed harmful. OSHA is a government agency that regulates occupational safety and health. OSHA sets legal limitations on noise exposure in the workplace. These restrictions are based on the time-weighted average of a worker's 8-hour workday.

Noise is one of OSHA's permitted activities for an 8-hour workday; the exposure limit (PEL) for all workers is 90 dB (A) (27). 8 hours at 90 dB (A), 4 hours at 95 dB (A), and 2 hours at 100 dB (A) are the daily maximums for standard exposure. OSHA mandates that if workplace noise levels exceed the recommended levels of exposure to noise, employers must adopt hearing conservation programs for workers. However, in many low- and middle-income nations, excessive noise is the most common compensable occupational hazard (28).

Ethiopia's occupational safety and health directive also provides that exposure to noise is to be limited to 90 dB (A) for 8 hours, 92 dB (A) for 6 hours, 95 dB (A) for 4 hours, 97 dB (A) for 3 hours, 100 dB (A) for 2 hours, and 102 dB (A) for 1 and a half hours (29).

### **2.2.2 Measured noise level and variation in metals industry**

Various academic studies have demonstrated that metal sector workers are subject to excessive noise levels. According to a field survey study carried out at 26 industrial facilities in Malaysia, the levels of occupational noise exposure varied by industry and were 28% for 91–140 dB (A) and 72% for 86–90 dB (A), putting all workforces at high risk. The metal industry (2091) was found to have the largest percentage of noise-exposed workers, followed by the textile (631), and food industries (439) (30). Another study conducted among iron and steel factory workers in Tanzania showed that the average personal noise exposure in the studied factories was 92 dB (A) (range of job group means: 85–96 dB (A); personal exposure was significantly higher in the rolling mill section (93 dB (A)) than in the furnace section (90 dB (A)). Among the job groups, the cutters located in the rolling mill section had the highest noise exposure (96.2 dB (A)) (6). The maximum sound pressure of 109 dB (A) was recorded at the electric arc furnace, according to a similar study on the status of noise pollution in the metal melting industry. The furnace, casting, and cooling beds were also the areas with the most noise pollution, according to the visual isotonic curves (31). The study conducted on cold rolling mills revealed that the noise level

measured with the dosimeter ranged from 20 to 140 dB, and average noise exposure levels were significantly higher. According to this finding, the majority of rolling plant workplaces are exposed to noise levels higher than 87 dB (A) at the 8-hour threshold (32). Another study on the steel sector in the United Arab Emirates revealed that workers were exposed to noise levels between 70 and 96 decibels (A) and a range of 76 to 101 decibels (SPL) (33). Another investigation of metal manufacturing in Malaysia found that the typical noise exposure ranged from 63.3 to 101.5 dB (A); likewise, 25% of the workforce exhibits signs of hearing loss (34). The study conducted on the metal fabricating sector in Nairobi revealed that the overall measured noise level in the studied area ranged from 72 dB (A) to 114 dB (A) (35). . Another study surveyed the noise levels in the metal and textile industries in Addis Ababa, Ethiopia, and found that 26.2% of workplaces had noise levels above 90 dBA (36).

### **2.2.3. Relation of noise levels and TTS**

Exposure to noise levels above 85 dB (A) is associated with temporary threshold shifts (TTS) in human hearing. Nevertheless, there are few studies of noise and hearing from African countries. It is well established that prolonged exposure to loud noises causes an auditory threshold shift, which may be temporary or permanent. Recent research showed that noise-induced temporary threshold shifts are linked to cochlear nerve degeneration and a loss of synaptic connections to the inner hair cells (37).

### **2.3 Noise measurement method**

Personal noise exposure assessment and noise survey are the two broad categories of noise measurement methods. The goal of area measurement is to determine which areas require hearing protection. Personal noise exposure measurement is another method for calculating workers' daily noise exposure levels. A variety of sound-level measuring instruments are available. These are sound level meters (SLM), integrated sound level meters (ISLM), noise dosimeters, and sound frequency analyzers. For this study, we used a Bruel & Kjaer type 2250 digital sound level meter and a Bruel & Kjaer type 4448 noise dosimeter with a decibel parameter A scale that takes into account the frequency range to which the human ear is most sensitive. Bruel & Kjaer type 2250 digital sound level is a large, high-resolution color touch screen, data storage on plug-in memory cards, a standard USB computer interface, a dynamic range greater than 120 dB, a 3HZ to 20 KHZ wideband linear frequency range, and real-time

frequency analysis in 1/1 or 1/3 octave. The Brüel & Kjær type 4448 noise dosimeter has a fully charged battery and can measure for up to 28 hours. The internal non-volatile memory can store up to 180 hours of measurement data. Data is downloaded to post-processing PC software wirelessly through an IR-to-USB cable. A wide range of mounting accessories is available. Type 4448 versions come with a windshield, which provides extra protection for the microphone. Other capabilities of the Type 4448 include keys and display lock function, LED warning alarm for dangerous noise levels, 180 hours of logging storage, peak counting (in excess of 125, 137, and 140 decibels), preset measurement time of up to 12 hours, and rechargeable NiMH battery for up to 28 hours of operational time.

## **2.4. TTS and noise induced hearing loss**

Temporary threshold shift (TTS), which is the reversible hearing loss that occurs immediately after exposure to intense sound levels and which recovers over several hours or days after exposure, is considered an important indicator for the early development of irreversible hearing loss (38). Permanent threshold shift (PTS) is the same as TTS, except that it is an irreversible change of hearing. Thus, monitoring TTS after noise exposure among workers is an alternative and promising approach to facilitate the prevention of hearing loss (39).

An experimental study found that when digital music players were exposed to noise levels ranging from 93 to 102 dB (A) for four hours, their hearing threshold increased by 6.3 (SD = 3.9) (40). According to a study on temporary threshold shifts among iron and steel factory workers in Tanzania, 85.5% of the employees experienced TTS during the shift (20).

## **2.5. Temporary Loss and Associated Factors**

### **2.5.1. Socio-demographic factors**

Based on different study findings, hearing loss can be associated with socio-demographic factors such as age, sex, and educational status. According to the National Institute on Deafness, 15% of Americans between the ages of 20 and 69 have high-frequency hearing loss. Men are almost twice as likely as women to have hearing loss (38). A recent study in Australia showed that workers aged 20 to 64 were exposed to noise exceeding daily limits (85 dB) and the two leading causes of hearing loss were aging and noise exposure (41).

The study done in the police force showed that increasing age and longer duration of service are significant associated factors with hearing loss (42). Another study on the factors associated with hearing loss in textile mill workers carried out in Thiamine, Myanmar, showed that workers 35 years of age and older, those with less education than a high school diploma, and those who had worked in the factory for more than nine years were significantly more likely to have hearing loss (45). Research on hearing loss in Michigan, South Punjab, Pakistan, and among auto stamping and assembly workers revealed a substantial correlation between sex, age, length of employment, and education (43, 44).

### **2.5.2. Organizational factors.**

Organizational factors like working departments, noise exposure level, duration of exposure, and use of hearing protective devices are some factors associated with hearing loss.

Different studies showed that length of working hours, working department, duration of employment, and the intensity of noise exposure were associated with hearing loss (7, 9, 10, 18, 45).

Most studies agree that the use of hearing protection devices is a key factor in the prevention of hearing loss due to occupational noise exposure, and only these devices, and to a lesser extent, rehabilitation, can ensure good hearing health in workers exposed to this problem. The use of hearing protection measures at work and noise exposure duration are the best predictive factors of work-related hearing loss (43, 46, 47).

### **2.5.3 Individual factors**

Temporary hearing loss occurs with an ear infection, excessive ear wax, or exposure to loud noise (48). Research done on a group of textile industry workers in Karachi, Pakistan, showed that the multivariate model showed a significant association between head injury and trauma and also found a significant association with hearing loss (AOR: 2.2; 95% (CI=1.2-3.9) (28). Another study done in the Akaki basic metal industry in Addis Ababa revealed that prior exposure to noise at work and regular use of drugs for chronic illnesses including diabetes, HIV, and hypertension are linked to hearing loss at work (7).

#### **2.5.4. Behavioral factors**

Many studies concluded that the occurrence of hearing loss was significantly related to chat chewing, cigarette smoking, the characteristics of workers, workers with excess alcohol use, and the use of hearing protective devices or ear protectors. According to a study conducted in Kathmandu Metropolitan City, Addis Ababa, and Michigan, alcohol consumption and cigarette smoking have a significant association with For hearing loss (HL), the AOR was significant for current smokers compared with never smokers (but not significant for former smokers) (43, 49).

The study conducted on the pinball industry demonstrated that noise generated by earphones increases the risk of TSS at 1500 and 2000 Hz (8). Another study among metal and woodworkers in Gondar Town found that using an earphone to listen to music for longer than two hours a day (PR = 2.95, 95% CI: 1.32, 6.21) and playing music loudly (PR = 2.24, 95% CI: 1.05, 4.79) was linked to hearing impairments (50).

#### **2.6. Occupational noise prevention and control methods**

Occupational hearing loss is a prevalent occupational concern in various work environments worldwide (51). Occupational hearing loss is preventable, but currently, the interventions to prevent it involve many components. Based on the 2017 Cochrane review, to prevent NIHL in the workplace, engineering controls and better implementation of legislation are needed (52). The most effective noise control method, next to elimination and substitution, is engineering control, which is a physical modification to reduce noise exposure at the source. Engineering typically involves making changes in equipment or other changes to minimize the level of noise that reaches a worker's ear (53).

Administrative control, behind engineering control, is the next best form of noise exposure prevention. Studies in the United States revealed that hearing protection use remained stable at a low rate. To prevent hearing loss from occupational noise exposure, significant education and reinforcement of appropriate hearing protection use in the workplace are necessary (54). However, despite the existence of some policies, the prevention and control of noise exposure in the workplace are inadequate

## **2.7 Conceptual Frame Work**

The conceptual framework for this study was developed after reviewing the above literature about factors that have been contributing to the occurrence of temporary hearing loss among workers in the secondary aluminum production factory. It was used as a roadmap for pursuing the investigation. As shown below in Fig. 1, individual factors (head injury, ear infection, medication), socio-demographic factors (age, sex, educational status, and year of experience), organizational factors (working departments, noise level emitted from different machines, duration of exposure (length of working hours), engineering controls, availability of hearing protective devices), and behavioral factors (use of hearing protective devices, cigarette smoking, alcohol consumption, use of an earphone for music listening) are associated with temporary hearing loss.

