# TEMPORARY THRESHOLD SHIFT AMONG SMALL-SCALE METAL WORKERS EXPOSED TO NOISE LEVELS ABOVE 85 dB (A) IN DAR ES SALAAM, TANZANIA.

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**Master of Science Environment and Occupational Health Dissertation**

**Muhimbili University of Health and Allied Sciences**

**October 2024**

**Muhimbili University of Health and Allied Sciences**
**School of Public Health and Social Sciences**

# TEMPORARY THRESHOLD SHIFT AMONG SMALL-SCALE METAL WORKERS EXPOSED TO NOISE LEVELS ABOVE 85 dB (A) IN DAR ES SALAAM, TANZANIA.

**By**

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**A Dissertation Submitted in (Partial) Fulfilment of the Requirements for the Degree of Master of Science Environment and Occupational Health**

**Muhimbili University of Health and Allied Sciences**
**October, 2024**

## CERTIFICATION

The undersigned certifies that he has read and hereby recommends for acceptance by Muhimbili University of Health and Allied Sciences a dissertation entitled "Temporary Threshold Shift Among Small-Scale Metal Workers Exposed to Noise Levels Above 85 dB(A) in Dar Es Salaam, Tanzania." in (Partial) fulfillment of the requirements for the degree of Master of Science Environment and Occupational Health.

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(Supervisor)

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Date

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Ms. Witness John

(Co-Supervisor)

_____

Date

## DECLARATION AND COPYRIGHT

I Edson Mathias Protas, hereby declare this dissertation is my original work and that it has not been presented and will not be presented to any other University for a similar or any related degree award.

Signature…… Date……...

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## ACKNOWLEDGEMENT

First and foremost, I would like to thank God for granting me the strength, wisdom, and perseverance to complete this research. I extend my deepest gratitude to my parents and my fiancée, Yvonnehope Massawe, for her unwavering support and encouragement. I am immensely grateful to my supervisors, Dr. Israel Nyarubeli, Prof. Simon Mamuya, Miss Witness John, and Dr. Alex Tungu, whose guidance, expertise, and encouragement were invaluable throughout this research journey.

Special thanks to my friends and dear classmates, Mr. Simon Lwaho and Madam Evaline Asenga, for their camaraderie and support. I also extend my sincere appreciation to the DASICO and TAZARA leaders, who welcomed me warmly and provided substantial support in collecting data from their people. My gratitude also goes to the NORHED project and The School of Public Health and Social Sciences as well as the Department of Environmental and Occupational Health at MUHAS for providing the necessary resources and support. Finally, I appreciate participants of this study and all other DASICO and TAZARA team for their cooperation.

## DEDICATION

This work is dedicated to my daughter Aurora Edson Protas, believing one day she will be proud of her dad for the path I have chosen and make her proud of her Surname through this work and more works to come.

## ABSTRACT:

**Background:** Workers in small-scale metal industries in Tanzania are often exposed to noise levels above 85 dB(A) without using hearing protection. This exposure is linked to temporary threshold shifts (TTS), a precursor to permanent hearing damage. While global data highlight the prevalence of TTS in noisy workplaces, there is a lack of studies from African contexts on informal small-scale metal workers, particularly in Tanzania. Nevertheless, Effective control measures to reduce TTS effects, are crucially lacking in these settings.

**Objective**: The study aimed to determine Temporary Threshold Shift before earplug use and during earplug intervention among small-scale metal workers exposed to noise levels above 85 dB(A) in Dar es Salaam, Tanzania.

**Methods:** The study employed a controlled before-and-after design to investigate temporary threshold shift (TTS) among 55 small-scale metal workers. Participants exposed to noise levels above 85 dB underwent baseline audiometry tests without earplugs and post-intervention tests during earplug use. Data on factors influencing TTS, including age, smoking status, and ear infections, were collected through questionnaires and statistically analyzed and the impact of earplugs use on TTS was observed.

**Results:** Among 55 workers, 27% experienced temporary threshold shifts (TTS) at 4 kHz after noise exposure. Mean hearing threshold shifts at 1000, 2000, 3000, and 4000 Hz were not statistically significant. The highest shift was at 4000 Hz (1.6 dB), with TTS greater than 10 dB was most common at this frequency. Factors like age, smoking, earphone use, and ear infections did not significantly affect TTS. Noise exposure of 4-6 hours significantly increased TTS risk. Earplug use significantly reduced TTS at 4000 Hz from 27% to 12.7%, and at 1000 Hz from 14.6% to 9.1%, showing their effectiveness in preventing TTS.

**Conclusion:** The significant reduction in TTS at 4 kHz with earplug use highlights their pivotal role in safeguarding against noise-induced hearing damage. Addressing this frequency-specific vulnerability is crucial for protecting workers' hearing health in noisy environments.

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## ABBREVIATIONS

| | |
|---|---|
| DASICO | Dar es Salaam Small Industries Cooperatives |
| dB | Decibel |
| ISO | International Organization for Standardization |
| MUHAS | Muhimbili University of Health and Allied Sciences |
| NEMC | National Environmental Management Council |
| NIHL | Noise-Induced Hearing Loss |
| NRR | Noise reduction rating |
| OEL | Occupational Exposure Limit |
| OSH | Occupational Safety and Health |
| OSHA | Occupational Safety and Health Authority |
| PTA | Pure tone audiometry |
| SDGs | Sustainable Development Goals |
| SPSS | Statistical Package for Social Science |
| SSMIs | Small Scale Metal Industries |
| SNR | Single number rating |
| TTS | Temporary Threshold Shift |
| TWA | Time Weighted Average |
| WHO | World Health Organization |

## DEFINITION OF TERMS

| | |
|---|---|
| **Noise** | Noise is an unwanted sound or series of sounds that could have a negative impact on people(Seidman and Standring, 2010) |
| **Noise-induced hearing loss (NIHL)** | Is the result of multiple factors causing harm to the auditory systems after being exposed to loud noises in the workplace, outdoors, or during leisure activities. (Broomfield, 2015). |
| **Temporary threshold shift (TTS)** | Is the difference in hearing thresholds of a shift of 10 dB or greater change at 4 kHz in either ear between two consecutive audiometric measurements between post-work and pre-work |
| **Noise reduction rating (NNR)** | It is a measure used to indicate the level of protection a hearing protection device (such as earplugs or earmuffs) provides against noise exposure. The NRR is expressed in decibels (dB), and it estimates how much noise the hearing protection device can block when used correctly |

# CHAPTER ONE

## 1.0. INTRODUCTION

### 1.1. Background

Exposure to high noise levels above 85 dB(A) in the workplace without any protection increases the likelihood of developing Noise-induced Hearing loss (NIHL) among exposed workers (Ding, Yan and Liu, 2019). Workers in Mining, manufacturing industries, construction works, and agriculture have been reported to be exposed to high noise levels mainly produced by tools, operating machines, equipment, and different tasks performed which results in Noise-induced hearing loss(Sunde *et al.*, 2015; Lie *et al.*, 2016; Movahed and Ravanshadnia, 2022).

NIHL from noise exposure occurs in two stages it starts with temporary threshold shift (TTS) which is a reversible and temporary decrease in auditory sensitivity caused by exposure to high sound levels and recovering within hours to a few days after the noise exposure stops and precedes to permanent threshold shift (PTS). PTS is a permanent and irreversible condition resulting from prolonged exposure to loud noises or high-intensity impulse sounds, such as explosions(Kurabi *et al.*, 2019). An effective intervention in controlling Temporary Threshold Shift (TTS) will lower the occurrence of TTS, indicating a reduced likelihood of workers experiencing permanent threshold shift (PTS) due to recurrent exposure to high noise levels

The Global Burden of Disease Report of 2019 estimated that about 1.57 billion people which is 20.3% of the world's population were affected by any kind of hearing loss (Haile *et al.*, 2021), which accounted for 20% of the affected population(Haile *et al.*, 2021). Among the documented causes of hearing loss, noise exposure ranked second (Goines and Hagler, 2007). Additionally, male hockey officials exposed to an average noise level of 93 dB(A) in the United States were found to have a high prevalence of TTS of 86.2%(Adams and Brazile, 2017). Furthermore, a TTS prevalence of 77% was found among bartenders in Poland who were exposed to an average noise level of 95 dB(A)(Wolniakowska *et al.*, 2019). This suggests that noise exposure raises the risk of developing NIHL worldwide and that, for this reason, effective control measures are required in workplaces, regardless of economic status.

In developing nations, the impact of occupational noise exposure on workers' hearing health is of critical concern, with empirical studies revealing alarming rates of TTS. For instance, a study conducted in the forge hammering industry in Egypt documented strikingly high TTS rates of 90.9% and 87.5% among heavy and light hammering sections respectively, exposed to noise levels ranging from 112 to 139 dB(A) (Kamal *et al.,* 1989). Similarly, findings in Ethiopia show that 49% of textile factory workers experienced TTS during their shifts when noise exposure levels exceeded 90 dB(A)(Angaw *et al.*, 2021). Furthermore, studies conducted in India have also observed an increase in TTS(Nandi and Dhatrak, 2008). These statistics underscore the urgent need to address temporary threshold shifts as an occupational noise hazard in developing nations.

In Tanzania, 85.5% of workers exposed to noise levels exceeding 85 dB(A) in an Iron and steel factory developed TTS, as reported recently by Nyarubeli *et al.*, (2021). While other studies only focused on NIHL in general(Yhdego, 1991; Minja *et al.,* 2003; Mndeme *et al.,* 2012; Nyarubeli *et al.*, 2018) Remarkably, among these studies, there is a consistent observation of the absence of hearing protective devices, such as earplugs among workers exposed to elevated noise levels whereas earplugs serve as a safeguard against temporary threshold shift caused by noise exposure during work (Noah et al., 2017).

However, studies on earplugs' effectiveness in real working environments are scarce, and to our knowledge, none found to be done in developing countries. In addition, existing research on earplugs predominantly originates from the United States and Europe, lacking representation from African contexts, particularly in Tanzania where unique working conditions, weather, and climatic factors come into play. This diversity makes it challenging to identify the most suitable ear plug type for noise reduction intervention programs. Despite this, the accessibility and widespread use of earplugs in many workplaces underscore their potential as a simple and effective means to reduce occupational noise exposure(Noah et al., 2017).

Therefore, this study aims to determine the TTS levels before and during the earplug intervention and to assess the effectiveness of earplugs in reducing TTS levels among small-

scale metal workers exposed to noise levels above the occupational exposure limit of 85dB(A) in Dar es Salaam, Tanzania.

### 1.2. **Problem Statement**

Exposure to high noise levels that are above the noise exposure limit (NEL) stands as a significant public health concern (TBS, 2003). While existing studies in Tanzania primarily focus on formal sectors (Yhdego, 1991; ndem *et al.,* 2012; Nyarubeli *et al.*, 2018), only a limited number of studies focus on the informal small-scale metal industries (SSMI)(Minja *et al.*,2003).

Recent evaluations of Temporary Threshold Shift (TTS) have been conducted in formal sectors characterized by structured organization (Nyarubeli *et al.*, 2019). However, in the informal and less structured SSMIs, TTS and hearing protection interventions remain unexplored, leaving the extent of the issue largely unknown.

The lack of enough information on SSMIs highlights the need for an intervention study aimed at preventing and controlling Noise-Induced Hearing Loss (NIHL). Recognizing that TTS serves as a proxy indicator for NIHL, controlling TTS has the potential to mitigate Permanent Threshold Shift (PTS) and, consequently, reduce NIHL among workers in small-scale metal industries.

Therefore, this study aims to determine the TTS levels among small-scale metal workers as well as the effectiveness of earplugs in controlling noise exposure and in improving hearing health among informal SSMI in Dar es Salaam, Tanzania,

## 1.3. **The Conceptual Framework**

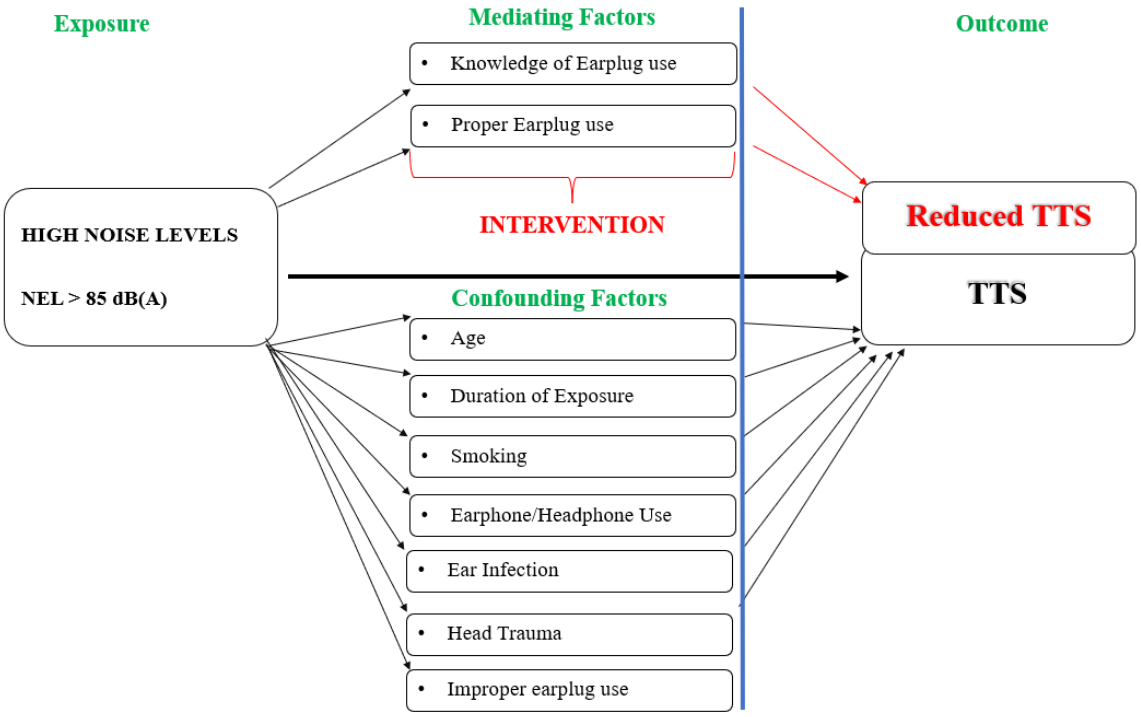



*Figure 1 1.3: The Conceptual Framework*

The conceptual framework delineates the direct relationship between exposure to high noise levels (above 85 dB[A]) and the consequent development of TTS among workers SSMIs. Simultaneously, highlights the interplay of mediating and confounding factors that influence TTS levels.

