
Addis Ababa University, College of Health Sciences

School of Public Health

# Welding Fume Exposure and Prevalence of Chronic Respiratory Symptoms among Micro and Small-Scale Enterprise Metal and office work in Akaki Kality, Addis Ababa, Ethiopia: A comparative cross-sectional study

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## Acronyms and Abbreviations

| | |
|---|---|
| ACGIH: | American Conference of Governmental Industrial Hygiene |
| AOR: | Adjusted Odds Ratio |
| ATS: | American Thoracic Society |
| CI: | Confidence Interval |
| COPD: | Chronic Obstructive Pulmonary Disease |
| COR: | Crude Odds Ratio |
| CSA: | Central Statistical Agency |
| EPI info: | Epidemiological information Package |
| ETB: | Ethiopian Birr |
| FCAW: | Flux Core Arc Welding |
| FCV: | Forced Vital Capacity |
| $FEV_1$: | Forced Expiratory Volume |
| GMAW: | Gas Metal Arc Work |
| IARC: | International Agency for Research on Cancer |
| MSSE: | Micro and Small Scale Enterprise |
| NIOSH: | National Institute for Occupational Safety and Health |
| OSHA: | Occupational Safety and Health Association |
| PPE: | Personal Protective Equipment |
| PVC: | Polyvinyl Chloride |
| RPE: | Respiratory Protective Equipment |
| SEG: | Similar Exposure Group |
| SMAW: | Shielded Metal Arc Work |
| SPSS | Statistical Package for Social Science |
| TUG: | Tungsten Inert Gas |
| TWA: | Total Weighted Average |
| USA: | United State of America |
| USD: | United State Dollar |

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## Abstract

**Background**: Exposure to welding fume can lead to different respiratory health disorders including lung cancer due to long term exposures. In Ethiopia there are no investigations conducted on the level of personal welding fume dust exposure and prevalence of chronic respiratory symptoms.

**Objectives**: This study aims at assessing chronic respiratory illness, associated factors, and the metal fume concentration among micro and small-scale enterprise metal workers and micro and small scale and office workers in Akaki Kality, Addis Ababa, Ethiopia.

**Methods:** A Comparative cross-sectional study was conducted on a total of 226 metal workers and 217 office workers. Subjects were selected using stratified sampling methods and the establishments were selected by using systematic random sampling technique. The respiratory symptoms were collected using structured questionnaire adapted from American thoracic society and observational checklists were used to assess respiratory protective equipment, work place ventilation and welding sites. The collected data were analyzed using SPSS version 23. Multivariate analysis was conducted to check the association between dependent and independent variables with p=<0.2. Considering P <0.05 as a significant association and 95% CI.

**Result:** The overall prevalence of chronic respiratory symptoms among metal and office workers were 23.9% and 9.2% respectively. The Geometric mean personal dust exposure among welders were 5.98 $mg/m^3$ (±GSD=1.54). A significance association were seen between welding fume exposure and occurrence of chronic respiratory symptoms in lower educational status (AOR: 5.11, 95% CI: 1.35, 19.33) not utilizing respiratory protective equipment (AOR: 3.33, 95% CI: 1.52, 7.31), not getting a safety training (AOR: 2.41, 95% CI: 1.10, 5.28) welding machine maintenance (AOR: 1.87, 95% CI: 1.01, 3.59) and doing welding task indoor (AOR: 6.85. 95% CI: 2.36, 19.89).

**Conclusion:** A significance association were seen between welding fume exposure and occurrence of chronic respiratory symptoms in educational status, usage of respiratory protective equipment, safety training, welding machine maintenance and welding site. Further investigation should be done to strength the finding.

**Key Words:** Welding fume Exposure, Chronic Respiratory symptoms, Associated factors

# 1. Introduction

## 1.1. Background

Welding is the process of joining two metal together by melting metals with a filler metal to form strong joint. The fumes that are produced during the welding process are metal like Aluminum, Arsenic, Chromium Cobalt, Copper, Iron, Lead, Manganese, Molybdenum, Nickel, Silver and etc. Fumes can also contain Gases like Argon, Helium, Nitrogen, Ozone, Carbon dioxide and others (1). Welding can be classified as flux core arc welding (FCAW), Shielded metal arc (SMAW), Gas metal arc (GMAW), Tungsten inert gas (TUG). Among those GMAW is widely used (1). According to the American Conference of Governmental Industrial Hygiene (ACGIH) the total weighted Average (TWA) exposure limit for welding fume should not exceed 5 $mg/m^3$ (2).

In each country all over the world welders accounts more than 1% of the labor force. They are exposed to welding fume in their daily activities (3). In the study conducted in Sweden welders who worked as welder for more than 15 years develop respiratory symptoms than those with less work experience (4). The burden of work related Chronic obstructive pulmonary disease (COPD) (10-15%) is higher among aged welders.