## Conceptual frame work

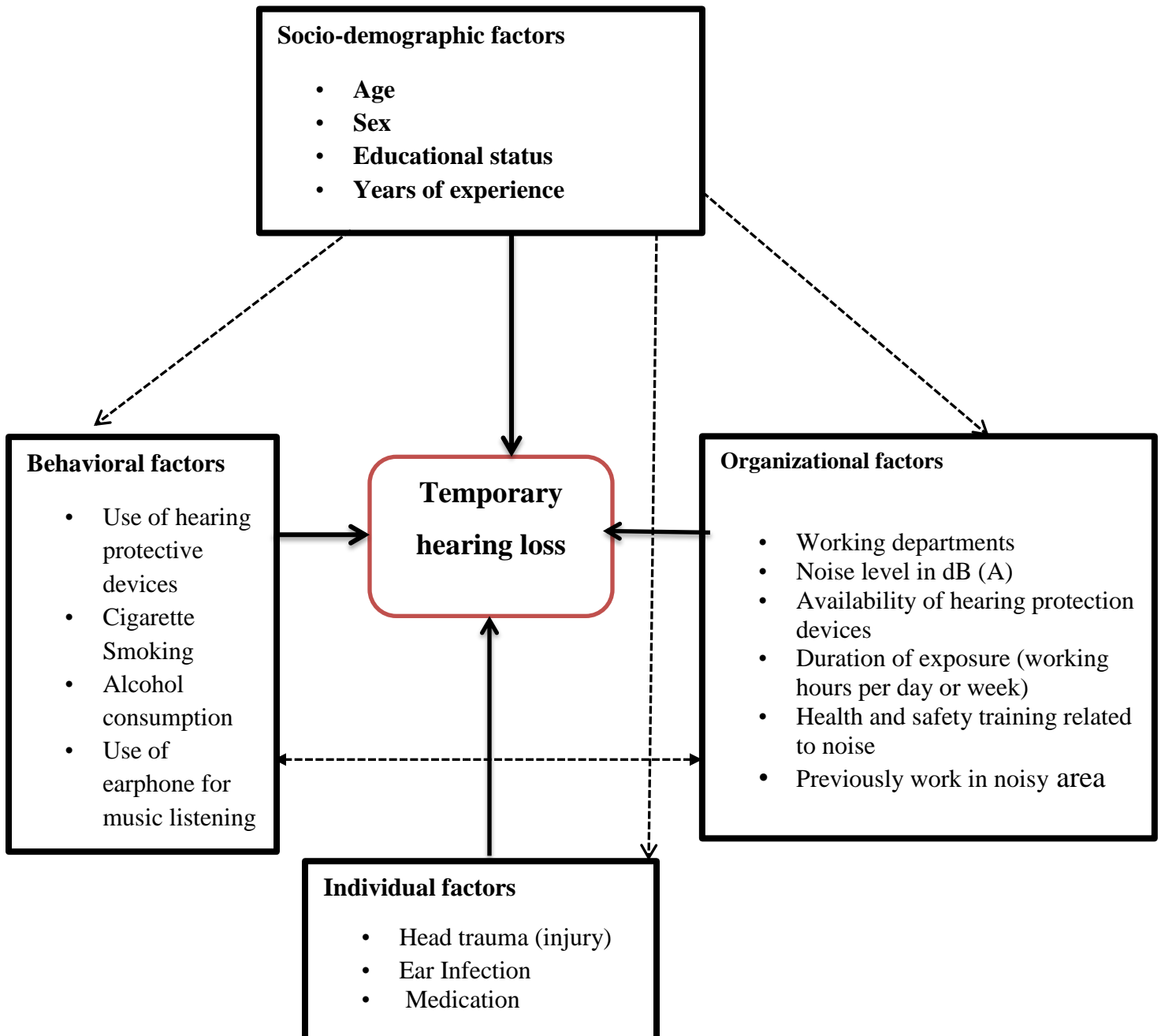


Figure 1 Conceptual frame work of temporary hearing loss and associated factors, 2023

(Source different literatures)

### **3. OBJECTIVES**

#### **3.1. General objective**

- The main objective of this study was to assess the level of occupational noise exposure, temporary hearing loss, and associated factors among secondary aluminum production factory workers in Debre Berhan Town, Ethiopia, in 2023.

#### **3.2. Specific objectives**

- To measure aerial and personal noise exposure levels among secondary aluminum production factory workers
- To estimate the prevalence of temporary hearing loss among secondary aluminum production factory workers.
- To identify factors associated with temporary hearing loss among secondary aluminum production factory workers.

## **4. METHODS AND MATERIALS**

### **4.1. Study area**

This study was conducted among workers at the secondary aluminum production factory in Debre Berhan Town, which is the capital city of the North Shewea Zone in the Amhara region of Ethiopia. The town is one of the preferred investment destinations in the country. The secondary aluminum production factory was one of the large-scale industries found in the town and was expected to have hazardous working conditions. It is located 130 kilometers north of Addis Ababa and 695 kilometers southwest of the regional capital, Bahir Dar. 579 employees were working in the factory (357 males and 222 females). The company manufactured household items such as kettles and pots by recycling secondary aluminum. The plant operates in three shifts. The principal working departments of the factory were raw material sorting and grinding, melting furnace, cold rolling mill, sizing aluminum sheet, pressing, and polishing.

### **4.2 Study design and period**

An institution-based cross-sectional study was conducted from April 1, 2023, to June 30, 2023

### **4.3. Source population**

All employees in a secondary aluminum production factory were a source of population.

### **4.4. Study Subjects**

Workers who were directly involved in the manufacturing process of the secondary aluminum production factory were the study subjects..

### **4.5. Eligibility criteria's**

**Inclusion criteria:** All production workers in a secondary aluminum production factory were included in the study.

**Exclusion criteria:** Workers who gave information and had known hearing problems due to head injuries or other cases were excluded from the study.

## 4.6. Sample size determination

### 4.6.1. Sample size determination for objective one (personal noise measurement)

Using the Similar Exposure Group (SEG) technique, the sample size for the measurement of personal noise exposure level was calculated. For instance, groups of workers engaged in equivalent noise-producing activities may be seen as similar. Five employees were selected at random from each of the six working departments using SEG methods, and each worker conducted two days of measurement (10 measures per department), for a total of 60 measurements throughout the six working departments (Table 1). The measurements were taken during the daytime shift from 6:00 a.m. to 2:00 p.m.

Table 1 sampling of workers in Secondary Aluminum Production Factory for personal noise level measurement based on similar exposure group method, 2023.

Working department	Similar exposure groups (N)	Sample size (n)	Total number of samples
Raw material sorting	27	5	10
Melting furnace	68	5	10
Cold rolling mill	27	5	10
Sizing Aluminum sheet	54	5	10
Press and kettle	249	5	10
Polishing	33	5	10
Total	458	30	60

### 4.6.2. Sample size determination for objective two (prevalence of temporary hearing loss)

To determine the sample size of the study participants for the prevalence of temporary hearing loss, we used a single population formula by taking the prevalence of hearing loss from the previous study conducted by Ayka Addis textile factory workers, which was 49% (9). So that  $p = 0.49$  and  $q = 1 - 0.49 = 0.51$ .

$$n = \frac{(Z\alpha/2)^2 P(1-P)}{d^2}$$

$$n = 383.8 = 384 \text{ Where;}$$

n: sample size;  $\alpha$ : the level of significance; 5% P: Prevalence of temporary hearing loss 49%

d: Maximum acceptable difference (margin of error = 5%)

$Z_{\alpha/2}$  = the value under the standard normal table for the given value of confidence level

Then, by considering the non-response rate of 10% (38) the final sample size was 422.

However, because the total number of workers in the production section is 458, with a small difference from the calculated sample size, we used all 458 workers in the production section as the sample size for objective 2.

#### **4.6.3. Sample size determination for objective three (factors associated with temporary hearing loss)**

The sample size was determined using the double population formula by considering the prevalence of noise-induced hearing loss among exposed and non-exposed iron and steel workers from a prior study conducted in Tanzania, which indicates a prevalence of 48% and 31%, respectively (55)

$$n = \frac{(Z_{\alpha/2} + Z_{\beta})^2 \times (P_1(1-P_1) + P_2(1-P_2))}{(P_1 - P_2)^2}$$

$$n=280$$

Adding 10% of non-response, the sample size for objective 2 was 308.

Where n is the sample size to be needed.

$P_1 = 0.48$  (proportion of noise-induced hearing loss among the exposed)

$P_2 = 0.31$  (proportion of temporary hearing loss among non-exposed)

$Z_{\alpha/2}$  = level of statistical significance: 1.96 at a confidence level of 95%.

$Z_{\beta}$  = desired power for 80% (0.80) power and

$P_1 - P_2$  = difference between proportions

Therefore, 308 are the smaller sample size as compared to 422 it was better to use the large sample size for objective 2.

## **4.7. Sampling methods**

### **4.7.1. Sampling method for personal and aerial noise measurement**

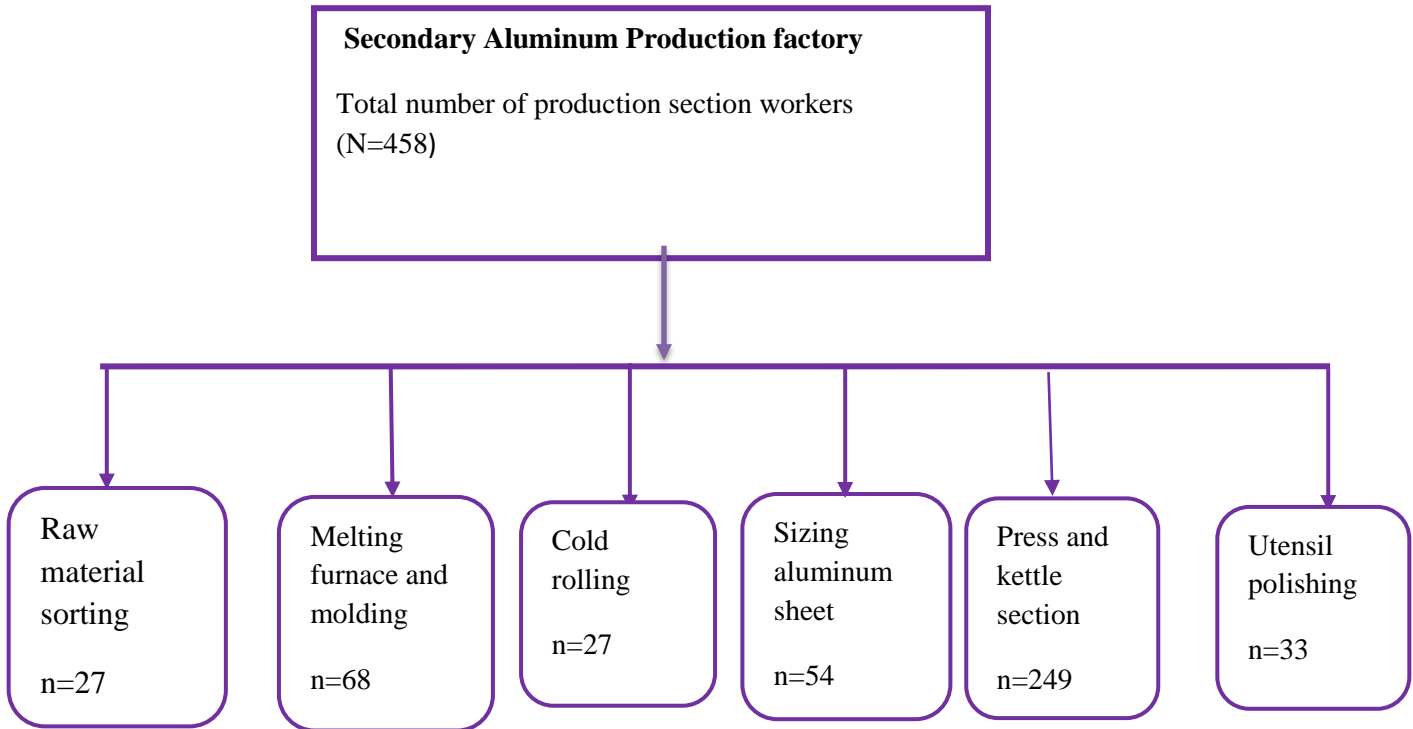
To select sample workers for personal noise exposure measurements; we used the principle of Similar Exposure Group (SEG) method in which workers with similar activities can be grouped at one. i.e. groups of workers exposed to noise in conditions or activities that can be considered similar. Based on this method a total of 30 individuals were selected randomly from each production work section, 5 from the raw material sorting and grinding, 5 from the melting furnace, 5 from cold rolling, 5 from sizing aluminum sheet, 5 from pressing and kettle, and 5 from polishing. Sixty personal dosimeter readings were taken in total.