**Direct Relationship:** Exposure to elevated noise levels serves as the primary driver for the development of TTS. Whereas the immediate impact of noise on auditory health establishes a clear cause-and-effect relationship.

**Mediating Factors:** The mediating factors, namely the knowledge and proper use of PPE, play a pivotal role in influencing the outcome. As a result of intervention efforts, increased awareness and effectiveness of earplugs, act as mechanisms to control and reduce TTS levels among SSMI

workers. This mediation pathway represents a proactive approach to mitigating the adverse effects of noise exposure.

**Confounding Factors:** These confounding factors introduce complexity to the scenario. These elements, such as Age, the duration of exposure, smoking, Use of earphones/headphones, Ear infection, Improper earplug use, and Head trauma can contribute to the occurrence of TTS among SSMI workers. Confounding factors represent challenges that, if not addressed, may impede the success of intervention strategies.

Therefore, the conceptual framework emphasizes the dual nature of factors influencing TTS in SSMIs. While exposure to high noise levels remains the primary catalyst, mediating factors, influenced by intervention efforts, offer a pathway for positive control. while confounding factors underscore the need for comprehensive strategies to address the multifaceted challenges associated with occupational noise exposure in small-scale metal industries.

## 1.4. **Rationale**

This study aligns with multiple Sustainable Development Goals (SDGs), with a focus on Goal 3: Good Health and Well-Being, prioritizing the health of small-scale metal workers. The research empowers these workers by raising awareness about the risks of noise exposure and demonstrating the effectiveness of Hearing Protection Devices (HPDs) like earplugs in preventing Temporary Threshold Shift (TTS).

Additionally, it contributes to Goal 8: Decent Work and Economic Growth, by informing Occupational Health and Safety (OSH) and environmental policies in Tanzania. The findings will help tailor regulations to address the specific hazards faced by workers in the informal metal industry, promoting a safer working environment.

In support of Goal 10: Reduced Inequality, the study fills a knowledge gap regarding the use of hearing protection devices in developing nations, contributing to global efforts aimed at improving workers' health and safety in similar settings.

Finally, the research advances Goal 17: Partnerships for the Goals, by promoting education and awareness initiatives both within academic circles and among the broader public. Through these efforts, it seeks to foster a culture of safety and prevention, ultimately driving behavioral change in workplaces.

## 1.5. Research Question

### 1.5.1. Main Research Question

i. What are the TTS levels among small-scale metal workers who are exposed to noise levels higher than 85 dBA in Dar es Salaam Tanzania?

### 1.5.2. Specific Research Questions:

i. What are the TTS levels among small-scale metal workers exposed to noise levels higher than 85 dBA?
ii. What are the factors influencing TTS among small-scale metal workers who are exposed to noise levels higher than 85 dBA?
iii. What are the TTS status during earplug use among small-scale metal workers who are exposed to noise levels higher than 85 dBA?

## 1.6.Research Objectives

### 1.6.1. Main Research objective

i. To determine TTS among small-scale metal workers who are exposed to noise levels higher than 85 dBA in Dar es Salaam, Tanzania.

### 1.6.2 Specific Research Objectives

i. To determine TTS among small-scale metal workers exposed to noise levels higher than 85 dBA in Dar es Salaam.
ii. To determine the factors influencing TTS among small-scale metal workers who are exposed to noise levels higher than 85 dBA in Dar es Salaam.
iii. To determine TTS during earplug, use among small-scale metal workers who are exposed to noise levels higher than 85 dBA in Dar es Salaam.

# CHAPTER TWO

## 2. LITERATURE REVIEW

Exposure to noise can lead to a decrease in the ear's sensitivity, known as a shift in the threshold of hearing. This shift means that only sounds louder than a certain level will be heard. The shift can be temporary or permanent, depending on the duration and intensity of the noise exposure(Miller, 1974), Temporary threshold shift (TTS) may also coincide with tinnitus, characterized by ringing in the ears. Moreover, repeated exposure to loud noises can exacerbate TTS and increase the risk of permanent hearing damage.

According to the World Health Organization (WHO), occupational noise exposure is a significant global health concern that poses risks to the auditory health and overall well-being of workers. Noise, defined as any unwanted or disruptive sound, has been recognized as a pervasive occupational hazard with the potential to cause Noise-Induced Hearing Loss (NIHL) among exposed individuals. NIHL is a prevalent form of hearing impairment resulting from prolonged exposure to elevated noise levels, and it has been identified as one of the leading causes of preventable hearing loss worldwide.

Globally, the WHO estimates that over 1.5 billion people, constituting approximately 20.3% of the world population, are affected by some form of hearing loss. Of particular concern is the impact of occupational noise exposure on workers, as noise-induced conditions contribute significantly to the overall burden of hearing impairment. In the occupational setting, exposure to noise levels exceeding 85 decibels (dB) poses a heightened risk of NIHL. This risk is particularly pronounced in sectors such as small-scale metal industries, where workers are often exposed to high noise levels arising from various industrial processes.

Occupational noise exposure in industries is characterized by high levels of machinery and metalworking processes. Small-scale metal workers, engaged in tasks such as welding, grinding, and machining, often confront noise levels surpassing the occupational exposure limit of 85dBA which may result in a temporary threshold shift (TTS) which is reversible and recovers within hours to days while prolonged TTS can lead to permanent threshold shift (PTS) (Alberti, 2001).

Therefore, TTS become an important aspect of preventive hearing loss services since TTS control (reducing or eliminating) among workers will also lead to PTS control (John H. Mills, Warren Y. Adkins, 1981).

**2.1. Temporary Threshold shift among small-scale metal workers.**

Studies have consistently identified small-scale metal workers as a high-risk group susceptible to Temporary Threshold Shift (TTS) due to prolonged exposure to elevated noise levels(Minja et al., 2003). In a seminal study conducted in India by (Singh et al., 2010), metal workers exhibited TTS, particularly in environments where comprehensive noise control measures were absent. The dynamic nature of metalworking tasks, characterized by the constant operation of heavy machinery and equipment, amplifies the vulnerability of these workers to TTS.

Expanding on this perspective, a cross-sectional study by (Themann and Masterson, 2019) conducted in a similar industrial setting revealed a significant correlation between the duration of daily noise exposure and the occurrence of TTS among metal workers. This study emphasized that even when noise levels fell below extreme thresholds, extended exposure could contribute to TTS, highlighting the nuanced nature of the relationship between noise exposure and auditory health.

Furthermore, (Hailu, 2015) investigation delved into the impact of age on TTS levels among metal workers. Their findings suggested that older metal workers experienced more pronounced TTS, emphasizing the importance of considering age-related factors in occupational noise exposure studies. This aspect adds a layer of complexity to understanding TTS, indicating that demographic variables can play a role in shaping the individual experience of noise-induced auditory shifts among metal workers. Collectively, these studies contribute to a comprehensive understanding of the intricate interplay between occupational noise exposure and the manifestation of TTS among small-scale metal workers. The findings underscore the need for targeted interventions and tailored preventive measures to address the specific challenges faced by this occupational group.

The variability in Temporary Threshold Shift (TTS) levels among small-scale metal workers is influenced by a multitude of factors, ranging from the intensity and duration of noise exposure

to individual susceptibility. Understanding these factors is crucial for developing effective interventions and tailored strategies to mitigate TTS in this occupational setting. The seminal work by (Singhet al., 2012) highlighted the critical role of the intensity and duration of noise exposure in shaping TTS levels among metal workers. Prolonged exposure to high noise levels, often characteristic of metalworking environments, correlated with an increased likelihood of TTS. This underscores the importance of considering not only the decibel level but also the cumulative duration of exposure in assessing the risk of TTS among workers.

Individual factors, such as age and pre-existing hearing conditions, contribute significantly to the variability in TTS levels. (Darwin, 1895) demonstrated that age is a notable factor, with older metal workers experiencing more pronounced TTS. This aligns with broader research highlighting the impact of age on auditory health, emphasizing the need for nuanced interventions that account for demographic variables. (Snapp *et al.*, 2023) study shed light on the impact of the lack of awareness and inadequate use of Hearing Protection Devices (HPDs) on TTS levels among metal workers. Insufficient knowledge about the risks of noise exposure and the importance of protective measures can result in suboptimal use of HPDs, contributing to higher TTS incidence. This emphasizes the need for educational initiatives and training programs to enhance awareness and promote proper HPD usage.

(Nguyen *et al.*, 2018) expanded the scope of understanding by investigating the role of co-exposure to other occupational hazards, such as chemicals and dust, in amplifying TTS levels among metal workers. This holistic approach recognizes that the workplace environment is multifaceted, with various risk factors interacting synergistically. Addressing TTS comprehensively requires interventions that consider the broader context of occupational health and safety. In essence, these studies collectively illuminate the multifactorial nature of TTS among small-scale metal workers. The interaction of intensity and duration of noise exposure, individual susceptibility, awareness of protective measures, and co-exposure to other hazards underscores the complexity of addressing TTS effectively in this occupational setting. The next section will delve into the efficacy of Hearing Protection Devices (HPDs) in preventing TTS,

providing insights into potential interventions to mitigate the impact of noise exposure on auditory health.

The literature consistently emphasizes the pivotal role of Hearing Protection Devices (HPDs) in mitigating Temporary Threshold Shift (TTS) among small-scale metal workers. Understanding the effectiveness of HPDs is crucial not only for ensuring the well-being of workers but also for informing occupational health and safety policies. The following studies shed light on the relationship between HPD usage and TTS prevention.

(Themann and Masterson, 2019) conducted a meta-analysis consolidating findings from various studies on HPD effectiveness. Their analysis reported a statistically significant decrease in TTS incidence when HPDs were consistently used in noisy occupational settings. This meta-analysis provides a comprehensive overview, reinforcing the consensus that the proper use of HPDs is a valuable strategy for preventing TTS among workers exposed to elevated noise levels. However, the study by (Kapil Singh *et al.*, 2018) delved into the challenges associated with HPD usage. Barriers such as discomfort, inadequate training, and improper fit were identified as factors contributing to suboptimal usage among metal workers. This study underscores the importance of not only providing HPDs but also ensuring comprehensive training programs, addressing comfort issues, and monitoring usage to enhance compliance and overall effectiveness.

These studies collectively affirm the crucial role of HPDs in preventing TTS among small-scale metal workers. The effectiveness of HPDs, when used consistently and correctly, is evident in reducing the risk of TTS. However, the challenges identified in (Kapil Singh *et al.*, 2018) study emphasize the need for a holistic approach that considers not only the provision of protective equipment but also factors influencing its usage. Understanding the nuances of HPD effectiveness contributes to the development of targeted interventions and educational programs. Such initiatives can address barriers to HPD usage, enhance awareness, and promote a culture of proactive hearing protection in small-scale metalworking environments. The effectiveness of HPDs becomes a cornerstone in the broader objective of preventing irreversible hearing damage and promoting the long-term auditory health of workers in these occupational settings.

To contextualize the challenges faced by small-scale metal workers and the importance of preventing Temporary Threshold Shift (TTS), it is essential to examine global statistics on occupational noise exposure. These statistics underscore the widespread nature of the issue and emphasize the need for comprehensive interventions to safeguard the hearing health of workers across diverse industries.

According to (Kapil Singh *et al.*, 2018), approximately 16% of hearing loss worldwide is attributed to occupational noise exposure, affecting around 600 million people. This staggering statistic highlights the significant impact of workplace noise on global auditory health. The WHO recognizes the urgent need for preventive measures to address the burden of hearing loss arising from occupational noise exposure.

The study by (Kim and Kang, 2013) estimates that 25% of the global workforce is regularly exposed to hazardous noise levels in their workplaces. This constitutes a quarter of the working population facing potential risks to their auditory health due to occupational noise. The ILO emphasizes the importance of implementing effective occupational health and safety measures to reduce these exposures and mitigate associated health risks.