On the study conducted in northern Iran 32% of welders have no health insurance and only 20% of the welders sough health care service (5). High prevalence of respiratory symptoms reported highly among welders who are smokers (6, 7).

In Ethiopia micro and small enterprise development program has been given attention by the government since 2004/05. The strategy was widely implemented overcome poverty and unemployment in the community.

## 1.1. Statement of the problem

Exposure to welding fume for a prolonged time causes metal fume fever which result in flu like dyspnea and cough like symptoms (2). According to International agency for research on cancer (IARC) in 2017 agents produced by the welding fume are carcinogenic for human being which categorize them as a group 1 cause of cancer (8).

Study conducted in Korea shows that high exposure to welding fume and lung functional test have a negative correlation (9). Study from Macedonia shows that 86.4% welders developed a respiratory symptoms duet to work place exposure (10). Study from turkey shows that welders who have a decreased $FEV_1$/FVC are those who work without mask and who work indoor (11).

According to the WHO global status report on non-communicable diseases, Ethiopia respiratory symptoms accounts 3% amongst the estimated 30% non-communicable diseases (12). Absorption of welding fume into interstitium and Alveolus lead to accumulation into lung macrophages then migrating to lymphatics, blood vessels and bronchiole leading to developing perivascular and peri bronchial fibrosis (13).

A study conducted in Gondar city assessed knowledge on occupational hazard and utilization of PPE among welders (14). Another study conducted in 2016 in Addis Ababa city assessed awareness of occupational hazard and associated factors among welders (15). Both studies did not investigate personal welding fume exposure level and the prevalence of respiratory symptoms among welders. Therefore, this study aims to assess the personal welding fume exposure to welding fume and prevalence of chronic respiratory symptoms among welders working in micro and small-scale enterprise metal working establishments.

## 1.2. Rationale of the study

According to the 2008 Central Statistical agency (CSA) survey there 799,358 MSE establishments employing 997,380 in Ethiopia (16). Gaps in creating enough working areas and continuous follow ups in small, micro enterprise workers and ignoring of the health related issues could lead to workers in this type enterprises could experience health related problems like respiratory problems(17).

And, in Ethiopia there are no any studies that are conducted concerning welding fume exposure and factors contributing for the occurrence of chronic respiratory symptoms on welder working in any type of industries that could help government official or any concerned body to help them came up with an intervention strategy.

## 1.3. Significance of the study

The finding from the study will be crucial for welders working in different form of industries to get a better understanding about the health effect of welding fume and the magnitude of the problems. It will also help welders and their employers to change the work practice and create a suitable working environment, to demand utilization of different personal protective equipment to make change in different unwanted behaviors that will lead to different health problems. Additionally, with a collaboration of other investigations it will help to develop preventive strategies by regulatory bodies. Furthermore, the study can serve as a baseline data to other researchers and it can also be used for different scientific practices.

# 2. Literature Review

## 2.1.Welding Fume Exposure

According to the American Conference of Governmental Industrial Hygiene (ACGIH) the total weighted Average (TWA) exposure limit for welding fume should not exceed 5 $mg/m^3$ (2). In 2014 on the study conducted in Sweden 50% of welders who participated in the study exceeded the total weighted Average exposure limit of welding fume (4). In 2015 in the study conducted in South Korea the average welding fume exposure were 7.7 $mg/m^3$ (9). In 2015 a study conducted in Saudi Arabia showed that the average welding fume exposure were 7.12 $mg/m^3$ (18). In another study conducted in Saudi Arabia in 2010 showed that the average welding fume exposure were 7.9 $mg/m^3$ (19). In 2018 a study conducted in Tanzania showed that the average welding fume exposure were 6.57 $mg/m^3$ (20).

## 2.2.Prevalence of Chronic Respiratory symptoms

Exposure to welding fume can cause an acute health effects like eye, nose and throat and a chronic health effect like damage to lung, larynx, kidney and nervous system. A prolonged exposure to the fume can cause produce chronic respiratory symptoms. This can be determined by duration of exposure type of welding material used, welding site and other behavioral factors (1). In the study conducted in Saudi Arabia the prevalence of Asthma Among welders was 11.36%. (6). In the study conducted in Northern Iran Respiratory Problem among welder accounts 40% of the occupational injuries (21). In the study conducted in North Korea the prevalence of COPD among welder in shipyard was 15% with a mean cumulative fume exposure of 7.7 $gm/m^3$ (9). In the study conducted in 2016 in Macedonia the prevalence of work related chronic respiratory symptoms like cough and Phlegm were higher among welders (which is-73.3%, P. value=0.013 and 80% P. value =0.046 respectively) (10).