Each department's job tasks were categorized, and for every machine that was recognized, an aerial measurement was performed three times over two days.

### **4.7.2. Sampling method for temporary hearing loss and its associated factors**

All 458 production workers were selected directly from each of the factory's six primary work departments using a simple random sampling procedure because the calculated sample size of 422 is almost exactly equal to the total number of production workers (with a little difference).

### Sampling procedure chart



**Figure 2 Sampling chart among Secondary Aluminum Production Factory Workers, 2023**

## 4.8. Data collection.

### 4.8.1. Study variables:

#### Dependent variable

- Temporary hearing loss

#### Independent variables

- **Noise level in dB (A)**
- **Socio-demographic factors:** age, sex, and educational status.
- **Individual Factors:** ear infection, head injury, and medication.

**Behavioral factors:** use of hearing protective devices, cigarette smoking, use of an earphone for listening to music, and alcohol drinking

**Organizational factors:** health and safety training related to noise, duration of exposure (working hours per day/week), and availability of hearing protection devices (HPDs), working department noise level, and previous work in noisy occupations.

### 4.8.2. Data collection procedure and tools for aerial measurements

Each working department's work tasks were categorized and measurements were made on the worker's hearing zone in the selected working machine using OSHA's definition of the hearing zone which is two feet wide. A Bruel & Kjaer type 2250 digital sound level meter was used to measure the area noise level of each department. The sound level meter was held 1.5 m above the floor, and the measurements were taken for two minutes and then three times in each work area (during an eight-hour work shift and a two-hour interval). Additionally, the noise level in each machine was measured for two days, and the average of these measurements was used to determine the section noise level. The sound level meter was calibrated at 94.0 dB before each measurement was conducted. A weighting characteristic was used since it is simulated as the human ear listening response.



**Figure 3 Brüel & Kjær type 2250 sound level meter and type 4448 noise dosimeter**

#### **4.8.3. Data collection for procedure and tools for personal noise exposure measurements**

Personal noise measurements were conducted to calculate the daily noise exposure levels of employees by professional data collectors after receiving the necessary training. Using the Brüel and Kjær type 4448, a full-shift personal noise exposure level measurement was carried out by placing the microphone as close to the worker's ear as possible and fastening it to their shoulder. To ensure accuracy, calibration was done on the noise dosimeters. When using the dosimeters, participants were told not to touch, play with, or shout into the microphone. Instead, they were to handle the dosimeters carefully. Additionally, we closely monitored them to search for any dosimeter errors throughout the measurement.

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**Figure 4 Indicate how personal noise level was measured.in Secondary Aluminum Production Factory workers, 2023**

#### **4.8.4. Data collection procedures and tools for prevalence of temporary hearing loss and its associated factors.**

A structured questionnaire was used to assess the risk factors for temporary hearing loss. Data was collected using pretested and structured Amharic version questionnaires and face-to-face interviews with the study participants. The questionnaire was focused on five parts: socio-demographic, work-related factors, behavioral factors, individual factors, and temporary hearing loss symptoms. Data collection was administered by three data collectors and two supervisors after two days of training. The questionnaire was asked to the selected workers within 2–5 minutes after the end of the exposure to identify the real temporary hearing loss that can be caused by noise exposure in the factory. An observational checklist was used to assess the organizational factors regarding noise control measures such as engineering control, the availability of hearing protective devices, excessive noise in the workplace, and the difficulty of communicating with nearby workers.

#### **4.9. Operational definition**

**Temporary hearing loss:** participant who had experienced at least one temporary hearing capacity loss symptom after exiting from work and disappeared or recovered to baseline unit 30 days or less (56).

#### **Temporary hearing loss symptoms are:**

Hearing problem now or shortly after leaving work

Ringing or troubled noise around the ear

Difficulty in communication with friends after exiting from work

Difficulty during a phone call conversation

Noise prevents normal conversation during work.

**Exposure duration/time:** is the length of hours that a worker is exposed to any noise level during work time (57).

#### **4.10. Data management**

Data was collected using face-to-face interviews with participants by three professional data collectors and two supervisors. Training and orientation were provided to data collectors and supervisors. Within the study area, in a separate room, data collection was conducted under the guidance of the investigator and supervisors. All necessary data was inspected and verified for it to be completed. An investigation was conducted into the personal noise level measurement device's functionality. The study's participants were instructed to handle the dosimeters carefully during operation and not to touch, interfere with, or shout into the device's microphone. A careful follow-up was carried out throughout the measurement to look for any dosimeter mishaps. Using the protector type 7825 software and the IR-to-USB cable that comes with the dosimeter, data from the dosimeter was wirelessly transmitted to a personal computer and saved in a separate folder. And data from the sound level meter for area noise level measurements was recorded in the prepared template, entered manually into a personal computer, and saved in a separate folder for analysis.

#### **4.11. Data analysis**

##### **4.11. 1. Data analysis for personal and aerial noise level measurement**

The downloaded data from the dosimeter to the post-processing PC protector type7825 software was entered into SPSS version 21 software for analysis. The mean average noise exposure level was calculated from the software and compared to the established standards. A simple linear regression was used to assess the relationship between noise exposure level and temporary hearing loss

##### **4.11.2. Data analysis for prevalence of temporary hearing loss**

The collected data was entered manually into Epi-Info version 7 for cleaning, editing, coding, organizing, and checking for missing values, and exported into SPSS version 21.0 for further analysis. Descriptive statistics were used to summarize the data and were presented in the form of tables and charts. An adjusted odds ratio (AOR) with a 95% CI of p-value  $\leq 0.05$  was used to see the association between the outcome variable and the independent variable.

#### **4.11. 3.Data analysis for associated factors with temporary hearing loss**

A binary logistic regression was used to examine the relationship between temporary hearing loss and each independent variable. Bivariate analysis was used to determine whether the independent variables were significantly associated with the outcome variables. Those variables  $p \leq 0.2$  were included in the multivariable analysis. Multivariable analysis was used to determine the relationship between dependent variables and all associated factors.

#### **4.12. Data quality assurance**

The questionnaire was translated into Amharic to guarantee the accuracy of the data. To guarantee the validity of the sample, 5% of the questionnaires were pre-tested before the formal data collection process started. To verify the accuracy and consistency of the data gathered, the primary investigator and supervisors examined and reviewed the completed questionnaires. To ensure uniformity, the data from the questionnaires was also translated back into English. Before being exported to SPSS version 21.0 for additional analysis, the collected data was manually entered into Epi-Info version 7 for cleaning, editing, coding, arranging, and checking for missing values

#### **4.13. Ethical consideration**

Ethical clearance was obtained from the Addis Ababa University Ethics Review Committee (ERC), and permission from the factory managers and written and verbal consent from the workers was gained after briefing about the purpose of the study. Great emphasis was given in explaining the fact that no individual will be obliged to participate in this study so that each participant has the right to decide whether to participate or not after full understanding of the purpose of the study, even the right to refuse to participate at any point in the study. Privacy and confidentiality of information given by each respondent were kept properly, and personal identifiers were removed.

#### **4.14. Dissemination of results**

The results of the study were submitted to Addis Ababa University College of Health Sciences School of Public Health, both in hard and soft copy, with the plan of presenting findings at appropriate seminars, workshops, and conferences. In addition, the document was disseminated to secondary aluminum production factories and the Ministry of Labor and Skill (MLS). Besides, publication of the study findings in a local or international journal was considered.

## 5. RESULTS

### 5.1 Socio demographic characteristics of respondents

A total of 458 workers participated in this study, making the response rate 100%. Among the total participants, 276 (60.1%) were males, with a mean age of 25.3 ( $\pm 3.64$ ) years.

All respondents have attained education from primary to higher education level, of which 32 (7%) were in grades 1–8, and 255 (55.7%) were in diploma and above. Regarding work experience, 130 (28.4) respondents had less than 1 year, 149 (32.5%) workers had one up to three years and 179 (39.1%) workers had more than 3 years. Regarding marital status, more than half (77.1%) of the participants were single. The mean monthly income for the study participants was 3033 Ethiopian Birr, with ranges from 1700 to 7163 ETB.

**Table 2 Socio-demographic characteristics of workers in Secondary Aluminum Production Factory, 2023**

Variables	Frequency (N=458)	Percent (%)
Sex		
Male	276	60.1
Female	182	39.9
Age (in years)		
19-24	191	41.7
25-30	205	44.8
31-40	62	13.5
Mean $\pm$ SD	25.3 $\pm$ 3.6	
Marital status		
Single	353	77
Married	105	22.9
Educational status		
Primary (1-8)	32	7
Secondary (9-12)	171	37.3
Diploma and above	255	55.7
Monthly income		
$\leq$ 2500	175	38.2
$>$ 2500	283	61.8
Years of experience		
$<$ 1 year	130	28.4
1-3	149	32.5
$>$ 3years	179	39.1

## 5.2. Behavioral factors of respondents in Secondary Aluminum production Factory.

All of the study participants reported that they did not have the habit of smoking or chewing. But only 127 (27.7%) had the habit of drinking alcohol, and 13 (2.8%) of workers participated in nightclubs. Out of 385 respondents who listen to music or radio, 274 (59.8%) used earphones for listening to music or radio. Only 35 (7.6%) of the study participants used hearing protection devices, while the majority, 423 (92.4%) did not use them while at work. The main reasons for not using HPDs among participants who didn't use hearing protective devices were that they were not available (not provided) 361 (78.6%), they were not comfortable 50 (10.9%), they knew nothing about them 7 (1.5%), and they didn't believe in their use 5 (1.1%). Some employees used cotton as a hearing protector.

**Table 3 Behavioral factors of workers in Secondary Aluminum Production Factory, 2023**

Variables	Frequency (N=458)	Percent (%)
<b>Drink alcohol</b>		
Yes	127	27.7
No	331	72.3
<b>Use of ear phone</b>		
Yes	274	59.8
NO	184	40.2
<b>Use of HPDS</b>		
Yes	35	7.6
No	423	92.4
<b>Reasons for not using HPDS</b>		
Is not available	361	78.6
Is not comfortable	50	10.9
I know nothing about it	7	1.5
I don't believe on its use	5	1.1

## 5.3. Individual factors of respondents in Secondary Aluminum Production Factory

The minority, 26 (5.7%) and 16 (3.5%) of the study participants, had head injuries and ear drain problems during their lives, respectively, and 86 (18.8%) reported having a severe headache confirmed by a physician. Again, 19 (4.1%) workers reported that there is disturbing noise around their residences from road traffic, mills, and religious institutions. A minority of 24 (5.2%) of the respondents reported that they regularly take medicine for different health

problems (kidney infection, stomach pain, asthma, headache, etc.). But no one can remember the name of the medicine they took. In addition, the majority, 182 (39.7%) of the study participants, reported that they had a problem with disturbance to their sleeping during normal sleeping hours, and 273 (59.6%) had a problem of feeling tired and worn out after waking up from sleeping. Regarding the previous hearing test, only 22 (4.8%) had a hearing test before the present job; almost there is no pre-employment hearing test; only 15 (3.3%) of the workers were pre-tested, but 443 (96.7%) had not tested.