According to the study conducted by (Singh et al., 2010), the challenges associated with establishing and enforcing specific occupational noise exposure limits have been notably addressed in developing nations, including those in Africa. The results from their research delve into the complexities associated with implementing and adhering to noise exposure limits, particularly in sectors such as small-scale metal industries. This underscores the need for a nuanced understanding of the occupational noise landscape in developing countries, where unique challenges may hinder the effective regulation of noise exposure.

In a related context, (Dudarewicz *et al.*, 2023) explored the nuances of Temporary Threshold Shift (TTS) in unique working environments, recognizing the necessity for tailored interventions and protective measures that are contextually relevant. Their findings emphasize the importance of understanding the dynamics of TTS in specific occupational settings, shedding light on the potential impact of noise on the hearing health of workers.

Furthermore, (Farrell et al., 2018) scrutinized the utilization of Hearing Protection Devices (HPDs) in small-scale industries, including the metal sector. The results from these research endeavors illuminate regional variations influenced by factors such as awareness, accessibility, and cultural considerations. This highlights the need for a comprehensive understanding of the socio-cultural landscape to effectively promote and implement preventive measures, such as the use of HPDs.

In another context, research conducted by (Moroe *et al.*, 2022) in Africa examined the impact of noise on the hearing health of textile workers, shedding light on the prevalence of NIHL and the challenges faced by workers in adopting preventive measures. This adds a broader perspective to the understanding of noise-induced hearing issues in diverse occupational settings within Africa.

Additionally, studies (Moroe, 2020) in South Africa explored noise exposure in the mining industry, emphasizing the need for comprehensive strategies to protect workers from occupational noise-induced damage. The mining industry poses unique challenges due to the nature of the work environment, and understanding the dynamics of noise exposure in such settings contributes valuable insights to the broader discourse on occupational hearing health.

Complementing these insights, (Nyarubeli, 2019) investigated different types of HPDs and their common use in small-scale industries. Their findings contribute to a nuanced understanding of the advantages and limitations of various devices. Such insights are crucial for tailoring interventions to the specific needs of workers, ensuring that the chosen HPDs are not only effective but also culturally and contextually appropriate.

Building on this existing knowledge base, (Abraham *et al.*, 2019) provided a snapshot of the current state of noise exposure in small-scale metal industries in Dar es Salaam, Tanzania. Their study laid the foundation for recognizing both progress and persisting challenges in occupational noise control within the region. The historical context presented by Abraham et al. serves as a backdrop for understanding the trajectory of noise exposure management in Tanzania, offering valuable insights into the unique challenges faced by workers in this setting.

However, despite these efforts, a discernible knowledge gap persists in comprehending the effectiveness of HPDs in mitigating TTS among small-scale metal workers in Dar es Salaam. The lack of specific studies addressing this population not only underscores the underrepresentation of certain occupational groups in research but also hampers the development of targeted interventions and policies tailored to the unique needs and challenges faced by these workers.

### 2.2. Factors influencing Temporary Threshold Shift.

Small-scale industries orient their businesses mostly on the domestic market although recently they entered the international market(Syarif, 2004). Most of the literature has been shown to identify many confounding and meditating factors involved in one way or another to influence Temporary threshold shifts among workers exposed to more than acceptable noise limit.

**Confounding factors**

Duration of exposure: A study conducted in Tanzania on Temporary Threshold Shift in iron and steel factory workers revealed that workers were exposed to high noise which exceeded the recommended level limits and 85% of workers developed TTS after completing their shift. The study suggests that the duration of exposure of workers from the beginning of their shift to the end influences Temporary Threshold Shifts(Nyarubeli *et al.*, 2021).

Also, a study conducted on Temporary Hearing Loss among factory workers in the Oromia Region, Ethiopia showed that most workers developed TTS after their shift had ended. This study also proves duration of exposure has much influence on Temporary Threshold Shifts among workers exposed to loud noise(Angaw et al.,2021).

Earphone Use: An overview study on occupational Induced Hearing Loss among workers revealed that exposure to loud noise can result in a Temporary threshold shift. The study also emphasized that workers who are continuously exposed to excessive noise may be exposed to impaired transmission of both high and low-frequency sound to the brain(Chen et al., 2020).

Another study done on Temporary Threshold Shifts induced by loud voice signals communicated through Earphones in pinball industries revealed that workers wearing earphones as a mode of communication in noisy environments developed TTS compared to those who didn't wear headphones or earphones. Hence the study also proves that loud voices are good confounding factors of TTS among workers in their workplaces (Idota *et al.*, 2010).

Age: A study done on the evaluation of Noise-induced Hearing Loss among workers of ahvaz steel companies showed that age and working experience are the most two important factors influencing Temporary threshold shift (TTS) and permanent threshold shift (PTS). The study supports there is a significant relationship between age and the TTS of workers exposed to loud noises(Rangkooy *et al.*, 2018).

Another study done on hearing threshold levels among steel industry workers in Thailand revealed that hearing threshold loss related to working experience was greater compared to age and workstation. These findings show age and working experience influence Temporary Threshold Shifts (TTS) when exposed to loud noise above the normal acceptable limit(Kerdonfag et al., 2019).

Smoking: A research study done in Ethiopia on hearing loss and its associated factors among metal workshop workers found cigarette smoking is among the factors associated with increasing odds of Temporary Threshold Shifts(Melese and Adugna, 2022). Therefore, it is emphasized that metal workshop workers who are at high risk of developing temporary or permanent hearing loss must be noticed and preventive strategies must be introduced.

Ear infections: One of the causes of Temporary Threshold Shift is ear infections. When dealing with an ear infection, the area behind the eardrum is prone to a build-up of fluids that puts pressure on your ear structures correlated with hearing(Lexis, 2022).

A narrative review study on the effects of ear infections on hearing ability revealed that otitis media the infection that occurs in the middle ear can lead to Temporary Threshold Shifts.

They showed that the infection causes inflammation of the middle ear and may reach the ear drum and sometimes cause the rapture of the eardrum as a side effect. Hence the fluid in the

middle ear then obstructs the normal hearing ability causing TTS which comes and goes away(Jamal et al., 2022).

Another occupational noise-induced hearing loss prevalence study done on steel-making plants proved that hygienic practices such as cleaning and storage of HPDs can lead to the infection of the ears which increases the possibility of getting Temporary threshold shifts (acute hearing loss). The study also suggested that antibiotics taken were seen to increase the chance of TTS but further studies must be done to prove it(Nkosi et al., 2015).

Head trauma: According to Hearing Center of Excellence Temporary hearing loss and permanent hearing loss are often associated with Traumatic Brain Injuries (TBI). This is due to that TBS damages the inner ear or because there is damage to the part of the brain that processes sound(Excellence, 2023).

A systematic review study from 1996 to 2017 done on hearing loss after traumatic brain injuries without associated temporary bone fracture showed there is a significant association between Temporary Threshold Shifts and Permanent Threshold Shifts and Traumatic Bone Injuries (TBI). The study also suggests the severity of bone injuries influences the nature of hearing loss either TTS or PTS(Remenschneider et al., 2018).

**Mediating factors**

Proper earplug use: A study done on the Improvement of Occupational Noise Temporary Threshold Shift by active noise control earmuff and bone conduction microscope among workers engaged in steel pipe manufacturing, revealed the decrease of TTS among workers after using the new modified earmuffs. The workers gave credit to the device due to its superiority in its conventional clearness of voice-hearing (Temporary *et al.*, 2002).

Knowledge of hearing protective devices use: A study conducted on the development and pilot test of hearing conservation training for construction workers revealed that after training the workers on the importance of using hearing protective devices during noise levels above 85 dB, this doubled the use of the devices and produced a significant outcome on reducing the TTS(Msph, 2007).

Another systematic review study on interventions to prevent occupational-induced-induced hearing Loss revealed that most of the studies discussed showed implementation of hearing conservation programs such as Training. Through this Training, the study shows a considerate decline in TTS among workers and an increase in the use of HPDs especially in conditions of excess noise levels(Matas, 2021).

### 2.3. Temporary Threshold Shift during the use of earplugs to small scale metal workers

Earplugs have been shown to significantly reduce the risk of temporary threshold shift (TTS) by decreasing noise exposure intensity(Gong *et al.*, 2021). Studies in various occupational settings, like manufacturing and construction, have demonstrated their effectiveness. For instance, research published in the Journal of Occupational and Environmental Medicine found that earplug use lowered TTS levels compared to no protection. Additionally, earplugs are beneficial in environments with impulse noise, such as firearms training or live music concerts, where sudden loud sounds can cause auditory damage. Overall, evidence underscores the crucial role of earplugs in preventing TTS and preserving hearing health in noisy settings(Forouharmajd *et al.*, 2022).

In a study published in the Journal of the Acoustical Society of America, researchers explored how earplug insertion depth affects noise attenuation and prevention of temporary threshold shift (TTS). Participants exposed to simulated industrial noise wore earplugs inserted at varying depths in the ear canal. Results showed that deeper insertion led to greater noise level reduction and lowered TTS risk compared to shallow insertion. This highlights the importance of proper earplug insertion for maximizing effectiveness in protecting against TTS and other noise-induced hearing impairments(Prell, 2022).

A study published in the International Journal of Audiology examined different earplug types' effectiveness in reducing temporary threshold shift (TTS) among musicians exposed to high noise levels during rehearsals and performances. Comparing custom-molded musician earplugs, generic foam earplugs, and no protection, results showed significant TTS reduction with both types of earplugs compared to no protection. Custom-molded musician earplugs offered slightly

better protection, particularly in the mid-frequency range. This underscores the importance of using tailored ear protection, like musician earplugs, to mitigate TTS risk in music-related activities(Kraaijenga, 2016).

A study done on evaluating the effectiveness of ear plugs in preventing TTS in auto parts factory in China showed that earplug fit test revealed to have reduced much occurrence of TTS. The study also suggests that expanding the offer of different types of hearing protection, and employee education about the importance of protecting their hearing were recommended to the occupational health and safety program. This shows how hearing protective devices like earplugs are very effectively in protecting or play vital role in preventing TTS(Gong *et al.*, 2021).

# CHAPTER THREE

# 3. METHODOLOGY

## 3.1. **Study Design**

A controlled before and after (CBA) design was used in this study to investigate the temporary threshold shift levels among small-scale metal workers exposed to noise levels above 85 decibels in Dar es Salaam, Tanzania.

## 3.2. Study Area.

This study was conducted in two small-scale metal factories which were purposively selected in Dar es Salaam at DASICO (SSI-A) located at Gerezani-Kariakoo and TAZARA (SSI-B) located at Vetenary Market, Tazara near HESLB (High education Students Loan Board) in Temeke Municipal Council, This SSIs are mainly focused on metal fabrication activities with a population size of 200 and 150 respectively in Dar es Salaam Tanzania.

These small-scale metal factories are made up of self-employed men, in which they form a cooperative organization and they have leaders who represent them as the corporation. Different products are made from the metal fabrication process which can be stretching, folding, heating, and other processes that produces their final products which are specifically for small-scale use for example, cooking stoves, chicken feeding apparatus, Cups for making cakes and ice-cream, Metal buckets, metal suitcases and other small products that are mostly used for household purposes.

## 3.3. **Study population**

The study involved a total of 56 workers from two small-scale metal factories exposed to noise levels above 85dB (A), they were selected from sections that had high noise levels compared to other sections.

### 3.3.1.**Inclusion Criteria**

1. All workers situated in environments with noise levels of 85 dBA and above.

### 3.3.2. Exclusion Criteria

1. Workers with current ear or nasal discharge.
2. Workers experiencing mental health challenges that hinder their ability to perform audiometry tests.

## 3.4. Description of the intervention study

This interventional study aimed to identify the TTS levels and the factors affecting TTS, as well as determine the effect of earplugs on TTS among workers exposed to noise levels above 85dB (A). Workers from two small-scale metal factories were invited and explained in detail about the study and all the procedures that will be involved in gathering the necessary information.

### 3.4.1. **Prio- intervention training on earplug use**

The training of these workers was performed in groups of 20 workers at a time and took 20 minutes per group.The training focused on the procedures of inserting the earplugs and fit-testing was done for each participating worker. Some information given during the training included: - that noise may cause hearing loss, that Noise-induced hearing loss is permanent but can be prevented, that they need to use the earplugs when they are performing their duties or in a noisy environment, that failure to use earplugs even in a short time while working in high noise levels may highly compromise their effectiveness and lastly the hygiene and the shelf life of the earplugs was discussed.

Each worker was provided with a pair of earplugs every day during the project period. The leaders of the workers were trained on how to distribute earplugs and keep records (these groups served as project assistants). The research team conducted check-monitoring an everyday observation to ensure smooth operation.

### 3.4.2. **Earplugs - intervention phases**

**i. Baseline:**

Before the audiometry test, workers were invited for an otoscopy performed by a registered doctor to identify obstructions, discharges, and other factors that might disqualify them from

participating in the study. Workers were excluded due to a complete obstruction by earwax in one ear. Baseline hearing assessments were conducted using air-conduction audiometry both pre- and post-work: in the morning before starting work and in the afternoon during working hours. These tests were performed without the use of earplugs. Additionally, questionnaires were administered to gather information on socio-demographic factors and other variables related to Temporary Threshold Shift (TTS) and earplug use.