## 2.3. Socio-Demographic Factors and chronic Respiratory Symptoms

In different articles Socio-demographic status of welder can define the development of chronic respiratory symptoms. One of the factors that can determine the health status of the welders is than their socio-economic status. In 2010 a study from Iran the prevalence of chronic bronchitis among welders were 11.5% (AOR=9.7, 95%, CI 1.65-55.50) and Phlegm among welders

(28.3%) is higher than office workers (9.4%) with a P. value = 0.013 (22). In 2016 in study conducted in eastern Nepal 81% of welders live below the poverty line (5). In 2013 on the study conducted in North central Nigeria shows that 44.2% of the their study participants did not attend more than a primary level education and among those welder 64.9% of them are not aware of the effect of the fume that is produced during welding activities (23). Study from north Korea indicate the risk of developing COPD the highest prevalence of COPD were seen among welders found in 50-59 age group (which is 49%) and welder who have more than 30 years' experience (which is 32%) (9). Study from USA in eastern Tennessee in 2010 welder who having been working for longer period has significantly developed respiratory symptoms (P. *value*= 0.04) (24).

### 2.4. Working Environment and chronic Respiratory Symptoms

While discussing about the working environment of and chronic respiratory symptoms factors like ventilation mechanism of the working area, types of welding material and personal protective devices used and location of the welding site can be taken into consideration (7, 9, 25). A systematic review of cohort study conducted on 2012 shows a declining respiratory functional test among welders who are smokers and those who do not have a local ventilation system (7). Study from the northwest Iran more than 50% welders did not take into the consideration their working place ventilation system and in calibrating the machine they are using (25). In 2018 study from Iran indicate that 60% respiratory symptoms like cough and Phlegm and Asthma like Symptoms were seen among welders using GMAW (25).

### 2.5.Administrative factors and Chronic Respiratory Symptoms

Another factor that can contribute for the occurrence of chronic respiratory among welders is behavioral factors like Utilization of Personal Protective Equipment (PPE), Smoking and Khat chewing, Utilization of Health care service and so on (6, 15, 21). Study from Saudi Arabia shows that the highest prevalence of health related issued like Asthma and other respiratory disorder were seen welders who are smoker and chewers (6). Study from northwest Iran shows that 36% did not use respiratory mask to prevent themselves from inhaling a welding fume (21). In 2017 on the study conducted in Northwest Iran 36% of welders do not use respiratory masks for

prevention, only 20% visited a doctor for respiratory problems and 58% of welders are smokers (21). The study from Korea shows that 51% welders who developed COPD (9). The same study from Ethiopia shows that 65% of the welders do not use any type of PPE and among the 35% who uses PPE only 19.8% of the welders uses respirators. Additionally, the study shows that 44% of them are smokers, 39.5% are Khat chewers and 58% of them alcohol consumers (15).

### 2.6. Behavioral factors and chronic Respiratory Symptoms

Another factor that can contribute for the occurrence of chronic respiratory among welders is behavioral factors like Utilization of Personal Protective Equipment (PPE), Smoking and Utilization of Health care service (6, 9, 15, 21). Study from Saudi Arabia shows that the highest prevalence of health related issued like Asthma and other respiratory disorder were seen welders who are smoker and chewers (6). Study from northwest Iran shows that 36% did not use respiratory protective equipment to prevent themselves from intake a welding fume into their respiratory system (21). In 2017 on the study conducted in Northwest Iran 36% of welders do not use respiratory masks for prevention and only 20% visited a doctor for respiratory problems and 58% of welders are smokers (21). The study from Korea shows that 51% welders who developed COPD (9). The same study from Ethiopia shows that 65% of the welders do not use any type of PPE and among the 35% who uses PPE only 19.8% of the welders uses respirators. Additionally, the study shows that 44% of them are smokers, 39.5% are Khat chewers and 58% of them alcohol consumers (15).

### 2.7.Summary of literature review

The reviewed literature shows that exposure to dust produced by welding fume can cause chronic respiratory symptom. The literatures also made an effort in associating the occurrence of chronic respiratory symptoms among welders with socio demographic status (Age, sex, monthly income, educational status, duration of working as a welders), behavioral factors (utilization of PPE, Smoking, chewing, alcohol consumption and healthcare service seeking behavior), Administrative factors (working time in day and in week, getting a health and safety training, supervision and availing PPE and first aid kit) and working environments (Types of welding material used by the welders, ventilation and calibration of the machineries and location of the welding site). Some of the literatures also tries to indicate that a prolonged exposure to welding