Table 4 Individual factors of workers in Secondary Aluminum Production Factory, 2023

Variables	Frequency (458)	Percent (%)
Ever had head injury		
Yes	26	5.7
No	432	94.3
Ever had ear drain/infection		
Yes	16	3.5
No	442	96.5
History of taking medication		
Yes	24	5.2
No	434	94.8
Had severe head ache		
Yes	86	18.8
No	372	81.2
Had sleep disturbance		
Yes	182	39.7
No	276	60.3
Disturbing noise around respondent's residence		
Yes	19	4.1
No	439	95.9
Had pre-employment test		
Yes	15	3.3
No	443	96.7
Feeling tired and worn out after waking up from sleeping		
Yes	273	59.6
No	185	40.4

#### 5.4. Work related factors among Secondary Aluminum Production Factory Workers

Out of 458 study participants, 22 (4.8%) workers in the secondary aluminum production factory worked in other noisy jobs (construction, textile, metal work, garage, plastic factory, wood processing, and others). All workers had a working time of 8 hours per day and 48 hours per week, and they had only one day of rest per week. However, there was an overtime work system; 181 (39.5%) employees reported that they had an overtime of 4–12 hours per week. In addition to this, 209 (45.6%) workers were engaged in relatively high-noise work sections, such as cold rolling mills, sizing aluminum plates, polishing, melting furnaces (in hot rolling mills), and raw material sorting.

. The majority of 361 (78.6%) workers reported there are no hearing protective devices in the factory. Regarding occupational training, only 51 (11.1%) of workers reported that they took training about noise exposure and its preventive mechanisms, but the majority of the respondents, 407 (88.7%), reported that they did not take any training about noise exposure and its health effects

Table 5 Work related factors among Secondary Aluminum Production Factory workers, 2023

Variables	Frequency (N=458)	Percent (%)
<b>Working department</b>		
Cold rolling	27	5.9
Sizing	54	11.8
Polishing	33	7.2
Furnace	68	14.8
Raw material sorting	27	5.9
Press and kettle	249	54.2
<b>Total working hours per week</b>		
=48 hours	277	60.5
>48 hours	181	39.5
<b>Availability of HPDs</b>		
Yes	97	21.4
No	361	78.6
<b>Taking training about noise</b>		
Yes	51	11.1
No	407	88.9
<b>Previously work in noisy area</b>		
Yes	22	4.8
No	436	96.2

### 5.5 Personal noise dosimeter measurements

The average personal noise exposure was 92.03 dB (A). (n = 60) (Table: 6). The highest personal noise exposure levels registered among sizing work section workers ranged from 91.2 to 99.4 LAeq, and the lowest was recorded among press and kettle section workers from 84.8 to 92.9 LAeq. About 63.3% of all measurements were above the Ethiopian OEL of 90 dB (A) and 96.6% of the WHO OEL of 85 dB (A) for 8 hours. The workers were found to be exposed to high peak noise levels, of which 38.3% of personal measurements exceeded the OEL of 137 dB (C). The average peak noise level measurements were 134.04 dB (C), ranging from 128.9 to 140.6 dB (C). The noise levels for each of the six work sections are displayed in the following table

**Table 6 Personal Noise Exposure Level among Secondary Aluminum Production Factory Workers, 2023**

Working departments	No of samples	Minimum LAeq (dB (A))	Maximum LAeq (dB (A))	Mean LAeq (dB (A))	% OEL >90dB(A)	% OEL >85dB(A)	LC peak dB (c)
Cold rolling	10	94.7	97.4	96.3	100	100	140.6
Sizing	10	91.2	99.4	94.6	100	100	134.2
Polishing	10	86.5	96.9	91.7	60	100	131.1
Furnace	10	89.3	95	91.5	70	100	138
Raw material	10	85.7	99	90.8	40	100	128.9
Press	10	84.8	92.9	87.3	10	80	131.4
All	60	88.7	96.9	92.03	63.3	96.6	134

## 5.6 Area noise level measurements

The highest area noise level was registered from the hot shearing machine in the sizing work section, and the lowest was registered from the washing machine in the press work sections. .

**Table 7 Aerial Noise Exposure level of Different Production Work sections in Secondary Aluminum Production Factory, 2023**

Working departments/sections	Area noise level measurements LAeq (dB (A))				
	Type of machine	Reading 1	Reading 2	Reading 3	Average
<b>Raw material sorting</b>	Crasher/grinding machine	94	96	97	97
	Cutting machine/Saw/	100	99	98	
<b>Melting furnace</b>	Hot rolling machine	93	90	91	91
<b>Cold rolling mill</b>	Cold rolling machine 2	98	99	95	95
	Cold rolling machine 3	91	91	95	
<b>Sizing</b>	Hot shearing machine	103	101	101	95
	Cold shearing machine	93	94	92	
	Punching machine	95	95	95	
	Circle cutter machine	94	93	93	
	Bailing machine	91	89	88	
<b>Press</b>	Bearing machine	88	87	86	87
	Fitting design machine	87	87	88	
	Washing machine	83	83	80	
	Pressing machine for utensil	86.5	87	86	
	Bending machine	93	94	93	
<b>Polishing</b>	Utensil polishing machine	90	88	91	93
	Buffing machine	97	97	97	
	Kettle cover polishing machine	92	90	90	

## 5.7. Prevalence of temporary hearing loss among Secondary Aluminum Production factory workers

The prevalence of each temporary hearing loss symptom among the six work sections of workers was: 32.5%; hearing loss exactly after exiting from work; 52.8% ringing or trouble noise around their ears; 43.9% difficulty in communication with friends. 42.2% difficulty during phone call conversation and 56.3% noise prevents normal conversation during work. And the overall prevalence of temporary hearing loss was 69%. (Table: 8)

**Table 8** Prevalence of Temporary Hearing Loss among Secondary Aluminum Production Factory Workers, 2023

Variable	Temporary hearing loss	Work sections						
		Cold rolling	Sizing	Polishing	Furnace	Raw mate	Press	All sections
Hearing problem now/exactly after exiting from work	Yes	18	33	14	17	8	59	149
	No	9	21	19	51	19	190	309
Ringing/trouble noise around the ear	Yes	22	33	19	36	14	118	242
	No	5	21	14	32	13	131	216
Difficulty in communication with friends after exit from work	Yes	18	28	12	27	8	108	201
	No	9	26	21	41	19	141	257
Difficulty during phone call conversation	Yes	18	29	12	28	8	103	198
	No	9	25	21	40	19	146	260
Noise prevents normal conversation during work	Yes	20	39	19	38	16	126	258
	No	7	15	14	30	11	123	200
At least one temporary hearing	Yes	23	47	26	47	21	152	316
	No	4	7	7	21	6	97	142

## **5.8 Bivariate analysis of socio-demographic factors among Secondary Aluminum Production Factory workers**

The bivariate analysis summarized in Table 9 below showed that sex and work experience were significantly associated with temporary hearing loss ( $P < 0.05$ ). However, the age and educational level of the study participants were not significantly associated ( $p > 0.05$ ). The work experience of the respondents was significantly associated with temporary hearing loss. Those workers who had more than three years' experience were two times more likely to develop temporary hearing loss [COR 2, 95% (CI= 1.29–3.44)] when compared to workers who had less than one year. Regarding sex, being male was 1.63 times more likely to develop temporary hearing loss [COR 1.63, 95% (C= 1.09–2.43)] when compared to females.

**Table 9** Bivariate analysis of socio-demographic factors and temporary hearing loss among workers in Secondary Aluminum Production Factory

Variables/characteristics	Temporary hearing loss		COR at 95% CI	P-value
	Yes N (%)	No N (%)		
Sex				
Male	202 (44)	74 (16.2)	1.63 (1.09-2.43)	0.017
Female	114 (24.9)	68 (14.8)	1.00	-
Age ( in years)				
19-24	115 (25)	76 (16.6)	1.00	-
25-30	158 (34.5)	47 (10.3)	2.22 (1.44-3.43)*	0.0001
31-40	43 (9.4)	19 (4.1)	1.49 (0.81-2.76)	0.19
Educational status				
Primary	23 (5)	9 (2)	1.01 (0.44-2.28)	0.99
Secondary	110 (24)	61 (13)	0.71 (0.47-1.07)	0.11
Diploma and above	183 (40)	72 (15.7))	1.00	-
Work experience in years				
<1 year	79 (17)	51 (11)	1.00	-
1-3years	100 (21.3)	49 (10.7)	1.32 (0.81-2.15)	0.27
>3 years	137 (29.9)	42 (9.2)	2.11 (1.29-3.44)	0.003

### 5.9. Bivariate analysis of work related factors among workers in Secondary Aluminum Production Factory

As shown in Table 10 below, the work section and length of working hours of the study participants were significantly associated with temporary hearing loss ( $p < 0.05$ ). However, previously work in noisy areas, taking occupational training, and disturbing noise around respondents' residences was not significant ( $p > 0.05$ ). Workers who worked overtime (greater than 48 hours) per week was 2.16 times more likely to develop temporary hearing loss [COR 2.16, 95% (CI 1.4–3.3)] when compared to those who worked than 48 hours. Workers who work in sizing and cold rolling mill work sections were 4.3 and 3.7 times more likely to develop

temporary hearing loss [COR 4.3, 95% (CI=1.86–9.87)] and [COR 3.7, 95% (CI= 1.23–10.94)] respectively when compared to workers who worked in press work sections.

**Table 10** Bivariate analysis of work related factors among workers in Secondary Aluminum Production Factory

Variables/characteristics	Temporary hearing loss		COR at 95% CI	P-value
	Yes	No		
Working hours				
=48hours	174 (38)	103 (22.5)	1.00	-
>48hours	142 (31)	39 (8.5)	2.16 (1.4-3.3)	0.0001
Working department				
Cold rolling mill	23 (5)	4 (0.9)	3.67 (1.23-10.94)	0.02
Sizing	47 (10.3)	7 (1.5)	4.29 (1.86-9.87)	0.001
Polishing	26 (5.7)	7 (1.5)	2.37 (0.99-5.67)	0.53
Furnace	47 (10.3)	21 (4.6)	1.43 (0.80-2.54)	0.22
Raw material sorting	21 (4.6)	6 (1.3)	2.23 (0.87-5.73)	0.09
Press and kettle	152 (33)	97 (21.2)	1.00	-
Taking training about noise				
Yes				
No	35 (7.6)	16 (3.5)	1.00	-
	281 (61.4)	126 (27.5)	1.02 (0.54-1.91)	0.95
The presence of disturbing noise around residence				
Yes	14 (3)	5 (1.09)	1.27(0.44-3.6)	0.65
No	302 (65.3)	137 (29.9)	1.00	--
Previously work in noisy area				
Yes	19 (4)	3 (0.65)	2.96 (0.86-10.18)	0.08
No	297 (64.8)	139 (30)	1.00	

#### 5.10 Bivariate analysis of behavioral and individual factors among Secondary Aluminum Production Factory

The bivariate analysis as indicated in Table 11 showed that behavioral and individual factors such as using a hearing protective device, listening to music or radio, using an earphone for listening to music or radio, removing ear wax, participating in a dance club, having ever had a

head injury, and having a history of medication were not significantly associated with at least one temporary hearing loss ( $P > 0.05$ ). However, drinking alcohol was significantly associated ( $P < 0.05$ ). Workers who drink alcohol are 1.97 times more likely to develop temporary hearing loss [COR 1.97, 95% (CI =1.22-3.19) when compared to workers who do not drink.