**ii. Active Intervention Phase:**

After the baseline air-conduction audiometry, earplugs were provided to the participants, and they were retrained on proper earplug usage, including the need to change the earplugs every three days. During this phase, participants underwent another set of audiometry tests in the morning and afternoon while using earplugs in their daily activities, serving as pre- and post-work assessments. Participants were encouraged to continue using the earplugs consistently for three months.

### 3.5.Sample Size

To ensure a 90% statistical power at a 95% confidence level (2-sided), considering the data from a previous interventional study conducted in a steel manufacturing company where workers were exposed to an average A-weighted sound pressure level of 92-103 dBA, and utilizing ear plugs resulted in a mean temporary threshold shift (TTS) at 4 kHz of 19.6 dB (SD=10.7 dB) with a difference of 6.9 dB (Horie, 2002).

We estimated that assuming a similar noise exposure in our context, ear plugs will effectively reduce occupational noise exposure below the occupational exposure limit (OEL) of 85 dBA among small-scale metal factory workers.

**Given Data from the Study:**

Mean TTS with ear plugs $X_1 = 19.6$ dB,

Standard Deviation (SD) with Earplugs SD = 10.7 dB

Difference in TTS (d) = 6.9 dB

Confidence Level = 95%

Power = 90%

**Given Constants:**

| | |
|---|---|
| $Z_{\alpha/2}$ | Z-score for the desired confidence level (here, 1.96 for 95% confidence). |
| $Z_{\beta}$ | Z-score for the desired power (here, 1.28 for 90% power). |

From the formula for calculating the sample size needed to compare two groups when the endpoint is quantitative data(Charan and Biswas, 2013).

Hence, $$\text{Sample size} = \frac{2SD^2(Z_{\alpha/2}+Z_{\beta})^2}{d^2}$$

$$n = 50$$

To achieve the desired statistical power. A sample size of 50 workers was required from each factory, Moreover, we expect a non-response rate of 10% (0.10) is equal to 55.55.

Approximately 56 workers participated in the study.

### 3.6. Variables

#### 3.6.1. **Dependent variables (outcome variable)**

Temporary Threshold Shift (TTS).

#### 3.6.2. **Independent variables**

This study encompassed a range of factors that influence the outcome of Interest (TTS), which include;

I. Age: This variable was measured in years, capturing participants' chronological age at the time of the study.

II. Use of earphones/headphones in listening to music/radio: Participants were asked about the use of earphones/ headphones during working hours or after working hours.

III. Smoking status: Participants were categorized as nonsmokers, current smokers or former smokers based on questionnaires self-reported smoking habits.

IV. History of head trauma or injury: Participants were asked if they have ever experienced head trauma or injury and if so, to provide details such as the cause and severity.

V. Ear infections experienced during childhood or adulthood: This variable was assessed through self-reporting, where participants indicate whether they have a history of ear infections during childhood, adulthood, or both.

VI. Duration of exposure: Measured in hours, this variable captures the length of time of exposure before and after work (between two audiometric tests) participants have been exposed in small-scale metalworking activities.

Each of these variables provides valuable insight into factors potentially influencing temporary threshold shift levels among small-scale metal workers exposed to high noise levels.

### 3.7. **Investigation tools**

#### 3.7.1. **Questionnaire**

A questionnaire was used to gather information on the factors that may influence temporary threshold shifts.

#### 3.7.2. **Checklist**

Before audiometry, participants were interviewed using a checklist to report any ear discharge, running nose, or other upper respiratory infection symptoms, the time and date of their work departure in hours, and the most recent instance of high noise exposure that interfered with their ability to communicate. Also, During the first week of the intervention, an observation checklist was utilized to document the proper earplug use among workers.

### 3.7.3. **Instrumentation**

#### *3.7.3.1.* **Interacoustics audiometer AD 226, for measuring TTS.**

Pure tone audiometry (PTA) was carried out using the pre-calibrated Interacoustics audiometer AD 226 for air conduction frequencies (0.25 - 8 kHz) in both the left and right ears before the commencement of the shift and during work hours. The threshold was defined as the lowest tone level at which two responses are obtained out of three pure-tone presentations during an ascending run. All measurements took place at the workplaces, within a soundproof mobile audiometric booth specifically designed for this purpose. Before the audiometric test, an otoscopic examination was conducted to identify any potential ear canal obstruction. Participants with complete obstruction were excluded from the study.

#### *3.7.3.2.* **Hearing protective devices (Earplugs).**

Workers exposed to noise levels above 85dB (A) were required to wear earplugs during work. The ability of the earplug to attenuate noise (measured in dB) [standardized noise reduction rating -NRR or mean Single number rating - SNR] was the primary factor in selecting the specific types of earplugs to be used in this study. The assigned NRR was reduced by 7 dB before being subtracted from the actual measured average 8-hour noise levels (LEX,8h) to determine the suitability of the device to be used. The A-weighted scale (dBA) was used to determine occupational noise exposure.

According to earlier research, the average noise exposure in the metal factory, LEX, was 92 dBA for eight hours(Nyarubeli *et al.*, 2018). If the same circumstances persist in these workplaces, Earplugs with an NRR of at least 14 dB were selected. As previously mentioned, however, the actual noise reduction obtained in the field with any earplug would be significantly less than the assigned NRR, and their efficacy is heavily dependent on their appropriate use. Furthermore, the assigned NRR value represents the best-case scenario of noise attenuation and is obtained under ideal laboratory conditions. Therefore, also we implemented a strict derating criterion(Safety, 1998) to be at least comfortable.

## 3.8. **Validity and Reliability issues**

### 3.8.1. **Validity:**

The study complied with established protocols, such as ISO standards, by using a wide range of measurement instruments, such as Interacoustics audiometers. A controlled before and after design improved internal validity and makes it possible to investigate causal relationships. The derating criterion for earplugs also took into consideration real-world circumstances, which adds to the findings' external validity.

### 3.8.2. **Reliability:**

Measurement tools, such as audiometer, were calibrated by ISO standards to ensure reliability. Consistency is ensured through repeated audiometry tests at 2 and 8 kHz, with a threshold for dependable responses that has been established. The study's strict sampling methodology, which took into account potential hearing abnormalities and non-response rates, adds to the overall dependability of the findings. Adherence to ethical principles, including participant confidentiality and data management, is crucial to augmenting the credibility and dependability of research findings.

## 3.9. **Data Management and Analysis**

### 3.9.1. **Data Management**

Every piece of data was gathered and managed carefully. The names of the employees were kept on a different datasheet. Every employee received an identification code for information linking and follow-up. The employee's identification was in paper documentation.

Data entry and analysis were done using Stata version 25. During the study period, the code list and the original paper data were locked away in one of MUHAS offices and were not accessible to anyone else. The database was set up on a particular MUHAS computer.

### **3.9.2. Data Analysis**

A total of 224 audiometry tests were done on both ears on the frequencies of 250, 500, 1000, 2000, 3000, 4000, 6000, and 8000 in two phases, whereas one phase was before the use of earplug and the next phase was during the use of earplugs, data was initially inserted into Excel

for coding and cleaning, and the incomplete data due to loss to follow-up were removed and only 55 data were analyzed both in Excel and in Stata software version 25.

**3.9.2.1 Temporary Threshold shift among small scale metal workers;**

TTS was defined as the difference in hearing thresholds of a shift of 10 dB or greater change at 1,2,3 or 4 kHz in either ear between two consecutive audiometric measurements between post-work and pre-work, whereas the frequency at 4Khz was used to define TTS among the small scale metal workers and the remaining frequencies of 1,2 and 3 kHz where used to observe the trend of TTS across the frequencies.

The calculation of temporary threshold shift (TTS) involved determining the difference in hearing thresholds of a shift of 10 dB or greater change at 4 kHz in the right ear between two consecutive audiometric measurements between post-work and pre-work for each measured frequency and ear, This was done using Microsoft excel from MS office 2016 where the difference in the post and pre audiometry frequencies at 4 kHz which was greater or equal to ten were considered as TTS present then a descriptive statistics was used to analyze the effect of noise exposure to Temporary Threshold Shift levels under Stata software Version 15 and A paired sample T-test was used to check for statistical significance.

**3.9.2.2 Factors Influencing Temporary Threshold Shift.**

Descriptive analysis was used to summarize the data to understand the distribution and characteristics of TTS levels and other variables. Potential determinants of hearing threshold shifts, including age and duration of exposure (in hours), were categorized. Other variables were dichotomized: current smoking status (yes/no), ear infection (yes/no), head trauma (yes/no), earphone/headphone use (yes/no), and smoking status (yes/no).

Data analysis was performed using Stata version 15, the outcome variable (TTS) was common, hence conventional logistic regression in bivariate analysis would have overestimated the odds ratio. Additionally, log-binomial regression for multivariable regression was not conclusive for the variables. To address this,

a weighted modified Poisson regression with robust standard error to estimate prevalence ratios (PR) and to estimate the relative risk directly (McNutt *et al.*, 2003).was used. Using a selection cut-off point of $p \leq 0.05$ in bivariate analysis, a weighted modified multivariable Poisson regression model with robust standard errors was built to identify independent risk factors for TTS among small-scale metal workers(Zou, 2004). The significance level was set at 0.05, and a two-tailed p-value was used for all analyses. Finally, the multivariable regression analysis using the same Poisson regression model adjusted the risk for TTS.

#### 3.9.2.3 Roles of Earplugs on Temporary Threshold Shift.

The difference between TTS measured at the frequency of 4000Hz after the use of earplugs and that before the use, was used to assess their role of in the reduction of TTS. Statistical methods were used to compare the extent of TTS between the conditions with and without earplugs. Whereas the Chi-square test was used to determine if there were significant differences in TTS levels before the use of earplugs and during the use of earplugs.

## 3.10. Ethical Issues

The research proposal underwent an ethical review process by the Institutional Review Board (IRB) at Muhimbili University of Health and Allied Sciences (MUHAS) to obtain clearance for the study. Strict adherence to ethical considerations was maintained, and any ethical issues were appropriately addressed. Prior permission to conduct the study was obtained from the management of the relevant small-scale factories.

Written and informed consent was sought from each participating worker. If there is a need for workplace photos or clear images of workers, explicit permission was obtained from the respective individuals and factories. Confidentiality was rigorously maintained, and no information about individual participants was disclosed to unauthorized parties.

Workers identified with Temporary Threshold Shift (TTS) were provided with appropriate advice and guidance.

Some of the important ethical components needed to be considered which include voluntary participation and consent in which through this participant were made aware of their autonomy

to choose whether or not to participate in the study. Confidentiality where anticipants were made aware of the confidentiality of their information. Risks and benefits Participants were informed that there were no immediate benefits from taking part in this study and that while there is a small chance that information may reach their management. lastly Reimbursement where the participants' participation was free of charge.

# CHAPTER FOUR

## 4.0 RESULTS

### 4.1. DEMOGRAPHIC CHARACTERISTICS

The study initially was planned to involve 56 participants **(31 from Industry A and 24 from Industry B).** One participant was excluded due to a loss to follow-up, resulting in 55 participants being recruited, which corresponds to a response rate of 98.21%. The average age of participants was 42± 14.96, with the majority (n=21; 38.18%) in the range of 40-59 age group. Education levels varied most of the participants 70.91% had attended primary school. Most participants were married (n=43; 78.18%), and Employment status was predominantly permanent (n=50; 90.91%), **more details in Table 1.**

***Table 1: Demographic characteristics of the study population in relation to TTS status of the respondents (n=55)***

| Variables | n=55 (%) | Status of TTS | | P-value |
|---|---|---|---|---|
| | | no | yes | |
| | | n (%) | | |
| **Age Categories** | | | | |
| 20-29 | 16 (29.09) | 11 (68.75) | 5 (31.25) | 0.48 |
| 30-39 | 11 (20) | 9 (81.82) | 2 (18.18) | |
| 40-59 | 21 (38.18) | 14 (66.67) | 7 (33.33) | |
| ≥60 | 7 (12.73) | 6 (85.71) | 1 (14.29) | |
| **Education Level** | | | | |
| Never been to school | 6 (10.91) | 5 (83.3) | 1 (16.67) | 0.28 |
| Primary school | 39 (70.91) | 26 (66.67) | 13 (33.33) | |
| Secondary school | 10 (18.18) | 9 (90.00) | 1 (10.00) | |
| **Marital Status** | | | | |
| Married | 43 (78.18) | 32 (74.42) | 11 (25.58) | 0.73 |
| Separated | 2 (3.64) | 1 (50) | 1 (50) | |
| Single | 10 (18.18) | 7 (70) | 3 (30) | |
| **Employment Status** | | | | |
| Permanent | 50 (90.91) | 35 (70.00) | 15 (30) | 0.15 |
| Temporary | 5 (9.09) | 5 (100) | 0.0 | |
| **Cigarrete Smoking** | | | | |
| No | 38 (69.09) | 27 (71.05) | 11 (28.95) | 0.67 |
| Yes | 17 (30.91) | 13 (76.47) | 4 (25.53) | |
| **Head Trauma** | | | | |
| No | 48 (87.27) | 37 (77.08) | 11 (22.92) | 0.06 |
| Yes | 7 (12.73) | 3 (42.86) | 4 (57.14) | |
| **Earphone use** | | | | |
| No | 26 (47.27) | 18 (69.23) | 8 (30.77) | 0.58 |
| Yes | 29 (52.73) | 22 (75.86) | 7 (24.14) | |
| **Ear Infection** | | | | |
| No | 53 (96.36) | 38 (71.70) | 15 (28.30) | 0.38 |
| Yes | 2 (3.64) | 2 (100.00) | 0 | |
| **Duration of exposure** | | | | |
| ≤3 hrs | 2 (3.64) | 2 (100) | 0 | 0.17 |
| 4-6 hrs | 47 (85.45) | 32 (68.09) | 15 (31.91) | |
| ≥6 hrs | 6 (10.91) | 6 (100) | 0 | |