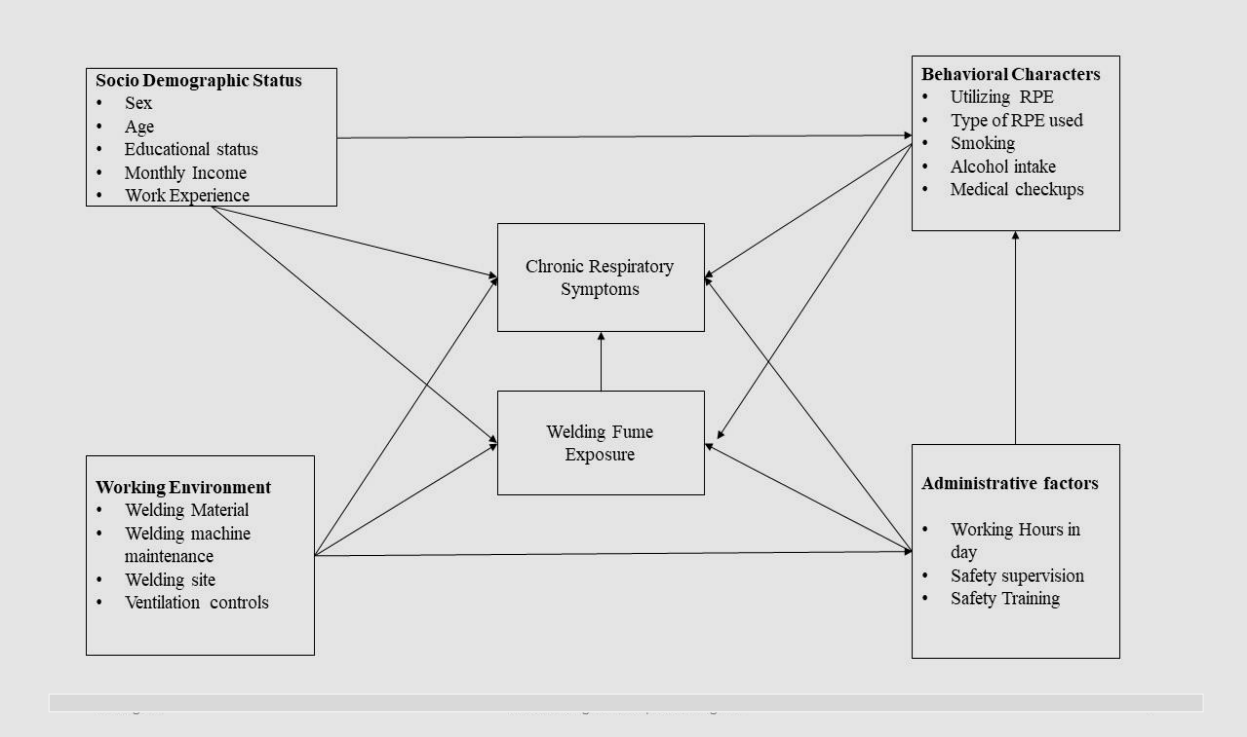
fume and by the effect of different metal and gases that are produced by welding fume it can cause cancer of the lung. This was also somehow verified by animal experiments.

Taking all the above-mentioned factor in consideration this investigation focused on assessing the exposure of welding fume and prevalence of chronic respiratory symptoms among micro and small-scale enterprise metal workshops welders working in Akaki Kality, Addis Ababa, Ethiopia.

## Conceptual framework

Efforts has been made to develop a summarizing conceptual frame work presented below by taking the above reviewed literatures into consideration about the exposure of welding fume and occurrence of chronic respiratory symptoms can be associated with socio-demographic status behavioral, administrative and work place conditions directly or indirectly through continuous exposure. This conceptual frame work helped us to design a research question regarding the welding fume exposure and respiratory symptoms, to determine the indicators and impact of welding fume exposure on the occurrence of chronic respiratory symptoms and for presenting relationship among study variables.

Figure 1: Conceptual framework designed for exposure to welding fume and factors contributing for the occurrence of chronic respiratory symptoms among metal workers



# 3. Objectives

## 3.1. General objective

To assess personal welding fume exposure level and the prevalence of chronic respiratory symptoms among small scale enterprise metal workers in Akaki Kality, Addis Ababa, Ethiopia

## 3.2. Specific objectives

To assess the prevalence of chronic respiratory symptoms among welders working in micro and small-scale enterprise metal work in Akaki Kality, Addis Ababa, Ethiopia

To assess factors associated with welding fume exposure and occurrence of chronic respiratory symptoms among welders working in micro and small-scale enterprise metal work in Akaki Kality, Addis Ababa, Ethiopia

To assess personal welding fume exposure level among small scale enterprise metal workers in Akaki Kality, Addis Ababa, Ethiopia

# 4. Methods

## 4.1. Study area

Akaki kality is one of the 10 sub cities found under the Addis Ababa city administration which is found on the south side of the city. There are 13 woredas in the sub-city. According the sub-city administration, the total population of the sub-city is estimated around 241,084. There are 91 metal working shops which are known by the sub-city micro and small-scale enterprise office. Among those working shops there are 658 metal workers working as a welder (26). So, the study area was at Micro and small-scale enterprise metal work found in Akaki Kality sub-city, Addis Ababa, Ethiopia

## 4.2. Study design and period

A comparative cross- sectional study was conducted to assess welding fume exposure and prevalence of chronic respiratory symptoms among metal workers and office workers from September 01, 2020 to September 28, 2020.