**Table 11 Bivariate analysis of behavioral and individual factors among workers in Secondary Aluminum Production Factory**

Variables	Temporary hearing loss		COR at 95% CI	P-value
	Yes	No		
<b>Alcohol intake</b>				
Yes	100 (21,8)	27 (5.9)	1.97 (1.22-3.19)	0.006
No	216 (47)	115 (25)	1.00	-
<b>Using HPDs</b>				
Yes	27 (60)	7 (91.5)	1.00	-
No	288 (62.9)	135 (29.5)	0.53 (0.23-1.25)	0.15
<b>Listening music/radio</b>				
Yes	261 (57)	124 (270)	0.69 (0.39-1.22)	0.20
No	55 (12)	18 (3.9)	1.00	-
<b>Using earphone to listening music r</b>				
Yes	191 (41.7)	83 (18)	1.09 (0.73-1.63)	0.69
No	125 (27.3)	59 (12.9)	1.00	-
<b>Removed ear wax</b>				
Yes	14 (3)	3 (0.65)	1.00	-
No	302 (65.9)	139 (30.3)	0.47 (0.13-1.65)	0.24
<b>Participate in dance club</b>				
Yes	10 (2.2)	3 (0.66)	1.5 (0.41-5.59)	0.53
No	306 (66.8)	139 (30,3)	1.00	-
<b>Ever had head injury</b>				
Yes	20 (4.4)	6 (1.3)	1.53 (0.6-3.9)	0.37
No	296 (64.5)	136 (29.7)	1.00	-
<b>History of medication</b>				
Yes	18 (3.9)	6 (1.3)	1.37 (0.53-3.53)	0.52
No	298 (65)	136 (29.7)	1.00	-

### **5.11 Multivariate analysis of associated factors among workers in Secondary Aluminum production Factory**

Those variables such as sex, age, educational status, work experience, alcohol intake, using a hearing protective device, and previously working at a noisy job were not significantly associated with temporary hearing loss in multivariate analysis ( $P > 0.05$ ). However, the work departments, sections, and length of working hours of the study participants were significantly associated with temporary hearing loss ( $P < 0.05$ ). (Table.12). Workers who engaged in the sizing work section were 2.99 times more likely to develop temporary hearing loss [AOR 2.99, 95% (CI =1.19–7.5)] when compared to workers who worked in the press work section. Workers who worked overtime (greater than 48 hours) per week was 2.16 times more likely to develop temporary hearing loss [AOR 1.82, 95 % ( CI =1.14-2.9)] when compared to those who worked less than 48 hours.

**Table 12 Multivariate analysis temporary hearing loss and Associated Factors among workers Secondary Aluminum Production Factory Workers**

Variables	Temporary hearing loss		COR (95% CI)	AOR (95% CI)
	Yes	No		
<b>Sex</b>				
Male	202	74	1.63 (1.09-2.43)*	0.83 (0.48-1.42)
Female	114	68	1.00	1.00
<b>Age (in years)</b>				
19-24	115	76	1.00	1.00
25-30	158	47	2.22 (1.44-3.43)	1.79 (1.07-2.97)
31-40	43	19	1.49 (0.81-2.76)	1.01 (0.49-2.07)
<b>Educational status</b>				
Primary (1-8)	23	9	1.01 (0.44-2.28)	1.13 (0.48-2.67)
Secondary (9-12)	110	61	0.71 (0.47-1.07)	0.99 (0.63-1.55)
Diploma and above	183	72	1.00	1.00
<b>Work experience</b>				
<1year	79	51	1.00	1.00
1-3 years	100	42	1.3 (0.81-2.150)	1.23 (0.72-2.010)
>3 years	137	42	2.11 (1.29-3.44)*	1.34 (0.71-2.53)
<b>Working departments</b>				
Cold rolling	23	4	3.6 (1.23-10.94)*	2.59 (0.76-8.85)
Sizing	47	7	4.29 (1.86-9.87)*	2.99 (1.19-7.5)**
Polish	26	7	2.37 (0.99-5.670)	1.75 (0.69-4.45)
Furnace	47	21	1.43 (0.8-2.540)	1.03 (0.49-2.12)
Raw material sorting	21	6	2.23 90.87-5.730	1.29 (0.44-3.82)
Press and kettle	152	97	1.00	1.00
<b>Working hours/ week</b>				
=48 hours	174	103	1.00	1.00
>48hours	142	39	2.16 (1.4-3.3)*	1.82 (1.14-02.9)**
<b>Using HPDs</b>				
Yes	28	7	1.00	1.00
No	288	135	0.53 (0.23-1.25)	1.02 (0.39-2.68)
<b>Previously work at noisy job</b>				
Yes	19	3	2.96 (0.86-10.18)	2.58 (0.71-9.34)
No	297	139	1.00	1.00
<b>Alcohol intake</b>				
Yes	100	27	1.97 (1.22-3.19)*	1.27 (0.70-2.29)
No	216	115	1.00	1.00

Note: 1.00=reference value, \*P<0.05 for COR and \*\*p<0.05 for AOR

### **5.12. Working environment observation in Secondary Aluminum Production Factory**

Using a prepared checklist with some questions relating to noise and working conditions, the working environment was observed. During the observation, there was a high level of noise emitted from the machines. Noisy machinery or sections were not isolated from the rest of the operation; there were no engineering or administrative controls to reduce excessive noise emitted from the machines. It was difficult to interact with nearby workers due to the overwhelming noise in the workplace. There was no ongoing preventive health program to educate employees about the safe level of noise and the health effects of noise exposure. No training was given to the workers. Regarding personal protective equipment, the majority of workers were not using hearing protective devices during work time.

We also observed that some employees used cotton as a hearing protector. The factory had a safety officer. Safety rules were posted in a certain work section and in the compounds with the local language (Amharic) to make them clear. The other observation regarding the noise level indicated that noise in the two cold rolling, hot rolling (furnace), sizing, and polishing work sections was very disturbing and higher than in the raw material sorting and pressing work sections.

## ***6. DISCUSSION***

In this study, the average noise level experienced by the workers in the six work sections was 92.03 dB (A). More than 63% of the personal measurements exceeded the Ethiopian OEL of 90 dB (A) and 96.6% above the World Health Organization OEL of 85 dB (A).

The average noise level in this study was comparable to the study done among iron and steel factory workers in Tanzania (92.2 dB (A)) (6). These findings demonstrated that the noise level in the secondary aluminum production sector varied between sections in the range of 85–99.4 dB (A). These results are comparable to the research conducted among steel industry workers in Thailand and China (18, 59).

The highest noise exposure levels were recorded in cold rolling sections, followed by sizing, which is comparable with the study conducted among iron and steel factory workers in Tanzania (6). This study indicated that 63.3% of the workers had daily exposure levels above 90 dB (A) for 8 hours. However, by OSHA standards, the Ethiopian Occupational Safety and Health Directive Regulation states that the noise level and corresponding time exposure are 90 dB (A) for 8 hours (29). Furthermore, almost all workers did not use hearing protection. This could be a reason for the high prevalence of temporary hearing loss in this study.

The findings of the aerial noise measurement also showed that the highest noise exposure was recorded in the sizing work part, ranging from 90 to 102 LAeq, while the lowest level was recorded in the press work section, ranging from 82 to 94 LAeq. The average aerial noise exposure level of each work section, except the press section, was above the exposure limit standards.

The present study indicated that noise level was not significantly associated with temporary hearing loss. This is similar to the study done among the Akaki basic metal industry in Ethiopia and the metal fabricating industry in Johor, which was not a significant factor in hearing loss,

and in Tanzanian iron and steel workers, which found no significant association between occupational noise levels of 85.0–95.5 dB (A) (7, 20, 34).

However, in other studies, it was one of the determinants of hearing loss (10). The possible reason for this lack of relation between noise level and temporary hearing loss is that hearing loss is likely influenced by other factors such as age, gender, educational level, duration of exposure, the effect of healthy workers, etc. However, the possibility of developing hearing loss cannot be neglected as noise exposure increases.

The prevalence of temporary hearing loss in this study was 69%, which was lower than that of a study done in Tanzania with Iron and steel workers (85.5%) (20). This difference might be due to the differences in the hearing loss assessment methods. For example, in the Tanzanian study, they used audiometry, while in this study; hearing loss was assessed with a questionnaire.

About 56.3% of employees reported that their regular conversations with coworkers were being disrupted by excessive noise. The issue is nearly similar to research carried out in the metal fabrication industry in Kamukunji, Nairobi, wherein 53.4% of the labor force identified noise as the primary cause of speech disturbance (35). Although 52.2% of the workers had experienced buzzing or ringing in the ear, which was higher than the study conducted in the metal fabricating industry in Johor, which was 30%, This difference might be due to the level of noise emitted from the machine, the level of difference in experience of using a hearing protective device, and the noise control measures implemented (34). Besides, 43.2% of workers had difficulties in a telephone conversation, which was comparable to the study among Ayka Addis textile Ethiopia, which was 44.85% (9).

There was concern about the psycho-behavioral impact of noise. Approximately 39.7% and 18.8% of the employees, respectively, stated that noise at work interferes with sleep and causes headaches. The result was different from a study conducted among Indian steel industry workers, of whom 25.5% and 44.6%, respectively, This study found that the factory failed to provide workers with appropriate hearing protection devices, which was consistent with the findings of a

study carried out among Ayka Addis textile and metal factory workers in Gondar city, Ethiopia (9, 10).

In this study, working sections and duration of exposure (length of working hours) were significantly associated with hearing loss. This finding was consistent with other studies (7, 9, 10, 18, 45). In addition the previous contributing factors, 11.1% of secondary aluminum production workers reported being aware of the negative effects of exposure to loud noises. This awareness was comparatively higher than that of steel workers in the United Arab Emirates, who reported being aware of these effects at a rate of 4.1% (33).

## ***7. Strengths and limitations of the study***

- **Strengths of the study**

- A combination of questionnaires, personal and aerial noise measurements, and a workplace observational check list were used in the study.

- ❖ **Limitations of the study**

- Lack of literature on temporary hearing loss and associated factors among aluminum industry workers
- This study used self-reported hearing loss, which can cause bias, and the recommended method is to use audio meter readings to determine the extent of the workers' temporary hearing loss.