## 4.2. TEMPORARY THRESHOLD SHIFTS AMONG SMALL-SCALE METAL WORKERS

From a total of 55 workers who participated in the study a total of 15 workers (27%) had TTS at the frequency of 4 kHz after being exposed to noise, A paired sample T-test was run to check for statistical significance. The study found no statistically significant increase in the mean hearing threshold shifts from pre- to post-shifts at audiometric frequencies of 1000, 2000, 3000, and 4000 Hz (P- value > 0.05). The difference in mean hearing thresholds was highest at 4000 Hz [Arithmetic Mean (AM) = 1.6 dB, SD = 9.8 dB], compared to 1000 Hz (AM = 1.1 dB, SD = 10 dB), 2000 Hz (AM = 0.1 dB, SD = 8.6 dB), and 3000 Hz (AM = 1 dB, SD = 10.6 dB)

The greatest proportion of hearing threshold shifts greater than 10 dB was observed at 4000 Hz (approximately 27% of the PTA measurements), compared to about 24%, 13%, and 15% at 3000, 2000, and 1000 Hz, respectively, **refer to figure 2 and 3.**

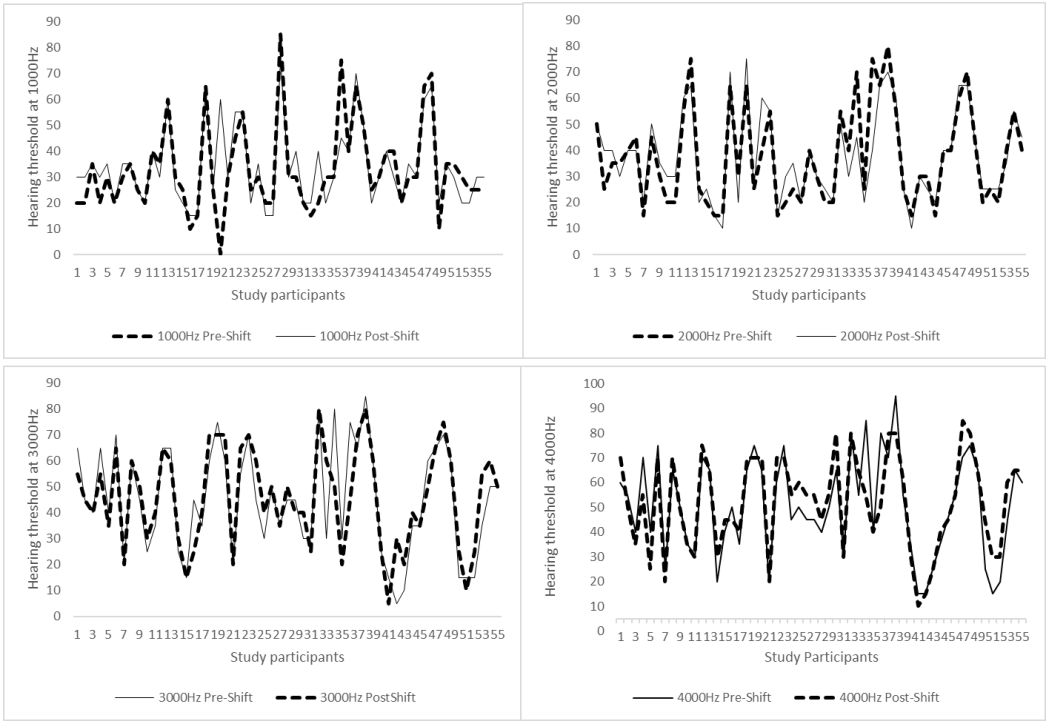



***Figure 2: Pre-shift hearing threshold (solid lines) and post-shift hearing threshold (dotted lines) for the frequencies 1000, 2000, 3000, and 4000 Hz among noise-exposed workers (N = 55).***

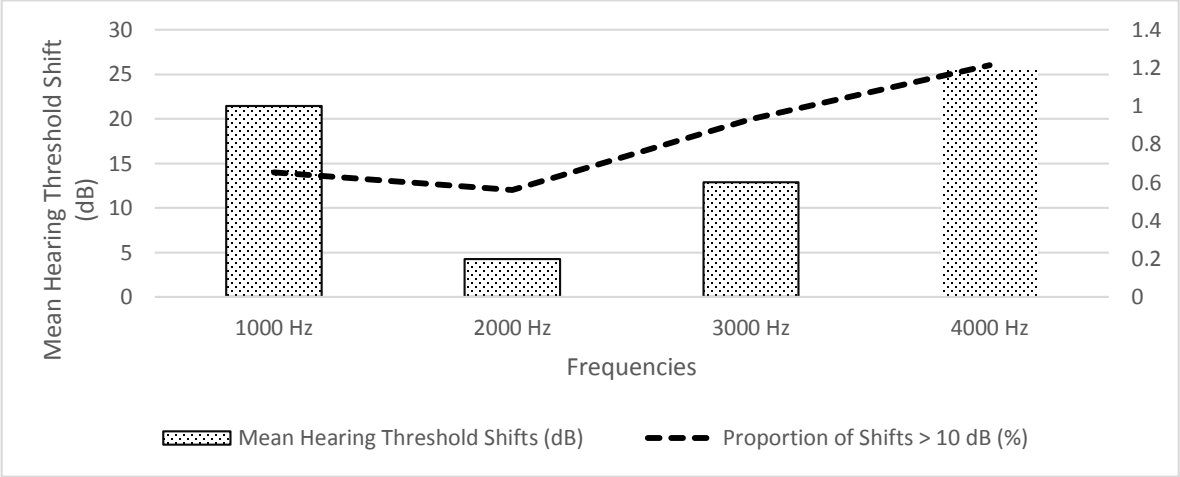



***Figure 3: Mean Hearing Threshold Shifts and Proportion of Shifts Greater Than 10 dB Across Different Frequencies"***

**4.3. FACTORS INFLUENCING TTS**

From table 2, the factors examined include age, smoking status, history of head trauma, earphone use, ear infections, and duration of noise exposure. After conducting weighted modified Poisson regression with robust standard errors, the following results were obtained. Age was not significantly associated with TTS status (APR: 1, 95% CI: 0.96-1.04, p=0.94), with 10 participants aged ≥35 years (28.57%) and 5 participants aged ≤35 years (25%) reporting TTS. Smoking status was also not significantly associated with TTS (APR: 1.03, 95% CI: 0.78-1.17, p=0.67), with 4 smokers (25.53%) and 11 non-smokers (28.95%) reporting TTS. Earphone use (APR: 0.94, 95% CI: 0.79-1.14, p=0.58) and ear infections (APR: 0.93, 95% CI: 0.84-0.93, p<0.000) showed no significant associations, with 7 earphone users (24.14%) and 2 participants with ear infections (3.64%) reporting TTS. Head trauma approached statistical significance (APR: 1.14, 95% CI: 1.00-1.30, p=0.059), with 4 participants with head trauma (57.14%) experiencing TTS compared to 11 without head trauma (22.92%). Duration of noise exposure

for 4-6 hours significantly increased the risk of TTS (APR: 1.28, 95% CI: 1.19-1.46, p<0.000), with 15 participants (31.91%) affected. There were no cases of TTS reported for exposure ≥6 hours. Overall, only the duration of noise exposure (4-6 hours) showed a statistically significant association with TTS, while head trauma approached significance, **Refer to table 2.**

**Table 2: Prevalence Ratios and P-values for Factors Associated with Temporary Threshold Shift (TTS) Among Small-Scale Metal Workers**

| Variable | | TTS present- n (%) | PR | P-value | APR |
|---|---|---|---|---|---|
| **Age** | | | | | |
| | ≤35years | 5 (25) | Reference | | |
| | ≥35years | 10 (28.57) | 1 (0.96-1.04) | 0.94 | 1.00 (0.79-1.19) |
| **Duration of exposure** | | | | | |
| | ≤3 hrs | 0 | Reference | | |
| | 4-6 hrs | 15 (31.91) | 1.32 (1.19-1.46) | 0.000 | 1.28 (1.07-1.51) |
| | ≥6 hrs | 0 | 1 | 1.000 | 0.95 (0.79- 1.09) |
| **Smoking** | | | | | |
| | No | 11 (28.95) | Reference | | |
| | Yes | 4 (25.53) | 0.96 (0.78-1.17) | 0.67 | 1.03 (0.83-1.31) |
| **Head Trauma** | | | | | |
| | No | 11 (22.92) | Reference | | |
| | Yes | 4 (57.14) | 1.13 (1.00-1.30) | 0.059 | 1.14 (1.01-1.3) |
| **Earphone use** | | | | | |
| | No | 8 (30.77) | Reference | | |
| | Yes | 7 (24.14) | 0.95(0.79-1.14) | 0.58 | 0.94 (0.77-1.14) |
| **Ear Infection** | | | | | |
| | No | 53 (96.36) | Reference | | |
| | Yes | 2 (3.64) | 0.88(0.84-0.93) | 0.000 | 0.93 (0.85-1.07) |

## 4.4. TEMPORARY THRESHOLD SHIFT DURING EARPLUG USE

There was a significant reduction in TTS at 4000 Hz, with the proportion of workers experiencing TTS dropping from 27.3% before earplug use to 12.7% during earplug use (Crude OR = 0.46, 95% CI: 0.33-0.64). At frquency of 1000 Hz, the proportion of workers experiencing TTS decreased from 14.6% before earplug use to 9.1% during earplug use (Crude OR = 0.62, 95% CI: 0.43-0.89). At 2000 Hz, there was no change in the proportion of workers with TTS, which remained constant at 12.7% both pre- and during earplug use (Crude OR = 1.00, 95% CI: 0.68-1.46). At 3000 Hz, there was a notable decrease in TTS, with the proportion of affected workers decreasing from 23.6% before earplug use to 18.2% during earplug use (Crude OR = 0.77, 95% CI: 0.61-0.98), from the significant reduction of TTS at 4000Hz it indicates that earplugs are of significant importance in controlling TTS, **Refer to figure 4.**

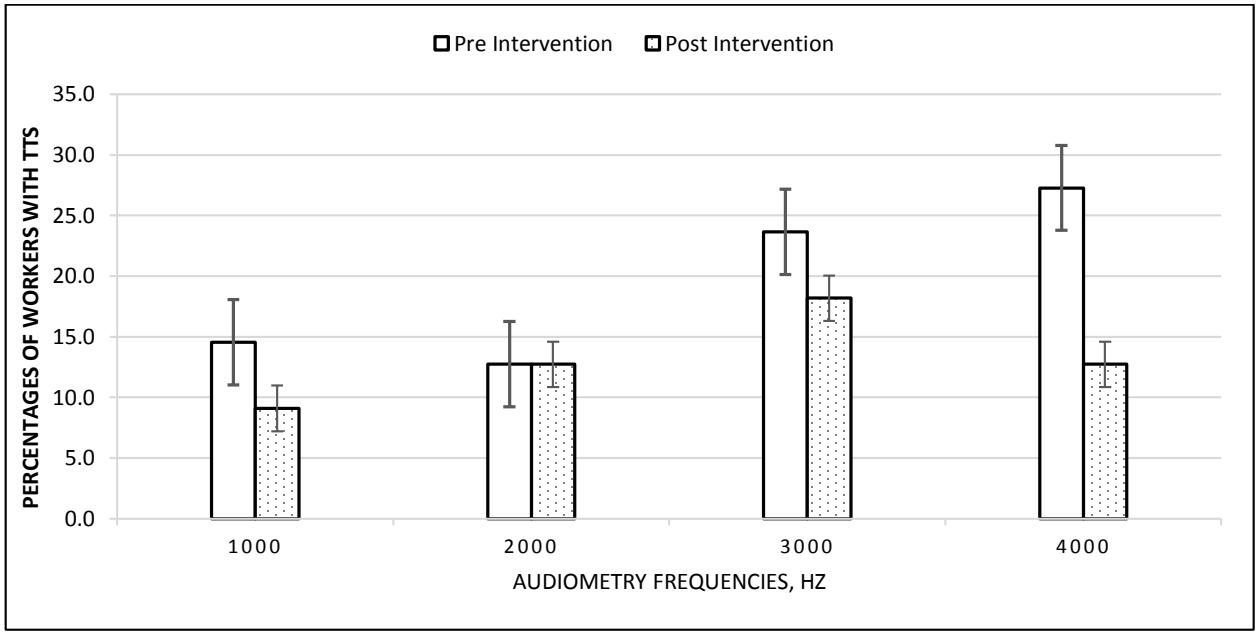



***Figure 4: Differences in TTS levels before and during the use of earplugs on frequencies of 1000, 2000, 3000, and 4000***

# CHAPTER FIVE

# 5.0 DISCUSSION

## 5.1 TEMPORARY THRESHOLD SHIFT AMONG SMALL-SCALE METAL WORKERS

This study examined the prevalence of temporary threshold shift (TTS) among small-scale metal workers, focusing on changes in hearing thresholds after noise exposure. Of the 55 participants, 27% experienced TTS at 4 kHz, a finding consistent with previous research that highlights the susceptibility of higher frequencies to noise-induced hearing loss. However, the paired sample T-test revealed no statistically significant increase in mean hearing threshold shifts from pre- to post-shifts at the audiometric frequencies of 1000, 2000, 3000, and 4000 Hz (P-value > 0.05). Despite the lack of statistical significance, the mean hearing threshold shifts were notably highest at 4000 Hz (AM = 1.6 dB, SD = 9.8 dB), indicating a trend that warrants further investigation.