## Source population

The study population were all metal workers who work at Micro and small-scale enterprise metal work and Micro and small-scale enterprise office workers found in Akaki Kality sub-city, Addis Ababa, Ethiopia.

## 4.3. Study population

All eligible metal workers who work at the selected micro and small-scale enterprise metal work establishments and Micro and small-scale enterprise office workers found in Akaki Kality, Addis Ababa, Ethiopia.

## 4.4. Inclusion and Exclusion Criteria

### 4.4.1. Inclusion Criteria

Metal workers who are directly engaged in welding activity in the micro and small-scale enterprise workers with 1 year and above experience.

### 4.4.2. Exclusion criteria

- Metal workers who are also engaged in painting activities
- Metal workers who are less than 18 years of age

## 4.5. Sample size

### 4.5.1. Sample size for Objective one (prevalence of chronic respiratory symptoms)

The study conducted in northwest Shoa, Ethiopia showed that the prevalence of respiratory symptoms among Cement factory workers and Civil servants workers were (32% and 13.8% respectively) with a P-value <0.001 (27). The sample size for prevalence of respiratory symptoms among welders was calculated with a double proportion formula with Epi info version 7.2.1.0 with the following assumption:

- $P_1$: 32%: prevalence for respiratory symptoms among exposed group
- $P_2$: 13.8% prevalence of respiratory symptoms among non-exposed group
- $Z_{\alpha/2}$: level of significance at 95% Confidence interval= 1.96
- $Z_{\beta}$ : 85% power

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

$$= \frac{(1.96 +0.85)^2 * ((0.32 (1-0.32) + 0.138 (1-0.138))}{(0.32 – 0.138)^2} = \mathbf{210}$$

Adding 10% for non-response rate it became- **233**

So, the total sample size for assessing prevalence or respiratory symptoms was **466**; 233 for exposed and 233 for non-exposed groups.

### 4.5.2. Sample size for objective two (Associated factors)

Study from Tanzania shows that the prevalence of Reparatory symptoms among welders who have work experience more than 5 years and less 5 years is 37.5% and 17.1% with P value of 0.025 respectively (20). The sample size to assess factors associated for the occurrence of chronic respiratory symptoms among welders was calculated using double proportion formula with Epi info version 7.2.1.0 with the following assumption:

- $P_1$: 37.5%: prevalence for respiratory symptoms among welders who have more than 5 work experience

- $P_{2:}$ 17.1% prevalence of respiratory symptoms among welders who have less than 5-year work experience
- $Z_{\alpha/2}$: level of significance at 95% Confidence interval= 1.96
- $Z_{\beta}$ : 85% power

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

$$= \frac{(1.96 +0.85)^2 * ((0.371 (1-0.371) + 0.171 (1-171))}{(0.371 - 171)^2} = 242.2 \sim \mathbf{188}$$

Adding 10% for non-response rate it became- **209**

So, the total sample size for assessing factors associated with the occurrence of respiratory symptoms was **418**; 209 for exposed and 209 for non-exposed groups

### 4.5.3. Sample size for objective three (personal welding fume exposure level)

The Sample size for personal welding dust exposure assessment was determined based on Rappaport SM., et al, 2008; who suggested 5-10 randomly selected individuals in a Similar Exposure Group (SEG) are adequate to estimate the exposure level for welding fume exposure amongst the group based on personal exposure measurement (28). SEG within the establishments which was assumed that they have the same exposure level because they are engaged in the same activity. Among the 13 woredas, 3 woredas (woreda 6, 7 and 8) with highest number of Micro and small-scale metal working establishment were selected and from each woreda 5 welders were selected to measure welding fume exposure level. A total of 30 dust measurement from 15 randomly selected welders were collected.

Table 1: Summary of the sample size determination for welders working in Micro and small-scale enterprise metal work, Akaki kality, Addis Ababa, Ethiopia, 2020

| Specific Objectives | Variables | Prevalence | Confidence interval | Sample Size | | Total Sample Size | Reference |
|---|---|---|---|---|---|---|---|
| | | | | Exposed | Non-Exposed | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Spe Obj-01 | Prevalence of Chronic Respiratory Symptoms | Prevalence of RS among exposed group 32%, Prevalence of non-exposed group 13.8% | 95% | 233 | 233 | 466 | Seyoumk., et al, 2014 |
| Spe Obj-02 | Associated factors with respiratory Total personal welding fume dust exposure | 37% welders with more than 5 years' work experience and 17.1% less than 5 years work experience | 95% | 209 | 209 | 418 | Meena GG., et al, 2018 |
| Spe Obj-03 | Total Welding fume Exposure | 5-10 SEG | | 15 welders from 3 Establishment and 3 Woredas (6, 7 & 8) | | 30 | Rappaport SM., et al, 2008 |