## ***8. CONCLUSIONS***

This study indicated that workers in a secondary aluminum production factory are exposed to a very high noise level with a high prevalence of temporary hearing loss. The working departments and duration of exposure (length of working hours) were the determinant factors of hearing in this population. The majority of the workers didn't use hearing protective devices. The workers working in the cold rolling mills, sizing, and buffing (polish) production work sections without hearing protective devices were harmed the most.

## 9. RECOMMENDATIONS

The following recommendations for various account table bodies may be made in light of the study's findings:

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### **For safety officer**

- Implement a continual preventive health program to teach employees about the right noise level and the health effects of hazardous noise.

### **For owner/Managers**

- Should implement noise control measures, like engineering and administrative, to reduce workers' noise exposure.
- Should provide workers with an ear protector to reduce exposure to noises.

### **. For Ministry of Labor and Skill**

- Establish rules and regulations requiring industry-wide hearing conservation programs.
- Should monitor, measure, record, and report noises
- **For future research**, audiometric measurements of secondary aluminum production factory workers should be used in the future.

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## *11. ANNEES*

### **Annex I: participants information sheet**

Hello, my name is .....and I am here on behalf of Meseret Nigussie, a post graduate student from Addis Ababa University College of Health science school of public health department of Environmental and occupational health. I am here to collect information about Ethal aluminum factory workers for the study purpose, and requesting you to participate in this study which would require your response for questions on some related issues.

**1. Topic:** Assessment of noise exposure level, temporary hearing loss and associated factor among Ethal aluminum factory workers in North Sheoa zone, Ethiopia, 2023.

**2. Objective of the study:** To assess the level of noise exposure, temporary hearing loss and its associated factors among workers in Ethal Aluminum factory in North Sheoa Zone Amhara region Ethiopia in 2023. And this information collected from you serve as a baseline information for the country to take a corrective action and to identify the magnitude of the problem in the country as well as to Proper implementation to reduce occupational noise hazards in the metal industries.

**3. Participation procedure and Guidelines:-**The information you provide will be kept completely anonymous. Your name will not be written on the questionnaire. Your answers are completely confidential. It will take only about 20 minutes to complete the interview.

**4. Participant Benefit and risk:** Your participation in the study does not involve risks. You also may experience some benefits from participating in this study. You will be advised how you protect yourself from the effect of noise and use hearing protective devices properly. If you are one of the participants affected with hearing impairment necessary arrangements will be made with the industry management to provide counseling and referral for further diagnosis and treatment.

**5. Study design:** Institutional based cross - sectional study will be conducted from April,1 to June,30, 2023.

**6. Rights to refuse or withdraw:** You don't have to answer any questions that you don't want to answer and you have a full right to withdraw from the study at any time.

**7. Right as a participant:** You have a right to ask any question(s), if you need clarification on the study please contact:

Meseret Nigussie

Phone: +251911776957 E-mail: mesiyemar21@gmail.com.

**Annex II; Informed Consent form**

Having the above information, I kindly ask you to take part in the study.

I the undersigned will like to approve that, as I give my consent to participate in this study after detailed objective of the study have been explained to me in the language I understand. I have also understood that I can withdraw my consent any time without loss of any personal benefits.

1. If yes, continue to the following questions
2. If no, provide compliment, and skip to the next participant

Participant signature: \_\_\_\_\_ Date: \_\_\_\_\_

Interviewer: Name \_\_\_\_\_ signature \_\_\_\_\_

Name of principal investigator Meseret Nigussie

Phone: +251911776957 E-mail: [mesiyemar21@gmail.com](mailto:mesiyemar21@gmail.com)

Questionnaire code: \_\_\_\_\_ Work site: \_\_\_\_\_

Time started \_\_\_\_\_ Time completed \_\_\_\_\_

Result of interview:

1. Completed
2. Respondent not available
3. Refused
4. Partially completed

Checked by Supervisor: Name \_\_\_\_\_ signature \_\_\_\_\_ Date \_\_\_\_\_

**Annex III English Version Questionnaires**

Code of participant-----

Date of data collection -----

<b>PART I; Socio-demographic characteristics</b>			
<b>S.N</b>	<b>Question</b>	<b>Response</b>	<b>Skip</b>
101	Sex	1. Male 2. Female	
102	Age	-----years	

103	Religion	1. Orthodox 2. Muslim 3. Catholic 4. protestant 5. Other-----	
104	Marital status	1. Single 2. Married 3. Divorced 4. Widowed	
105	Educational status	1-8 (primary) 2. 9-12(secondary) 3. Technical/College diploma 4. Degree/above	
106	Total service year in this industry	-----years	
107	What is your income per month	-----ETB	
<b>PART II. WORK RELATED AND NOISE EXPOSURE LEVEL RELATED FACTORS</b>			
<b>201</b>	Have you ever worked in a noisy area before this job?	1. YES 2. No	
<b>202</b>	If your answer is “Yes” for Q number 201 what type? Please Specify it	1. Construction 2. Textile factory 3 Garage 4 Flour mill 5. Others(specify);-----	
<b>203</b>	If yes Q 201 work experience in that industry	-----years/month	
<b>204</b>	Do you have a second job now that have noise	1. yes 1. NO	
<b>205</b>	If yes for Q number 204 what? Please specify	1. Construction 2. Garage 3. Transport 4. others_____	
<b>206</b>	The name of working department	1.. Raw material sorting 2. Melting furnace 3. Cold rolling, 4. Sizing 5. Pressing aluminum sheet 6. Utensil polishing	
<b>207</b>	How many hours do you work per day?	-----hours	
<b>208</b>	How many days do you work per week?	-----days	

<b>209</b>	How much overtime per week do you have?	1. 4hours 2. 5-8hours 3. 9-12 hours 4. No overtime 5.Others	
<b>210</b>	<b>Is there a shift in your schedule?</b>	1.Yes 2.No	
<b>211</b>	If “Yes” for Q number 210, how is the schedule of the shift?	Weekly 2. Monthly 3. Every 3 month 4. Other: _____	
<b>212</b>	Have you had any occupational safety training / education related to noise?	1. Yes 2.No	
<b>213</b>	If Yes Q. 212, How long since your last training/education	----- days/months/years	
<b>214</b>	Is there disturbing noise around your resident?	1.Yes 2.No	
<b>215</b>	If “YES” for Q number 214, what is the source of that noise?	1. Mill 2. Traffic road noise 3. Religious noises 4. Other (specify):____	
<b>216</b>	At what time is this noise present?	1. The whole day 2. The whole night 3. 24 hours 4. Other (specify):____	
<b>217</b>	How do you rate this noise level from the residential area?	1. Very high 2. High 3. Moderate 4. Low	
<b>PART III. INDIVIDUAL FACTORS</b>			
<b>301</b>	Have you had a pre-employment hearing test?	1. Yes 2. No	
<b>302</b>	Have you had a previous hearing test?	1.Yes 2.NO	
<b>303</b>	Was either of your past life ever told by a doctor that you had a severe headache?	1.Yes 2. No	
<b>304</b>	Have you ever faced head injury in your lifetime	1.Yes 2.No	
<b>305</b>	Does the head injuries had problems related to ears	1.Yes 2.No	
<b>306</b>	Have you ever removed ear wax by doctors in your lifetime	1.Yes 2. No	

307	Have you ear drain, ear infection under / above 18 years	1.Yes/ under 18 years 2.Yes/above 18 years 3.No/under 18 years 4.No/above 18 years	
308	Do you take more than 30 minutes to sleep after falling on the bed	1.Yes 2.No	
309	Do you have problem waking up several times per night (3 times and above)	1.Yes 2.No	
310	Do you have problem waking up before you finished your normal sleep at morning	1. Yes 2. No	
311	Do you have problems feeling tired and worn out after waking up with the usual amount of sleep?	1.Yes 2. No	
312	Do you regularly take ototoxic medications?	1. Yes 2. No	
313	If yes Q.312.what is the type of medicine?	Explain?	
314	Has anyone in your family lost hearing before the age of 50?	1.Yes 2. No	

**PART IV. BEHAVIORAL CHARACTERISTICS OF PARTICIPANTS**

401	Do you drink alcohol?	1. Yes 2. No	
402	If yes, Q.104 average frequency?	1. Daily 2. Weekly 3. Monthly 4. Yearly	
403	Do you smoke cigarettes?	. Yes 2. No	
404	If yes Q403, how many per day?	_____/single/ -----/packet/	
405	Do you chew chat?	. Yes 2. No	
406	If yes Q405, how often?	1. Daily 2. 1-3 days per week 3. Rarely (monthly	
407	Do you use any hearing protection devices to protect your ear while at work	1. Yes 2. No	
408	If yes, what type of ear protection do you use?	1. Earmuffs/headphones 2. Ear plugs 3.Others	
409	If yes, how often do you use ear protection devices??	1. Always 2. Sometimes	

		3. Rarely	
410	If No, what is the reason not to use ear protective devices??	1. Not available/provided 2. I know nothing about it 3. I don't believe on its use 4. Is not comfortable for use 5. Other reason_____	
411	Do you listen to music?	1. Yes      2. No	
412	If Yes Q411, how loud do you play this music?	1. Quit      2. Moderate 3. Loud	
413	How often do you listen to music or radio?	1. Sometimes 2. Usually 3. Often	
414	How many hours do you use earphones to listen to music?	1. Not used 2. <2hrs. 3. > 2hrs	
415	Do you participate in music, dance clubs?	1. Yes      2. No	
<b>PART V. TEMPORARY HEARING LOSS RELATED SYMPTOMS QUESTIONNAIRE</b>			
501	Do you have hearing problem now	<b>1. Yes</b> <b>2. No</b>	
502	Do you feel you have hearing problems exactly after you exit from work?	1. Yes 2. No	
503	Do you feel that there is a difference between the two ears?	1. Yes 2. No	
504	Do you have any r there is a difference ringing/ trouble noise in your ears or head?	1. Yes 2. No	
505	If "Yes" Q504, one or both ears?	1. One ear 2. Both ears	
506	If Yes Q504 in one ear, which one ear?	1. Right ear 2. Left ear	
507	If "Yes" Q504, for how long period of time?	_____	
508	Your hearing potential during communication with your friends exactly after exit from work?	1. Without difficulty 2. Do miss some conversation 3. Do miss a lot 4. Difficult conversation	
509	Hearing the condition of a phone call exactly after exit from work?	1. Without difficulty 2. Do miss some conversation 3. Do miss a lot 4. Difficult conversation	
510	Do noise levels prevent conversation	1. Yes	

	with co-workers in a normal voice level when at work?	2.No	
511	Have you noticed ringing/temporary reduction in hearing after you arrive at home?	1. Yes 2. No	
512	Have you noticed a change in your hearing/your ability to understand words in everyday speech?	1. Yes 2. No	

#### IV: Checklist for observation of working place noise and health and safety practice

**Table 7 Checklist for observation of working Environment in Secondary Aluminum production factory**

S/N	Safety factors	Yes	No	Remark
1.	Is there excessive noise in the workplace and is it difficult to communicate with nearby workers?			A yes requires that it difficult to communicate with a person standing 1 meter away without shouting
2.	Have work areas where noise levels make voice communication between employees difficult been identified and warning signs or safety rules in the workplace are posted?			Yes, requires no lack of such signs or posts while inspection around
3.	Have I tried isolating noisy machinery from the rest of the operation and enclosing it effectively?			Yes requires that noisy machinery are separated from the rest of operation and enclosed
4	Where engineering controls are determined not feasible, are administrative controls (i.e. worker rotation) being used to minimize individual employee exposure to noise?			A yes requires that administrative controls (worker rotation) have been applied to reduce employees noise exposure
5.	Is there an ongoing preventive health program to educate employees in safe levels of noise and exposure effects of noise on their health, and use of personal protection?			Attainment of yes requires written programmers for action worked out with them.
6	Is approved hearing protective equipment (noise attenuating devices) available to every employee working in areas where continuous noise levels exceed?			Requires no lack of such equipment and used by each workers while inspection around

7	If they use ear protectors, are employees properly fitted and instructed in their use and care?			A yes requires an example of training given for employer about properly fitted and instructed in their use and care of hearing protection devices
8	Does the industry have health and safety personnel that develop written health and safety programs to educate and prevent them from noise hazards?			Attainment of yes requires either implementation as result of initiative from health and safety personnel or written program for action worked out with them
9	Does the industry follow a written health and safety plan for action in the workplace?			A yes requires completion of at least one of the measures in the plan
10	Are training needs considered in connection with new employment, equipment or other changes?			A yes requires an example of training given as a consequence of a change

That is the end of our observation. Thank you very much for taking time to answer these questions.