The proportion of hearing threshold shifts greater than 10 dB was highest at 4000 Hz (approximately 27% of PTA measurements), which aligns with the findings of Nyarubeli et al. (2020), who reported significant threshold increases at this frequency among iron and steel workers. This frequency-specific vulnerability is well-documented in the literature, with higher frequencies often being more affected by noise exposure than lower frequencies (Nyarubeli et al., 2020; Dobie, 2008). In our study, the hearing threshold shifts at 1000 Hz (AM = 1.1 dB, SD = 10 dB), 2000 Hz (AM = 0.1 dB, SD = 8.6 dB), and 3000 Hz (AM = 1 dB, SD = 10.6 dB) were lower, yet the shifts at 3000 Hz also showed a considerable proportion of TTS greater than 10 dB (24%).

The variability in TTS observed among the workers can be attributed to several factors, including differences in individual susceptibility to noise, and the duration and intensity of noise exposure, Previous studies have highlighted the role of individual factors such as age, smoking, diet, and genetic predispositions in influencing susceptibility to noise-induced hearing loss

(Fuente & Hickson, 2011). Additionally, the interaction between noise exposure and other agents such as ototoxic drugs and solvents can exacerbate hearing damage (Johnson & Morata, 2010).

The strengths of this study include the use of standardized methods for data collection, adherence to ISO standards for noise measurement, and the use of a controlled environment for audiometric testing. This methodological procedure ensures the reliability of the findings.

Comparing our findings to other studies, the prevalence of TTS among small-scale metal workers is lower than the 85.5% reported among iron and steel workers exposed to full-shift noise levels of 85–95.5 dB(A)(Nyarubeli *et al.*, 2021).This discrepancy may be due to differences in noise exposure levels, the duration of exposure, and the specific working conditions. For instance, studies among bartenders in Poland found a TTS prevalence of 77% at an average noise exposure of 95 dB(A)(Wolniakowska *et al.*, 2019), furthermore, findings correlated more with the male indoor hockey officials(Adams et al., 2017) Who had a very small duration of exposure of fewer than four hours, and a few sample size of 29 participants where the Hearing threshold shifts of 10 dB or greater were observed in 86.2% (25/29) of officials who were exposed to noise levels greater than 85dB, suggesting that higher noise levels correlate with higher TTS prevalence.

### 5.2. FACTORS AFFECTING TTS

The factors affecting temporary threshold shift (TTS) found that age, smoking status, earphone use, and ear infections were not significantly associated with TTS. This is contradictory to several other studies that have demonstrated associations between these factors and hearing health. The lack of significant association in this study might be attributed to various reasons including sample size limitations, For instance, the sample might not have been large or diverse enough to capture the effects observed in broader populations.

Also, the study identified significant associations with other factors. The duration of noise exposure emerged as a significant factor, with participants exposed to noise for 4-6 hours showing a higher risk of TTS (AOR: 1.28, p=0.000). This finding is supported by (Angaw et

al.,2021). Johnson et al. (2017), who demonstrated a clear dose-response relationship between the end of working shifts and TTS likelihood. Additionally, Furthermore, head trauma approached statistical significance (AOR: 1.14, p=0.059), suggesting an increased risk of TTS. This aligns with the study done by the Hearing Center of Excellence that Temporary hearing loss and permanent hearing loss are often associated with Traumatic Brain Injuries (TBI) (Excellence, 2023).These findings underscore the importance of noise exposure duration and head trauma as significant factors influencing TTS, warranting further exploration to better understand their impacts.

**5.3 TTS DURING EARPLUG USE.**

The mean hearing threshold shifts among individuals before and during earplug use was examined, The results indicated significant differences at 4000Hz frequency, The mean hearing thresholds at 4000 Hz decreased during earplug use from 15 (27%) reported TTS to 7 (13%), suggesting the earplugs's effectiveness in reducing TTS.

The mean hearing thresholds before the intervention were 14.6%, 12.7%, 23.6%, and 27.3% at 1000 Hz, 2000 Hz, 3000 Hz, and 4000 Hz, respectively. During the use of earplugs, these thresholds decreased to 9.1%, 12.7%, 18.2%, and 12.7%, respectively. The most significant reduction was observed at 4000 Hz, suggesting that higher frequencies are more sensitive to the earplug's effects. This pattern aligns with previous studies (Forouharmajd *et al.*, 2022) and (Gong *et al.*, 2021). as well as the study done to assess the Effectiveness of Earplugs in Preventing Recreational-induced–Induced Hearing Loss There were significant differences in the proportion of TTS to the group that used earplugs Specifically, TTS was observed in 4 of 50 ears (8%) in the earplug group vs 22 of 52 ears (42%) in the unprotected group indicating that earplugs are effective means in reducing TTS, particularly at the frequency of 4000 Hz (Ramakers *et al.*, 2016).

The unchanged threshold at 2000 Hz may be attributed to various factors, including earplugs used may not be effective in controlling noise at this frequency, or the presence of other confounding variables. This finding highlights the need for further research to understand the mechanisms underlying frequency-specific responses to hearing interventions.

### 5.4 Limitations

This study has several limitations that should be considered including most of the participants enrolled in the study had Noise-induced hearing loss, with very few who had normal hearing. The sample size was relatively small and may not capture the broader population's variability, potentially limiting the generalizability of the results. Furthermore, potential confounding factors such as diet, genetic predispositions, and ototoxic drug use were not controlled for, which could influence the study's outcomes. Future research should aim to address these limitations by incorporating larger, more diverse samples, longitudinal follow-up, and controlling for a wider range of potential confounders.

# CHAPTER SIX

# 6.0 CONCLUSION AND RECOMMENDATIONS

## 6.1 Conclusion

These findings emphasize the vital role of hearing conservation in noisy occupational settings. The study demonstrates the effectiveness of earplugs in significantly reducing temporary threshold shifts, reinforcing the importance of regular and proper use of hearing protection devices. Additionally, the results highlight exposure duration as a key factor in determining susceptibility to hearing loss, particularly at higher frequencies. While some workers exhibited temporary threshold shifts without permanent damage, the risk of progression to permanent hearing loss over time remains substantial. These insights call for stricter enforcement of noise exposure regulations, routine hearing assessments, and the adoption of comprehensive noise control strategies to safeguard long-term auditory health in the workforce.

## 6.3 Recommendations

Based on the findings of this study,

1. Promoting the use of hearing protection, such as earplugs, is crucial, particularly at higher frequencies where the risk of TTS is more pronounced.
2. Further research is needed to explore the mechanisms underlying frequency-specific responses to noise and hearing protection and to identify more effective protective strategies specifically Providing workers with easy-to-use earplugs, particularly those that do not require folding and rolling, can significantly reduce TTS, as these types are often more suitable for the work environment.
3. Future studies should include larger, more representative samples and consider a broader range of potential influencing factors to provide more comprehensive insights into TTS and its prevention.

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# APPENDICES

## Appendix I: Questionnaire English Version

Please answer all questions thoughtfully, providing as much detail as possible and to the best of your ability. Your responses will be kept strictly confidential and used solely for academic purposes. Thank you for your cooperation.

**Questionnaire number _____**

**Industry Identity _____**

**Instructions:** In all parts except part D, for questions with provided options, please indicate your answer by circling the corresponding number. For questions that require a written response, kindly fill in the provided spaces.

### PART A: SOCIO-DEMOGRAPHIC INFORMATION

| 1 | QUESTION | RESPONSE |
|---|---|---|
| A | Sex | 1. Male<br>2. Female |
| B | Age of participant | …… |
| C | Education Level | 1. Never been to school<br>2. Primary school<br>3. Secondary school<br>4. Tertiary education (vocational / technical college) |
| D | Marital Status | 1. Single<br>2 Married<br>3. Divorced<br>4. Widowed<br>5. Separated |
| E | Employment status | 1. Temporary<br>2. Permanent<br>3. Self-employed |

**PART B: OCCUPATIONAL NOISE EXPOSURE**

| **2** | **QUESTION** | **RESPONSE** |
|---|---|---|
| A. | How many hours do you usually spend at work? | 1. Less than 8<br>2. More than 8 |
| B. | Do you have break time for eating or relaxing | 1. Yes<br>2. No |
| C. | How many minutes/hours do you use for a break during your working hours? | …….. |
| D. | How often do you spend more than 8 hours at work? | 1. None<br>2. Occasionally<br>3. Every day in a week |

**PART C: KNOWLEDGE OF EARPLUG USE**

| **3** | **QUESTION** | **RESPONSE** |
|---|---|---|
| A. | Can exposure to noise cause hearing loss? | 1. Yes<br>2. No |
| B. | Have you ever used anything to protect your ears from loud noises at work?<br>If **No** proceed to **D** | 1. Yes<br>2. No |
| C. | What did use to protect your ears from loud noise? | …… |
| D. | Do you know what an earplug is?<br>If **No** proceed to **J** | 1. Yes<br>2. No |

| | | |
|---|---|---|
| E. | Do you know how to use an earplug to block out noise? | 1. Yes<br>2. No |
| F. | How long do you think you should wear earplugs during your work shift to protect your hearing? | 1. Less than 4 Hours<br>2. Between 4 to 8 Hours<br>3. More than 8 Hours |
| G. | How often do you think earplugs should be replaced or cleaned to keep them working well? | 1. Everyday<br>2. Once a week<br>3. Twice a week |
| H. | Are you aware of any problems that can happen if earplugs are not used correctly?<br>If **No** proceed to **J** | 1. Yes<br>2. No |
| I. | Mention the problem that may occur when earplugs are not correctly used | …… |
| J. | Are you aware of any problems that can happen if you don't use any hearing protection device including earplugs?<br>If **No** proceed to **L** | 1. Yes<br>2. No |
| K. | Mention the problem that may occur when you don't use any hearing protection device | …….. |
| L. | How do you feel about using earplugs to protect your hearing? | Not confident<br>Confident<br>I don't know |

**PART D. HISTORY**

**Instructions:** In this part, please indicate your answer by ticking either "Yes" or "No."

| **4** | **Question** | **Yes** | **No** |
|---|---|---|---|
| A. | Ear infection | | |
| B. | Ear pain | | |
| C. | Have you ever had any trauma or accidents that resulted in head injury? | | |

**PART E: EXPOSURE TO NOISE LEVELS**

| **5** | **QUESTION** | **RESPONSE** |
|---|---|---|
| A. | Are you engaged in any leisure activities with high noise exposure (e.g. playing in a band, attending concerts, disco/club other)?<br>If **No** Proceed to **C** | 1. Yes<br>2. No |
| B. | Please specify the type of leisure activity | ……. |
| C. | Do you usually use earphones/Headphones to listen to music or phone calls?<br>If **No** proceed to **E** | 1. Yes<br>2. No |
| D. | How frequently do you listen using earphones/headphones? | 1. Sometimes<br>2. Always |
| E. | Do you smoke cigarettes? | 1. Yes<br>2. No |
| F. | For how many years | …….. years<br>Number/day …… |
| G. | How many cigarettes do you smoke/day? | |

**Appendix II: Questionnaire_Swahili Version**

## DODOSO

Karibu kujibu maswali yafuatayo kwa umakini, kwa kutoa maelezo Kwa sehemu mbali mbali zilizopo katika Dodoso hili. Majibu yako yatahifadhiwa kwa siri kabisa na kutumika kwa madhumuni ya kitaaluma pekee. Asante kwa ushirikiano wako.

Namba ya Dodoso _____
Utambulisho wa Kiwanda kidogo _____

**Maelekezo:** Katika sehemu zote isipokuwa sehemu D, tafadhali eleza jibu lako kwa kuzungushia "Ndiyo" au "Hapana." Kwenye namba za upande wa kulia na kwa maswali yanayohitaji majibu ya maandishi, tafadhali jaza katika nafasi zilizotolewa.