## 4.6. Sampling procedure

**For Interview**

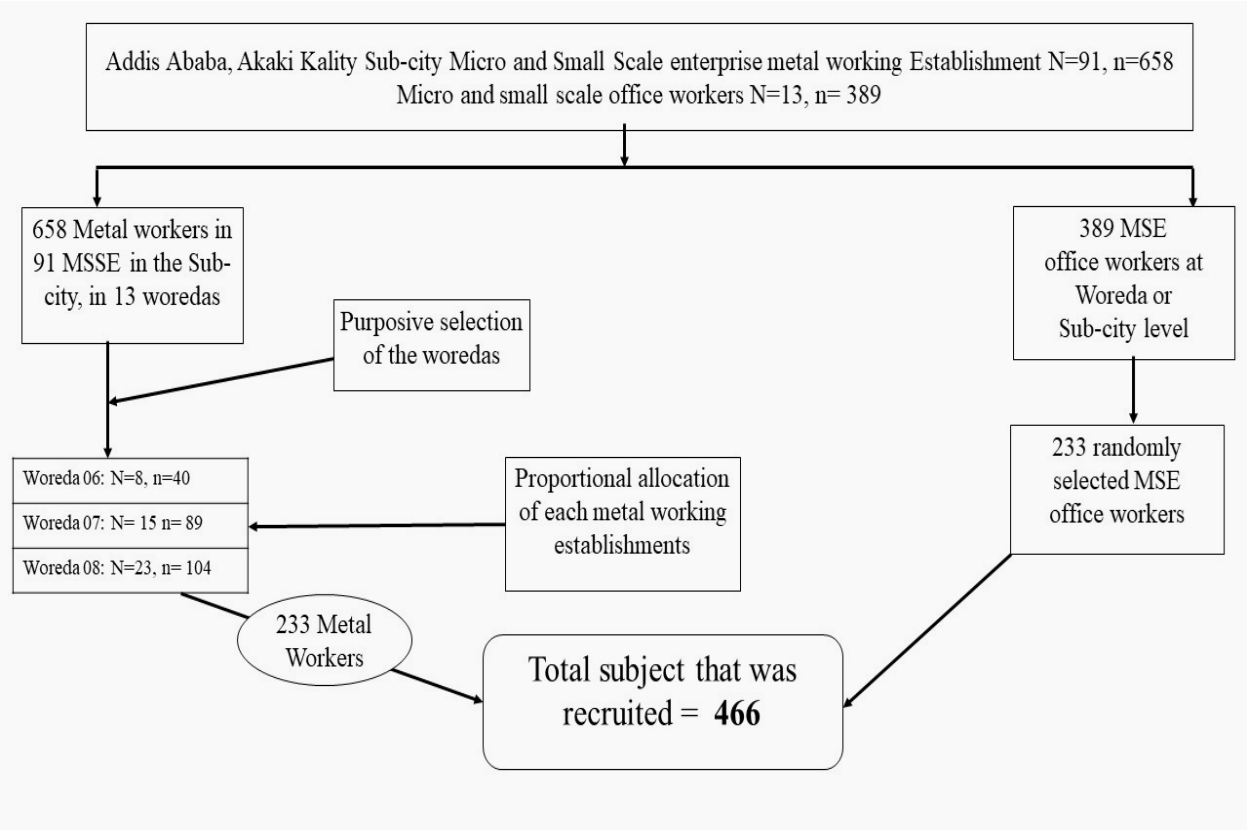
Akaki kality has 13 woredas in it and was selected because it has large number of micro and small-scale enterprise establishment in the city. Additionally, majority of the population in the sub-city is depended for living on industry and activities related to industry. There are a total of 91 micro and small-scale enterprise metal work establishments with total workers of 658. Using stratified random sampling method by assigning each woredas into strata sample from each woreda were selected based on their proportion ($n_i = N_i$ (n/N)). Three woredas with highest proportion of metal working establishments were purposively selected for this study (woreda 06, 07 and 08). After selecting the samples from the selected woredas the establishments to be in this study was selected using systematic random sampling method (K=N/n). As for the control group

subject working in micro and small-scale enterprise office at woreda and sub-city level were selected using simple random sampling technique.

**For Dust Sampling**

For dust sampling 3 metal working establishments were selected from those woredas which were selected for the interview. From those establishment a total of 15 metal workers (5 from each establishment) were selected.

Figure 2 Sampling procedure for Assessing Respiratory Symptoms among welders, Akaki Kality, Addis Ababa, Ethiopia, 2020




## 4.1. Data collection procedure

Primary data were collected using three kind of data collection tools. Questionnaires, observational checklists and personal dust measurements.