Name of investigator \_\_\_\_\_ Signature \_\_\_\_\_ Date \_\_\_\_\_

**Annex V: Amharic version participant information sheet**

ጤናይስጥልኝ! እንደምንአሉ?ሰሜ \_\_\_\_\_ ይባላል።እዚህ የተገኘሁት በአዲስ አበባ ዩኒቨርሲቲ ጤና ሳይንስ ኮሌጅ የህብረተሰብ ጤና ት/ ቤት የአካባቢ እና የሙያ ጤንነት ትምህርት ክፍል የድህረ-ምረቃ ተማሪ የሆኑት መሰረት ንጉሴን ወክሎ ነው።እርሶ በአሉምንደም ፋብሪካ ውስጥ በሚገኙ ሰራተኛ በድምጽ ብክለት እና ተያያዥ የጤና ችግሮች ላይ በሚደረገው ጥናት ውስጥ እንድትሳተፉ ተመርጠዋል። ከታች የተዘረዘሩትን ሀሳቦች ካነበቡት በኋላ ያልገባዎትነገር ካለ ከመስማማትዎ በፊት እንድትጠይቁ በትህትና እጠይቃለሁ።

1. የጥናቱ አላማ: በአሉምንደም ፋብሪካ ውስጥ የሚገኘውን የድምፅ ብክለቶች እና ሰራተኛው ላይ ያደረሰው የጤና ችግር ካለ የችግሩን መጠን ለመለካት ያለመ ነው። ይህ ደግሞ በሀገሪቷ ውስጥ ያለውን የስራ ቦታ ደህንነት ህጉን ትኩረት እንዲሰጠው ይረዳል።

2. መመሪያ: እርሶ የምትሰጡት መረጃ ለማንም ሳይነገር ሚስጥራዊነቱ የተጠበቀ ይሆናል።ስም በዚህ መጠይቅ ላይ አይጻፍም ወይም አይሞላም። ቃለ መጠየቁን ለመሙላት 20 ደቂቃ ይወስዳል።

3. ጉዳትናጥቅም: በዚህ ጥናት ላይ በመሳተፍዎ የሚያመጣው ጉዳት የለም።ጥቅሞች ግን ስለ ድምጽ ብክለት ለሚያስከትሉት ችግሮች እና መፍትሄወ ግንዛቤ ያገኛሉ።አጋጣሚ ሆኖ እርሶ የችግሩ ተጠቂ ቢሆኑ ከማኔጅመንቱ ጋር በመተባበረ የምክር እና የህክምና አገልግሎት እንዲያገኙ ጥረት ይደረጋል።

4. በጥናት ላይ ለመሳተፍ ያለመፈለግ: መመለስ የማትፈልጉ ከሆነ የግድ መመለስ የለብዎትም በማንኛውም ጊዜ ቃለ መጥይቁን ማቆም መብትዎ የተጠበቀ ነው።

5. የተሳታፊዎች መብት:ጥናቱን በተመለከተ ተጨማሪ ማብራሪያ ወይም ጥያቄ ካለዎት በሚከተለው አድራሻ መጠየቅ ይችላሉ።

መሰረት ንጉሴ

ስልክቁጥር:0911776957

ኢ.ሜል: mesiyemar21@gmail.com.

**Annex VI: Informed consent (Amharic version)**

የስምምነት መዋዋያ ቅጽ

ጥናቱን በሚያካሄድዎት አካል ስለጥናቱ በቂ መረጃ ተሰጥቶኛል። የዚህ ጥናት አላማም አሉምንም ፋብሪካ ያለውን የድምፅ ብክለት እና የሚያመጣውን ተያያዥ የጤና ችግሮች መለካትና ማጥናት መሆኑን ተረድቻለሁ። ከኔ የሚወሰደው መረጃ በእኔ ሊይ ምንም ዓይነት ጉዳት የማያስከትልና መረጃውን ለጥናት አላማ ብቻ እንደሚውል ተረድቻለሁ። ማንኛውም እኔን የተመለከተ መረጃ ሚስጥራዊነቱ የተጠበቀ ነው። እንዲሁም በጥናቱ ለመሳተፍ ፊቃደኛ ካልሆንኩ በጥናቱም ለመሳተፍ እንደማልገደድ ነገር ግን በዚህ ጥናት መሳተፊ ለሳይንሳዊ ዕውቀት ጠቃሚ መረጃ የማበርከትና ወደፊት በዚህ ዙሪያ ለሚሰሩ ስራዎች መሰረት የሚሆኑ ግብዓት መስጠት እንደምችል ተረድቻለሁ። በመሆኑምበዚህ ጥናት ላይ ለመሳተፍ የተስማማሁ መሆኔን በፊርማዬ አረጋግጣለሁ።

የተሳታፊው ፊርማ..... ቀን.....

ቃለመጠይቁን ያደረገው ስምና ፊርማ..... ቀን.....

የተቆጣጣሪው/ያረጋገጠው/ ስም----- ፊርማ-----

መጠይቁ የተጀመረበት ሰዓት ----- የተጠናቀቀበት ሰዓት-----

ወ.ጤት 1. ተጠቃሷል

2. ተጠያቂው አልተገኘም

3. ተጠያቂው ተቃዋሚ

4. በከፊል ተጠናቋል.

Annex: VII Amharic version questionnaire

የመጠየቂያ ቅጽ መለያ ቁጥር \_\_\_\_\_

መጠይቁ የተሞላበት ቀን \_\_\_\_\_

<b>ክፍል አንድ: ከስነ-ህዝብና ማህበራዊ ጉዳዮች ጋር የተያያዘ</b>			
ተ/ቁ	መጠይቅ	አማራጭ መልሶች	ማሳለፊያ
101	ፆታ	1. ወንድ      2. ሴት	
102	ዕድሜ	_____ ዓመት	
103	ሀይማኖት	1. ኦርቶዶክስ      2. ሙስሊም 3. ካቶሊክ      4. ፕሮቴስታንት 5. ሌላ: _____	
104	የጋብቻ ሁኔታ	1. ያላገባ/ች      2. ያገባ/ች 3. የፈታ/ች      4. የሞተበት/ባት	
105	የትምህርት ደረጃ	1. 1-8      2. 9-12 3. ዲፕሎማ 4. የመጀመሪያ ዲግሪ እና ከዚያ በላይ	
106	በዚህ ፊብሪካ ለስንት አመት በስራ ቆዩ?	_____ ዓመት	
107	አጠቃላይ የወር ገቢዎት ምን ያህል ነው?	_____ ብር	
<b>ክፍል ሁለት: ከስራና ክድምፅ መጋለጥ ጋር በተያያዘ</b>			
201	ከዚህ በፊት ድምፅ በበዛበት ድርጅት ሰርተው ያውቃሉ?	1. አዎ 2. አላወቅም	አላወቅም ካሉ ወደ ጥያቄ 204 ይለፉ
202	ለቁጥር 201 መልስዎ አዎ ከሆነ ምን አይነት ድርጅት ?	ይግለፁ _____	
203	ለስንት ግዜ/አመት ቆዩ?	_____ ዓመት	
204	አሁን ሌላ ድምፅ ያለው ተጨማሪ ስራ አለዎት ?	1. አዎ 2. የለኝም	የለኝም ካሉ ወደ ጥያቄ 206 ይለፉ
205	ለተራ ቁጥር 204 መልስዎ አዎ ከሆነ ምን ዓይነት ስራ ነው የሚሰሩት ?	ይግለፁ _____	
206	እዚህ እንዲስተራ አሁን የሚሰሩበት ክፍል ስም ምን ይባላል?	1. ጥሬ እቃ መረጣ ክፍል      2. ፈርነስ 3. ሳይዚንግ	

		4ፕረሲግ 5 ኮላዲንግ 6.ፖሊሺን ግ	
207	በዚህ የስራ ክፍል በቀን ለስንት ሰዓት ይሰራሉ?	ለ_____ ሰዓት	
208	በሳምንት ስንት ቀናት ይሰራሉ? _	ለ_____ ቀናት	
209	በዚህ ፋብሪካ ዉስጥ በሳምንት ስንት የትርፍ ሰዓት ሥራ አለዎት?	1. 4 ሰዓት 2. 5-8 ሰዓት 3. 9-12 ሰዓት 4. የለም 5. ሌላ_____	
210	በዚህ ፋብሪካ ሲሰሩ የስራ መቀያየር ፕሮግራም (የስራ ሽፍት) አለ?	1. አዎ 2. የለም	የለም ካሉ ወደ ጥያቄ 213 ይለፉ
211	ለቁጥር 211 መስዎ አዎ ከሆነ ሽፍቱ በየስንት ቀን ነው?	1. በየሳምንቱ 2. በየወሩ 3. በየ 3 ወሩ 4. ሌላ_____	
212	ከዚህ በፊት ከድምጽ ጋር በተያያዘ ስለስራ ቦታ ደህንነት ስልጠና ወስደዉ ያዉቃሉ?	1. አዎ 2. አላዉቅም	አላዉቅም ካሉ ወደ ጥያቄ 215 ይለፉ
213	ስልጠናዉን ከወሰዱ ምን ያህል ጊዜ ሁኖታል ?	------(ቀናት/ ወራት/ ዓመት)	
214	በሚኖሩበት ቤት አካባቢ የሚረብሽ ድምፅ አለ?	1. አዎ 2. የለም	
215	ለቁጥር 215 መልስዎ አዎ ከሆነ የድምፁ ምንጭ ምንድን ነው?	1. ወፍጮ ቤት 2. የመኪኖች ድምፅ 3. የሀይማኖት ተቋማት ድምፅ 4. ሌላ_____	
216	ይህ ድምፅ የሚኖረዉ መኛ ነው?	1. ቀኑን ሙሉ 2. ሌሊቱን ሙሉ 3. 24 ሰዓት 4. ሌላ_____	
217	የዚህን ድምፅ መጠን እንደት ይገልፁታል?	1. በጣም ከፍተኛ 2. ከፍተኛ 3. መካከለኛ 4. ዝቅተኛ	
<b>ክፍል ሶስት: የተሳታፊዉ የግለሰብ ታሪክ</b>			