**SEHEMU A: TAARIFA ZA KIJAMII-KIDEMOGRAFIA**

| **1** | **SWALI** | **MAJIBU** |
|---|---|---|
| A | Jinsia | 1. Mwanaume<br>2. Mwanamke |
| B | Umri wa mshiriki | …… |
| C | Kiwango cha Elimu | 1. Sijawahi Kwenda shule<br>2. Shule ya msingi<br>3. Shule ya Sekondari<br>4. Elimu ya juu (vyuo vya ufundi) |
| D | Hali ya ndoa | 1. Sijaona<br>2 Nimeoa/Nimeolewa<br>3. Nimetalakiwa<br>4. Mgane/Mjane<br>5. Nimeachana |
| E | Employment status | 1. Ajira yam da mfupi/mkataa<br>2. Ajira ya Kudumu<br>3. Kujiajiri |

**SEHEMU B: KELELE KATIKA ENEO LA KAZI**

| **2** | **MASWALI** | **MAJIBU** |
|---|---|---|
| A. | Unatumia masaa mangapi ukiwa kazini? | 1. Chini ya masaa 8<br>2. Zaid ya masaa 8 |
| B. | Je una muda wa mapumziko wa kula au Kupumzika? | 1. Ndio<br>2. Hapana |
| C. | Unatumia muda gani kwa mapumziko wakati wa masaa yako ya kazi? | …….. |
| D. | Je mara ngapi unatumia zaid ya masaa nane kazini? | 1. Hakuna<br>2. Mara kwa mara<br>3. Kila siku katika wiki |

**SEHEMU C:UELEWA KUHUSU MATUMIZI YA PLAGI ZA MASIKIO**

| **3.** | **MASWALI** | **MAJIBU** |
|---|---|---|
| A. | Je kukaa eneo la kelele kusababisha upotevu wa kusikia? | 1.Ndiyo<br>2.Hapana |
| B. | Umewahi kutumia kitu chochote kulinda masikio yako kutokana na kelele kubwa za kazini?<br><br>Ikiwa **hapana** endelea swali la **D** | 1.Ndiyo<br>2.Hapana |
| C. | Unatumia nini kulinda masikio yako kutokana na kelele kubwa ? | ..... |
| D. | Je, unazifahamu plagi za masikio?<br>Ikiwa **hapana** endelea swali la **J** | 1.Ndiyo<br>2.Hapana |
| E. | Je, unajua jinsi ya kutumia plagi za masikio kuzuia kelele masikioni? | 1.Ndiyo<br>2.Hapana |

| | | |
|---|---|---|
| F. | Je, unafikiri ni kwa muda gani unatakiwa kuvaa plagi za masikio pindi unapokuwa kazini? | 1.Chini ya masaa 4<br>2.kati ya masaa 4 hadi 8<br>3. Zaidi ya masaa 8 |
| G. | Unahisi ni mara ngapi plagiz za masikioni zinapaswa kubadirishwa au kusafishwa ili ziweze kufanya kazi vizuri ? | 1.Kila siku<br>2.Mara moja kwa wiki<br>3.Mara mbili kwa wiki |
| H. | Je, unatambua matatizo yoyote yanayoweza kutokea ikiwa plagi za masikio hazitumiwi kwa usahihi?<br>Ikiwa hapana endelea swali la herufi J | 1.Ndiyo<br>2.Hapana |
| I. | Taja tatizo linaloweza kutokea ikiwa earplug hazitumiki kwa usahihi ? | ..... |
| J. | Je, unatambua matatizo yoyote yanayoweza kutokea ikiwa hautumii kifaa chochote cha kulinda masikio ikiwa ni pamoja na plagi za masikio?<br>Ikiwa **hapana** endelea swali la herufi **L** | 1.Ndiyo<br>2.Hapana |
| K. | Je ni tatizo gani ambalo linaweza kutokea endapo hautatumia kifaa chochote kwa ajili ya kulinda masikio? | ..... |
| L. | Je,unahisia gani kuhusu kutumia earplug kulinda kusikia kwako? | 1. Sijiamini<br>2. Najiamini<br>3. Sijui |

**SEHEMU D: HISTORIA**

Maelekezo: Katika sehemu hii, tafadhali eleza jibu lako kwa kuchagua "Ndiyo" au "Hapana."

| **4.** | **MASWALI** | **NDIYO** | **HAPANA** |
|---|---|---|---|
| A. | Je unauonjwa wowote wa masikio? | | |
| B. | Je una maumivu yoyote ya masikio? | | |
| C. | Je,umewahi kupata majeraha au ajali ambayo imesababisha kuumia kichwa? | | |

**SEHEMU E: KUFICHULIWA KWA VIWANGO VYA KELELE**

| **5.** | **MASWALI** | **MAJIBU** |
|---|---|---|
| A. | Je, una shughuli za starehe zenye kuhusisha na kelele kubwa (mf. .kucheza muziki katika bendi,kwenda kwenye tamasha,disko/klabu, ningine)?<br>ikiwa **hapana** endelea na swali herufi **C** | 1.Ndiyo<br>2.Hapana |
| B. | Tafadhali taja aina ya shughuli ya starehe | |
| C. | Je, unatumia earphones/headphones kusikilizia muziki au kuongea na simu?<br>Ikiwa **hapana** endelea na swali herufi **E** | 1.Ndiyo<br>2.Hapana |
| D. | Je, mara ngapi unatumia earphones/headphones kusikiliza mziki au kuongea na simu? | 1.Mara chache<br>2.Mara kwa mara |
| E. | Je, unavuta sigara? | 1.ndiyo<br>2.Hapana |
| F. | Kwa miaka mingapi | .....miaka<br>Siku/idadi..... |
| G. | Je, unavuta sigara ngapi kwa siku? | ..... |

**Appendix III: Concent Form English Version**

**RESEARCH CONSENT FORM**

**Part A: Information Sheet**

**Title of the study:** Determining temporary threshold shift levels among small-scale metal workers exposed to noise levels above 85 dB(A) in Dar es Salaam, Tanzania: an intervention study on the effectiveness of earplug use.

**Introduction**

Greetings; My name is **Edson Protas** and I am from Muhimbili University of Health and Allied Sciences from the School of Public Health and Social Sciences. We are researching on the Temporary threshold shift levels before and after the use of earplugs and their effectiveness in reducing noise exposure **s**pecifically among small-scale metal workers in Dar es Salaam, Tanzania

This form describes necessary things you need to understand before we proceed, you can read it yourself, or I can read it for you. Feel free to ask any questions about this research before we proceed. After responding to your queries, you will decide whether or not to participate in this study. If you choose to participate, you will be required to sign this form and get a copy to keep.

**Purpose of the Study/Aim**

This study aims to determine temporary threshold shift levels among small-scale metal workers exposed to high noise levels in Dar es Salaam, Tanzania, and evaluate the effectiveness of earplug use. If you choose to participate, you'll be involved in various stages outlined below:

**Procedures**

1. **Pre-Intervention Training:**

You will undergo a pre-intervention training session on earplug use in groups of 20 workers at a time. This 20-minute session will cover the proper insertion of earplugs and fit-testing. You will be informed about the risks of noise exposure and the nature of noise-induced hearing loss. The importance of consistent earplug use, even for short durations, will be emphasized. During the project, you will be provided with a pair of earplugs daily, and supervisors will be trained to distribute them, keeping records of usage.

2. **Intervention Phases:**

**i. Baseline Assessment:**

Before the intervention, a baseline hearing assessment will be conducted, including audiometry pre- and post-work without earplugs. A short survey will capture socio-demographic factors, safety conditions, and climate factors related to earplug use. Participants from this assessment will be followed throughout the intervention.

**ii. Active Intervention Phase:**

The first intervention will span three months. Workers will be provided with earplugs to use during their shifts. Educational materials, including posters with hearing prevention messages, will be displayed in visible areas. Observations will ensure proper earplug use, and participants will be encouraged to share their experiences with earplugs use.

**iii. Evaluation Period (After Intervention):**

After the three-month intervention, evaluations will be conducted using audiometry, and information regarding factors influencing earplug use will be collected.

**Voluntary participation**

Participation in this study is voluntary; your information will not be shared with cooperative management or anyone not involved in the research. Also, you can stop participating at any point. Your decisions will not affect anything regarding your personal matters, particularly your job.

**Confidentiality**

The information collected will be stored in a password-secured computer and be used for this study only. No one will be given access to the data except the research team. During reporting identifying information will be removed, like names and positions.

**Risks and Benefits**

Your involvement in this study offers the advantage of gaining insights into the risks linked to noise exposure and the significance of Hearing Protection Devices (HPDs) in managing Temporary Threshold Shift (TTS). This knowledge empowers you to safeguard your auditory health and overall well-being.

However, participation in the study comes with potential drawbacks. These include the possibility of discomfort if earplugs are not worn correctly, and challenges in communication while using earplugs, preventing you from engaging in conversations effectively.

**Reimbursement**

Be informed that you will not be compensated for participating in this study.

**Who to Contact?**

If you have any questions about this study, kindly reach out to Edson Protas (Principal Investigator) by Phone; at +255620113511 and by email; at 98protas@gmail.com if you have any questions concerning your participation rights, contact the Muhimbili University of Health and Allied Sciences, Dr Nahya Masoud, Director of the Research, Publications and Innovation, through P. O. Box 65001, Dar es Salaam phone: 2150302-6.

**Do you have any questions?**

**Part B: Consent Form**

After reading all the required information, do you consent to participate in this study?

**Do you consent to participate? (Tick participant's answer)**

☐ Yes ☐ No

Signature of the participant Date

……. ……..

Signature of the interviewer Date

……. ……

**Appendix IV: Concent Form_Swahili Version**

**Fomu ya Ridhaa ya kushiriki Utafiti**

**Sehemu A: Taarifa za Utafiti**

Jina la utafiti: Kutambua vizingiti vya upotevu usikivu wa mda mfupi kati ya wafanyakazi wa viwanda vidogo vya chuma wanaofanyakazi katika maeneo ya kelele zaid ya decibel A ya 85 Dar es Salaam, Tanzania: utafiti wa ufanisi wa matumizi ya vifaa kinga vya masikio.

**Utangulizi**

Salamu; Jina langu ni Edson Protas na ninatoka Chuo Kikuu cha Afya na Sayansi Shirikishi Muhimbili, Shule ya Afya ya Umma na Sayansi za Jamii. Tunafanya utafiti kuhusu Kutambua vizingiti vya upotevu usikivu wa mda mfupi kati ya wafanyakazi wa viwanda vidogo vya chuma wanaofanyakazi katika maeneo ya kelele na kupima wa vifaa kinga vya masikio katika kupunguza kiwango cha kelele kati ya wafanyakazi wa viwanda vidogo vya chuma.

Fomu hii inaelezea mambo muhimu unayohitaji kuelewa kabla hatujaendelea, unaweza kuisoma mwenyewe, au naweza kukusomea. Jisikie huru kuuliza maswali yoyote kuhusu utafiti huu kabla hatujaendelea. Baada ya kujibu maswali yako, utachagua kushiriki au la. Ikiwa utachagua kushiriki, utahitajika kusaini fomu hii na kupata nakala yako.

**Lengo la Utafiti**

Utafiti huu unalenga Kutambua vizingiti vya upotevu usikivu wa mda mfupi kati ya wafanyakazi wa viwanda vidogo vya chuma wanaofanya kazi katika maeneo yenye viwango vya juu vya kelele. Ikiwa utachagua kushiriki, utahusika katika hatua mbalimbali zilizoainishwa hapa chini:

**Taratibu**

**Mafunzo Kabla ya matumizi ya vifaa kinga vya masikio.**

Utapata mafunzo kabla ya kuanza matumizi ya vifaa kinga vya masikio au plagi ambayo yatafanyika katika vikundi vya wafanyakazi 20 kwa zamu, mafunzo haya yatatumia muda dakika 20 na kuelekeza namna nzuri ya kuvaa plugin a kupima ukaaji wake katika sikio, Utapewa taarifa kuhusu madhara ya kelele katika eneo la kazi na uhalisia wa upotevu wa kusikia unaosababishwa na kelele. Umuhimu wa kutumia plagi mara kwa mara, hata kwa muda mfupi, utasisitizwa. Wewe utapewa plagi za masikio kila siku, na wasimamizi watafundishwa jinsi ya kusambaza na kuhifadhi kumbukumbu ya matumizi.

**Hatua za Mradi:**

**1. Upimaji wa Kabla ya kutumia vifaa kinga vya masikio:**

Kabla ya kuanza kuvaa plagi za masikio, upimaji wa kusikia utafanywa,kama msingi ikiwa ni pamoja na uchunguzi wa audiometri kabla na baada ya kazi bila plagi. Pia Utafiti mfupi utafanyika kujumuisha mambo ya kijamii, hali za usalama, na mambo ya hali ya hewa yanayohusiana na matumizi ya plagi. Washiriki wa upimaji huu watatazamwa wakati wa kipindi chote cha mradi.