**Questionnaires or Interview for assessing the chronic Respiratory symptoms**

Standardized structured questionnaires adapted from America Thoracic Society (AST) were used to assess chronic respiratory symptoms (29). The questionnaire included the socio-demographic status (age, sex, educational status, monthly income), behavioral factors (utilization of RPE, smoking, alcohol intake, medical Checkup for work related conditions), administrative factors (working hour and day, safety supervision, safety training) and work place environment (type of welding material used, welding machine calibration, welding site and type of ventilation). The questionnaire was prepared in English and translated to Amharic and translated back to English.

**Observational checklist**

Observational checklists were used to check working Conditions (Ventilation systems, Types of welding materials used, types and appropriateness of PPE they are using and location of welding area) during sampling personal dust exposure.

**Personal welding fume exposure**

The total welding fume exposure was measured from breathed zone (300mm hemisphere around the nose and mouth area) using Millipore closed faced containing 37mm Polyvinyl Chloride (PVC) filter attached to Side Kick Pump. The flow rate was set at 2 liter per minute After collecting the data, the filter paper containing cassette was transported back to the laboratory and post filter weight were measured. The dust measurement was repeated 2 times on the same subject.

## 4.7. Operational definition

- **Chronic Respiratory Symptoms**: Developing one or more symptoms of a cough, phlegm breathlessness, wheezing and chest illness with at least more than on month (29).
- **Chronic cough:** Experience of a cough as much as 4– 6 times per day occurring for most days of the week (≥ 4 days) or cough at all on getting up in the morning or during the rest of the day/night for at least three months in one year (29).
- **Phlegm:** Sputum expectoration as much as twice a day for most days of the week (≥ 4 days), or bring up phlegm at all on getting up in the morning, or during the rest of the day/night for at least three months in one year (29).

- **Breathlessness:** is a discomfort or difficult to breathe in different activities or a condition occurring when hurrying on the level ground or walking up a slight hill for at least 3 months in a year (29)
- **Chest tightness:** Pain that is felt on chest whenever exposed to cold that can keep on bed/indoor accompany by production of phlegm (29)
- **Current Smoker:** Study Participant who is currently smoking Cigarette on daily basis
- **Ex-smoker:** Study participant who never smoked cigarette for at least 1-year duration
- **Non- Smoker:** Study participants who had never smoked Cigarette in their entire life
- **Ever alcohol Consumer:** Study Participant who has history of drinking alcohol or currently consuming alcohol
- **Similar exposure Group (SEG)**: is a group of workers having the same general exposure profile for agents, task performed, frequency of task and materials used (28).
- **Micro and small-scale enterprise:**
    - **Micro enterprise:** An enterprise giving a service with less than or equal to 5 Human power with a total asset of less than or equal to 50,000 ETB (3000 USD or 2200 Euro).
    - **Small scale enterprise:** An enterprise giving a service with less than or equal to 5-30 Human power with a total asset of less than or equal to 500,000 ETB (30000 USD or 23000 Euro).
- **Welding fume**: Fumes that are formed when metal is heated above its boiling point and its vapor condense into a very fine, particle (solid particulates). A particle from the electrodes and the material being welded.
- **Metal workers**: Individuals who are engaged in joining metals or Cutting metals who are directly exposed to metal fume

## 4.8. Data management

A continuous field supervision and a daily meeting with data collectors was conducted while collecting data. The collected data was coded, cleaned and entered into Epi info version 7.2 and exported to SPSS version 23 for data analysis.

During dust sampling, dust sampling equipment's was checked for appropriateness. After sampling the cassette were handled carefully in the bag and transported back to lab. Data was entered into 2016 Microsoft excel sheet and exported to SPSS version 23 for data analysis.

## 4.9. Data analysis

**For prevalence of respiratory symptoms**

Descriptive statistics was used to describe the study population using frequency distribution, measure of dispersion and central tendency. Table was used to display the findings.

**For Associated factors with respiratory symptoms**

A bivariate analysis was used to identify if exposure variables are significantly associated with the outcome variable or not. Variables with p=<0.2 were included in multivariable analysis. The multivariable analysis was used to identify variables associated with both outcome and exposure and to identify the confounding variables. AOR with 95% of CI will be used to check the association between dependent and independent variables individually. Based on AOR with 95% CI variables with p <0.05 was considered as significant.

**For Welding fume exposure**

The sampling filter paper was measured at black lion BRHD core laboratory using calibrated Mittler Toledo Weighting Scale prior to the data collection. The finding from total personal welding dust of welding fume described using descriptive statistics like measure of central tendency (Geometric Mean) and measure of dispersion (Geometric standard deviation). The collected data was entered using Microsoft excel sheet. The finding will be compared with the standard (which is 5 mg/$m^3$ for total dust) (2). Tables was used to display the finding.