301	እዚህ መስሪያ ቤት ሊቀጠሩ ሲመጡ የቅድመ ቅጥር የጀር ምርመራ ተደርጎልቅታል?	1. አዎ 2. አልተደረገልኝም	
302	በተራ ቁጥር 301 ከተገለጸው ሌላ የጀር ምርመራ አድረግዎ ያውቃሉ?	1. አዎ 2. አላውቅም	
303	ከዚህ በፊት ሀኪም ቤት ሄደው የራስ ምታት አለባቸው ተብለው ያውቃሉ?	1. አዎ 2. አላውቅም	
304	በህይወት ዘመንዎ የደረሰብዎት የጭንቅላት አደጋ ነበር?	1. አዎ 2. የለም	
305	ለተራ ቁጥር 303 መልስዎ አዎ ከሆነ የጭንቅላት አደጋዎ ከጀር ጋር የተያያዘ ችግር ነበረዎት?	1. አዎ 2. የለውም	
306	ከዚህ በፊት ሀኪም ቤት ሄደው የጀር ኩክ አሰጥተው ያውቃሉ?	1. አዎ 2. አላውቅም	
307	የጀር ኢንፎክሽን ከ18 አመት በታች ወይም ከ18 ዓመት እና በላይ እያሉ አጋጥሞዎት ነበር ?	1. አዎ ከ18 ዓመት በታች 2. አዎ ከ18 ዓመት በላይ 3. የለም	
308	አልጋ ላይ ከተኙ በኋላ እቅልፍ ለመውሰድ ከ 30 ደቂቃ በላይ ይፈጅብዎታል?	1. አዎ 2. አይፈጅብኝም	
309	በአንድ ለሊት ወስጥ ሶስት ጊዜ እና ከ 3 ጊዜ በላይ ከቅልፊዎ የመንቃት ችግር አለብዎት?	1. አዎ 2. የለብኝም	
310	ጠዋት ጠዋት እቅልፍዎን ሳይጨርሱ የመነሳት ችግር አለብዎት?	1. አዎ 2. የለብኝም	
311	መደበኛውን እቅልፍዎን ተኝተው ሲነሱ የድካም እና የድብርት ስሜት አለብዎት?	1. አዎ 2. የለብኝም	
312	አሁን ወይም ሁሌ የምወስዱት መድኃኒት አለ?	1. አዎ 2. የለም	
313	ለተራ ቁጥር 311 መልስዎ አዎ ከሆነ የምን መድኃኒት ነው ሲወስዱ የነበሩት/የሚወስዱት?	ይግለጹ_____	
314	በቤተሰብዎ ውስጥ የመስማት ችሎታን ከ 50 ዓመት እድሜዎ/ዎ በፊት ያጣ ሰው አለ?	1. አዎ 2. የለም	

**ክፍል አራት: ከሰራተኛው ባህሪ ጋር በተያያዘ መጠይቆች**

401	አልኮል ይጠጣሉ?	1. አዎ 2. አልጠጣም	አልጠጣም ካሉ ወደ ጥያቄ 403 ይለፉ
402	ለተራ ቁጥር 401 ፣ መልስዎ አዎ ከሆነ በአማካኝ ይግለጹት?	1. በቀን 2. በሳምንት 3. በወር 3. በዓመት	
403	ስጋራ ያጨሳሉ?	1. አዎ 2. አላጨሰም	አላጨሰም ካሉ ወደ ጥያቄ 405 ይለፉ

404	ለተራ ቁጥር403 መልስዎ አዎ ከሆነ በቀን ምን ያህል ያጨሳሉ?	------(በፍሬ) ------(በፓኬት)	
405	ጫት ይቅማሉ?	1. አዎ 2. አልቅምም	አልቅምም ካሉ ወደ ጥያቄ 407 ይለፉ
406	ለተራ ቁጥር 405 መልስዎ መልስዎ አዎ ከሆነ ስንት ጊዜ?	. በየቀኑ 2. ከ1-3 ጊዜ በላይ 3. አልፎ አልፎ	------(በፍሬ) ------(በፓኬት)
407	የድምፅ መከላከያ መሳሪያ ይጠቀማሉ?	1. አዎ 2. አልጠቀምም	አልጠቀምም ካሉ ወደ ጥያቄ 410 ይለፉ
408	መልስዎ አዎ ከሆነ ምን አይነት መከላከያ መሳሪያ ይጠቀማሉ?	1. ኢርማፍስ 2. ኢርፕላንስ 3. ሌላ ካለ ይጥቀሱ	
409	መልስዎ አዎ ከሆነ በየስንት ጊዜ?	1. ሁልጊዜ 2. አንዳንድጊዜ 3. አልፎአልፎ	
410	ለተራ ቁጥር 407 መልስዎ አልጠቀምም ከሆነ ለምን?	1. መሳሪያው ስለሌለ 2. ስለመሳሪያው ብዙም ዕውቀት ስለሌለኝ 3. ለመጠቀም ስለማላምንበት 4. ምቹት ስለማይሰጠኝ 5. ሌላ ካለ ይጥቀሱ	
411	ሙዚቃ ያደምጣሉ?	1. አዎ 2. አላደምጥም	
412	መልስዎ አዎ ከሆነ በምን ያክል መጠን?	1.በመጠኑ 2.መካከለኛ 3.ጮክ ብሎ	
413	ሙዚቃ ለማድመጥ ኤርፎን በየስንት ጊዜ ይጠቀማሉ?	1. አብዛሆኛውን ጊዜ 2. አንዳንድ ጊዜ 3. ብዙ ጊዜ	
414	ሙዚቃ ለማድመጥ ኤርፎን ለስንት ሰዓት ይጠቀማሉ?	1. አልጠቀምም 2. ከ 2 ሰዓት በታች 3. ከ 2 ሰዓት በላይ	
415	ጭፈራ ቤቶች ፣ ዳንስ ኮንሰርት ይሳተፋሉ?	1.አዎ 2. አልሳተፍም	
<b>ክፍል አምስት: ጊዜያዊ የመስማት ችሎታ መቀነስ ምልክቶች ተዛማጅ ጥያቄዎች</b>			
501	አሁን የጆሮ ችግር አለብዎት?	1. አዎ 2. የለብኝም	

502	ልክ ከስራ ሲወጡ የመስማት ችግር እንዳለብዎት ይሰማዎታል?	1. አዎ 2. አይሰማኝም	
503	ልክ ከስራ ሲወጡ በሁለቱ ጆሮዎች መካከል የመስማት ልዩነት እንዳለ ይሰማዎታል?	1. አዎ 2. አይሰማኝም	
504	ልክ ከስራ ሲወጡ በጆሮዎ ወይም በጭንቅላትዎ ላይ የሚጮህ/የሚረብሽ ድምጽ አለ?	1. አዎ 2. የለም	የለም ካሉ ወደ ጥያቄ 508 ይለፉ
505	ለተራ ቁጥር 504፣ መልስዎ አዎ ከሆነ፣ በአንድ ወይም በሁለቱም ጆሮዎት ነው?	1. በአንዱ 2. በሁለቱም	
506	አንድ ጆሮ ከሆነ የትኛው ነው?	1. በቀኝ ጆሮ 2. በግራ ጆሮ	
507	ለምን ያክል ጊዜ ይቆያል? ወይም ከስንት ጊዜ በኋላ ይለቅዎታል?	ይግለፁ	
508	ልክ ከስራ እንደወጡ ከንድኞችዎ ስያወሩ የመስማት ችሎታዎ ምን ይመስላል?	1. በቀላሉ እሰማለሁ 2. ትንሽ ትንሽ 3. ብዙ ያመልጠኛል 4. አይሰማኝም	
509	ልክ ከስራ እንደወጡ በስልክ ሲያወሩ የመስማት ችሎታዎ ምን ይመስላል?	1. በቀላሉ እሰማለሁ 2. ትንሽ ትንሽ 3. ብዙ ያመልጠኛል 4. አይሰማኝም	
510	በተለመደ ድምጽዎት ከስራ ክፍል ባልደረባዎት ሲያወሩ የማሸናፊት ድምጽ እንዳትሰማሙ ይከለክላል?	1. አዎ 2. አይከለክልም	
511	ቤት ከደረሱ በኋላ መደወል/ጊዜያዊ የመስማት ችሎታ መቀነስ አስተውለዋል?	1. አዎ 2. አላስተዋልኩም	
512	በቀን ተቀን ከሰዎች ጋር በሚያደርጉት ንግግር የመስማት ወይም ቃላቶች የመረዳት ችሎታዎ የሆነ ለውጥ አስተውለው ያውቃሉ?	1. አዎ 2. አላወቅም	

ይህ የመጠይቃችን መጨረሻ ነው። እነዚህ ጥያቄዎችን ጊዜ ወስደው በመመለስ ላደረጉልን ትብብር ከልብ እናመሰግናለን።

**Annexes: VIII Participant information sheet for the noise exposure monitoring:**

How are you? I am Meseret Nigussie I came from Addis Ababa University, College of Health Science, and School of Public Health to conduct research. The aim of the study is to assess the effect of personal noise exposure on temporary hearing loss among workers in Ethal Aluminum factory in Amhara regional state of Ethiopia. Therefore, this study will have a great role in the control and prevention of noise related health effects among aluminum factory workers. Further, I believe that this study will help governmental institutions and stakeholders to focus in this area to solve the problems faced among these workers. During the study period standard dosimeter (noise level) measurement will be conducted. The study has ethical approval from the School of Public Health. You will be requested for the willingness after I provide you the required information about the study.

The procedure how to perform: you will be requested to fix the tools of noise level measurements on your body for quantifying the personal noise level exposure which is probably to be dumped to your ear from the machines. Small size noise level measuring equipment will be put on your shoulder. The tool has no interference with your health as well as your work. The sampling duration is to cover the whole working hours. The principal investigator will help you in fixing the tool, start and stop the Dosimeter equipment.

This study will not provide any direct benefit to the study participants. However, the information obtained from this study will help to generate data in order to design appropriate intervention methods. In addition to that, we will inform you of the exposure level you will have during the exposure assessment. This study will not have any harm to the study participants except spending time for the exposure measurement over the whole working hours. Your participation is voluntary and you have the right to be involved or not after being fully informed. Nothing will happen if you say “No”. If you feel discomfort with the measurement, please be free to withdraw or discontinue at any time you want. The exposure data will not be accessible to anybody other than the study members. Any personal information given by you will be kept confidential.

Whom to contact: If you have any question about the research you may contact Meseret Nigussie (PI) Addis Ababa University, College of Health Sciences, School of Public Health (Tel +251-9-

11-77-69 -57) or Dr.Samson Wakuma (Tel +251-9-23-94-09-98) or Dr.Yifokire Tefera (Tel +251-9-13-75-40-82) (advisors) Addis Ababa University, College of Health Sciences, School of Public Health or School of Public Health ethical review committee (Tel +251-115157701).

At this time, do you want to ask me anything about the purpose or content of this noise level measuring equipment? Are you willing to participate in the study?