**2. Kuanza kwa Mradi na matumizi ya vifaa kinga vya masikio:**

Hatua ya kwanza ya mradi itachukua miezi mitatu. Wafanyakazi watapewa pplagi ya kutumia wakati wa kazi. Vifaa vya elimu, ikiwa ni pamoja na mabango yenye ujumbe wa kuzuia upotezaji wa kusikia, vitapatikana kwenye maeneo yanayoonekana. Uangalizi utahakikisha matumizi sahihi ya plagi, na washiriki watapewa moyo kuelezea uzoefu wao wa matumizi ya masikio.

**3. Kipindi cha Tathmini (Baada ya matumizi ya vifaa kinga vya masikio):**

Baada ya kipindi cha miezi mitatu ya mradi, tathmini itafanywa kwa kutumia audiometri, na taarifa kuhusu mambo yanayoathiri matumizi ya plagi za masikio itakusanywa.

**Uhiari wa Kushiriki**

Taarifa zako hazitashirikishwa na uongozi wa ushirika au mtu yeyote asiye na uhusiano na utafiti. Pia, unaweza kuacha kushiriki wakati wowote. Maamuzi yako hayataathiri chochote kuhusu mambo yako binafsi, haswa kazi yako.

**Usiri**

Maelezo yatakayokusanywa yatahifadhiwa kwenye kompyuta iliyo na neno la siri na kutumika kwa ajili ya utafiti huu pekee. Hakuna mtu atakayepewa ruhusa wwa taarifa hizi isipokuwa timu ya utafiti. Wakati wa kuripoti, maelezo yanayotambulika kama majina na nafasi zitafutwa.

**Athari na Faida**

Ushiriki wako katika utafiti huu unakupa fursa ya kupata ufahamu kuhusu Madhara yanayohusiana na kufanya kazi kwenye maeneo yenye kelele na umuhimu wa Vifaa kinga vya masikio (plagi) katika kupunguza upotevu usikivu wa mda mfupi. Maarifa haya yanakupa uwezo ya lkulinda na kuituza ya masikio na ustawi wako kwa ujumla.

Hata hivyo, kushiriki katika utafiti kunaweza kuja na changamoto. Hizi ni pamoja na uwezekano wa huru ikiwa plagi za masikio hazitavaliwa kwa usahihi, na changamoto katika mawasiliano wakati wa kutumia plagi za masikio, huzuia uwezo wako wa kushiriki kwa ufanisi katika mazungumzo.

**Malipo**

Tafadhali fahamu kwamba hutalipwa fidia kwa kushiriki katika utafiti huu.

**Mtu wa Kuwasiliana**

Ikiwa una maswali yoyote kuhusu utafiti huu, tafadhali wasiliana na Edson Protas (Mtafiti Mkuu) kwa simu; kwa +255620113511 na kwa barua pepe; kwa 98protas@gmail.com. nkiwa una maswali kuhusu haki zako za kushiriki, wasiliana na Chuo cha Sayansi na Afya Shirikishi

Muhimbili kupitia Dk. Nahya Masoud, Mkurugenzi wa Utafiti, Machapisho, na Ubunifu, kupitia S. L. P. 65001, Dar es Salaam simu: 2150302-6.

Je, una maswali yoyote?

**Sehemu B: Fomu ya Idhini**

Baada ya kusoma habari zote muhimu, je, unakubaliana kushiriki katika utafiti huu?

Je, unakubaliana kushiriki? (Piga tiki kwenye jibu la mshiriki)

☐ Ndiyo ☐ Hapana

| | |
|---|---|
| Sahihi ya Mshiriki | Tarehe |
| …… | ……. ……. |
| Sahihi ya Msaili | Tarehe |
| …… | ……. …… |

## Appendix V: Ethical clearance letter

**UNITED REPUBLIC OF TANZANIA**

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

**OFFICE OF THE DIRECTOR – RESEARCH, PUBLICATIONS AND INNOVATION**

Ref. No.DA.282/298/01.C/2107 Date: 18/03/2024

MUHAS-REC-03-2024-2107
EDSON MATHIAS PROTAS
SHOOL OF PUBLIC HEALTH AND SOCIAL SCIENCES MUHAS

**RE: APPROVAL FOR ETHICAL CLEARANCE FOR A STUDY TITLED: TEMPORAL THRESHOLD SHIFT LEVELS AMONG SMALL-SCALE METAL WORKERS EXPOSED TO NOISE LEVELS ABOVE 85 DB(A) IN DAR ES SALAAM, TANZANIA.**

Reference is made to the above heading,

I am pleased to inform you that the Chairman has on behalf of the University Senate, approved ethical clearance of the above-mentioned study, on recommendations of the Senate Research and Publications Committee meeting accordance with MUHAS research policy and Tanzania regulations governing human and animal subjects research.

APPROVAL DATE: 18/03/2024
EXPIRATION DATE OF APPROVAL: 18/03/2025

**STUDY DESCRIPTION:**
**Purpose:**

The purpose of this study is to determine the temporal threshold shift (TTS) levels and their influencing factors among small-scale metal workers exposed to noise levels above 85 dBA in Dar es Salaam, Tanzania.

The approved protocol and procedures for this study is attached and stamped with this letter, and can be found in the link provided: https://irb.muhas.ac.tz/storage/Certificates/Certificate%20-%2015415.pdf and in the MUHAS archives.

**The PI is required to:**

1. Submit bi-annual progress reports and final report upon completion of the study.
2. Report to the IRB any unanticipated problem involving risks to subjects or others including adverse events where applicable.
3. Apply for renewal of approval of ethical clearance one (1) month prior its expiration if the study is not completed at the end of this ethical approval. You may not continue with any research activity beyond the expiration date without the approval of the IRB. Failure to receive approval for continuation before the expiration date will result in automatic termination of the approval for this study on the expiration date.
4. Obtain IRB amendment (s) approval for any changes to any aspect of this study before they can be implemented.
5. Data security is ultimately the responsibility of the investigator.
6. Apply for and obtain Data Transfer Agreement (DTA) from NIMR if data will be transferred to a foreign country.
7. Apply for and obtain Material Transfer Agreement (MTA) from NIMR, if research materials (samples) will be shipped to a foreign country.
8. Apply for and obtain permission to publish the results from National Institute for Medical Research. The application should be before submitting to a publisher and not concurrently through the email publications@nimr.or.tz.
9. Any researcher, who contravenes or fail to comply with these conditions, shall be guilty of an offence and shall be liable on conviction to a fine as per NIMR Act No. 23 of 1979, PART III section 10 (2)
10. The PI is required to ensure that the findings of the study are disseminated to relevant stake holders.
11. PI is required to be versed with necessary laws and regulatory policies that govern research in Tanzania. Some guidance is available on our website https://drp.muhas.ac.tz/.

20/03/24

Dr. Kasusu Nyamuryekung'e

**Ag. Chairperson, MUHAS Research and Ethics Committee**

Muhimbili University of Health and Allied Sciences
DIRECTOR
Research, Publications & Innovations
Box 65001

## Appendix VI: Introduction letter

**UNITED REPUBLIC OF TANZANIA**
MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY
MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES
**OFFICE OF THE DIRECTOR – POSTGRADUATE STUDIES**

In reply quote;
Ref. No. HD/MUH/T.853/2022

13TH May, 2024

District Executive Director,
Temeke District Council,
P.O.Box 46343,
**DAR ES SALAAM.**

**Re: INTRODUCTION LETTER OF EDSON MATHIAS PROTAS**

The bearer of this letter is Edson Mathias Protas (HD/MUH/T.853/2022), a student at Muhimbili University of Health and Allied Sciences (MUHAS) pursuing Master of Science Environment and Occupational Health.

As part of his studies he intends to do a study titled: **"Temporal Threshold Shift Levels Among Small–Scale Metal Workers Exposed To Nose Levels Above 85 DB(A) In Dar Es Salaam".**

The research has been approved by the Chairman of University Senate.

Kindly provide his the necessary assistance to facilitate the conduct of his research.

We thank you for your cooperation.

*Ms. Victoria Mwanilwa*
**For: DIRECTOR, POSTGRADUATE STUDIES**

35

IMEPOKELEWA
2 MAY 2024
MANISPAA YA TEMEKE
S. L. P 46343

c.c. Edson Mathias Protas

9 United Nations Road; Upanga West; P.O. Box 65001, Dar Es Salaam: Tel. G/Line: +255-22-2150302/6; Ext. 1015; Direct Line:+255-22-2151378;Telefax:+255-22-2150465;E-mail:dpgs@muhas.ac.tz;Web:https://www.muhas.ac.tz

**UNITED REPUBLIC OF TANZANIA**

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

**OFFICE OF THE DIRECTOR – POSTGRADUATE STUDIES**

In reply quote;
Ref. No. HD/MUH/T.853/2022

13TH May, 2024

To Manager,
Dar es Salaam Small Industry Co-Operative Society
L.T.D (DASICO),
P.O.Box 4608,
**DAR ES SALAAM.**

**Re: INTRODUCTION LETTER OF EDSON MATHIAS PROTAS**

The bearer of this letter is Edson Mathias Protas (HD/MUH/T.853/2022), a student at Muhimbili University of Health and Allied Sciences (MUHAS) pursuing Master of Science Environment and Occupational Health.

As part of his studies he intends to do a study titled: **"Temporal Threshold Shift Levels Among Small–Scale Metal Workers Exposed To Nose Levels Above 85 DB(A) In Dar Es Salaam".**

The research has been approved by the Chairman of University Senate.

Kindly provide his the necessary assistance to facilitate the conduct of his research.

We thank you for your cooperation.

*Ms. Victoria Mwanilwa*
**For: DIRECTOR, POSTGRADUATE STUDIES**

c.c. Edson Mathias Protas

9 United Nations Road; Upanga West; P.O. Box 65001, Dar Es Salaam: Tel. G/Line: +255-22-2150302/6; Ext. 1015; Direct Line:+255-22-2151378;Telefax:+255-22-2150465;E-mail:dpgs@muhas.ac.tz;Web:https://www.muhas.ac.tz

**Appendix VII: Permission letter**

THE UNITED REPUBLIC OF TANZANIA

PRESIDENT'S OFFICE, REGIONAL ADMINISTRATION AND LOCAL GOVERNMENT

TEMEKE MUNICIPAL COUNCIL

*In reply, please indicate*

REF: .....

Date: 22/05/2024

Temeke HQ

.....

TEMEKE MUNICIPAL COUNCIL

RE: RESEARCH PERMIT: EDSON MATHIAS PROTAS

Please refer to the heading above.

This is to inform you that, permission is granted to the above mentioned student/researcher from MUHIMBILI UNIVERSITY.....to conduct researcher on Temporal Threshold Shifts among Small-Scale Metal Workers.....

The study will be conducted from 26/06/2024 to 05/06/2024 2024.

Please give with necessary assistance.

For: MUNICIPAL DIRECTOR

Kny: Mkurugenzi Mtendaji Wa Temeke

(c.p.)

92 Mandela Road / Taifa, P.O BOX 46343, Dar es Salaam, Telephone +255222928132, Fax +255222928137, Email: temeke@temekemc.go.tz , Website: www.temekemc.go.tz

**DAR ES SALAAM SMALL INDUSTRIES CO- OPERATIVE SOCIETY LTD. (DASICO)**
**USHIRIKA WA VIWANDA VIDOGO D'SALAAM**
P.O. Box 4608, Dar es Salaam, Tanzania
Phone:2180019, Web:www dasico.co.tz Email:info@dasico.co.tz.
dasico1976@gmail.com
DSR38.

**Kumb. Na.: DSC/BC/Vol.0198/024.** **12 Machi, 2024.**

Mkuu wa Idara,
Idara ya Mazingira na Afya Mahali pa Kazi.
Chuo cha Afya na Sayansi Shirikishi Muhimbili (MUHAS).
**Dar es Salaam.**

**YAH: KURUHUSIWA KUFANYA MUENDELEZO WA UTOAJI MAFUNZO, UGAWAJI WA VIFAA VYA KULINDA USIKIVU NA UPIMAJI WA MASIKIO KWA WAFANYAKAZI WA DASICO LTD.**

Tafadhali rejea somo tajwa hapo.

Kwa niaba ya Bodi ya DASICO Ltd kupitia kikao chake maalum kilichofanyika tarehe 19.03.2024 pamoja na mambo mengine, pia kilipokea na kujadili barua yako ya tarehe 18.03.2024 yenye Kumb. Na. SPHSS/DEOH/VOL II/02, iliyoomba kufanya muendelezo wa utoaji wa mafunzo, ugawaji wa vifaa vya kulinda usikivu na upimaji wa masikio kwa wafanyakazi wa DASICO Ltd.

Hivyo basi kwa barua hii napenda kukufahamisha kuwa Bodi ya DASICO Ltd imeridhia/imekubali ombi hilo na umeruhusiwa kufanya muendelezo huo. Pia bodi inatoa shukrani zake za dhati kwenu kwa utafiti huo uliofanyika hapa kiwandani DASICO Ltd.

Ni matumaini ya Bodi ya DASICO Ltd kuwa utaipokea taarifa hii.

**Asante kwa ushirikiano wenu,**

MENEJA USHIRIKA WA DASICO LTD S.L.P 4608 DAR ES SALAAM

**Sijaona M. Mageta.**
**Katibu/Meneja.**
**Kny: Bodi ya DASICO Ltd.**