Figure 3 Formula to assess the dust concentration among metal workers, Akaki Kality, Addis Ababa, Ethiopia

- Volume (L)= Flow rate (L/min) * Sample time (Min)
- Volume ($M^3$) = $\frac{\text{Volume (L)}}{1000}$
- Mass contaminant on filter mass (mg) = Post-pre weight of filter (mg) – Blank (mg)
- Dust concentration (mg/$m^3$) = $\frac{\text{Mass of Contaminants (mg)}}{\text{Sample Volume } (m^3)}$

## 4.10. Variables

### 4.10.1. Dependent variables

- Chronic Respiratory Symptoms

### 4.10.2. Independent variables

- Welding fume exposure
- Socio-demographic status
- Behavioral factors
- Working conditions
- Administrative factors

## 4.11. Data quality assurance

The collected data were checked for completeness and consistency by the principal investigator during the data collection. The data were coded and the name of participant was not be mentioned while entering data. All the coded data were kept confidentially and it were accessed only by the principal investigator.

## 4.12. Ethical Consideration

Ethical clearance was collected from the Addis Ababa University School of Public Health Ethical Review Committee and a permission letter will be given. An official letter was written to the Akaki Kality sub city Micro and Small-scale enterprise office. Then a support letter from the office was obtained to the selected metal working establishments and office. The objective and the procedure of the study was explained to each individual. The participant information sheet will be given to the participant if they have any questions about the study.

The participants who fulfill the criteria and agreed to be in the study were given a written consent in Amharic and signed before data collection started and other purposes like taking photos. As compensation a brochure about welding fume and its health effect was prepared in local language and was given to the study participant. Privacy and confidentiality were ensured during data collection by making anonymous and assuring the collected will only be acceded by the principal investigator only to the participants. Participants have the right to withdraw at any time they want.

# 5. Result

## 5.1. Socio demographic Status

A total of 443 (226 metal workers and 217 office workers) participants were involved in this study which makes the response rate 95.06%. Among non-respondent 3 office workers were tested positive for COVID-19 and other 11 of their colleagues were on home quarantine. Additionally, 2 office workers were on annual leave. Among metal workers 4 of them were let go off the works of decreased in metal work market due to the pandemic and 3 workers were sent to other site for work for more than 3 days.

Among the study participant 369 (83.1%) were males and while the other 75 (16.9%) were females. The mean age for metal workers were 29 (±SD=6.796) and 28.58 (±SD=4.909) for office workers. Majority of metal and office workers were Christians 193 (85.4%) and 197 (90.8%) respectively. Most of metal workers in the study have attended only primary and secondary school (216 (95.6%), while 189 (87.1%) of the office workers have attended a higher educational (first degree and above). The mean work experience of metal workers and office workers was 5.47 (±SD= 5.166) and 4.25 (±SD=4.137) respectively. The mean monthly income for metal workers and office workers was 4620.44 and 5277.54 ETB respectively.

Table 2 Socio Demographic Character of metal workers and office work in Akaki Kality, Addis Ababa, Ethiopia

| Response | Metal workers | Office Workers | Total | P value |
|---|---|---|---|---|
| | n (%) | n (%) | n (%) | |
| **Sex** | | | | |
| Male | 213 (94.2) | 155 (71.4) | 368 (83.1) | <0.001 |
| Female | 13 (5.8) | 62 (28.6) | 75 (16.9) | |
| **Age Group** | | | | |
| Less than 25 | 80 (35.4) | 57 (26.3) | 137 (30.9) | 0.038 |
| More than 25 | 146 (64.6) | 160 (73.7) | 306 (69.1) | |
| **Marital Status** | | | | |
| Not Married | 150 (66.4) | 142 (65.4) | 292 (65.9) | 0.836 |
| Married | 76 (33.3) | 75 (34.6) | 151 (34.1) | |

| | | | | |
|---|---|---|---|---|
| **Religion** | | | | |
| Christian | 193 (85.4) | 197 (90.8) | 390 (88) | 0.81 |
| Muslim | 33 (14.6) | 20 (9.2) | 53 (12) | |
| **Educational Status** | | | | |
| Primary and secondary | 216 (95.6) | 28 (12.9) | 244 (55.1) | <0.001 |
| College education | 10 (4.4) | 189 (87.1) | 199 (44.9) | |
| **Work Experience** | | | | |
| Less than 5 Years | 142 (62.8) | 155 (71.4) | 297 (67) | 0.376 |
| More than 5 Years | 84 (37.2) | 62 (28.6) | 146 (33) | |
| **Monthly Income** | | | | |
| Less than 4000 ETB | 92 (40.7) | 59 (27.2) | 151 (34.1) | 0.003 |
| More than 4000 ETB | 134 (59.3) | 158 (72.8) | 292 (65.9) | |

### 5.2. Prevalence of Chronic Respiratory Symptoms

The overall prevalence of respiratory symptoms among metal workers and office workers was 23.9% and 9.2% respectively. The odds of developing a chronic respiratory symptom were higher among metal workers than office workers (OR: 2.82, 95% CI: 1.51, 5.26) after adjusting for sex, educational status, monthly income, respiratory protective equipment utilization, alcohol intake, working hours in a day, working day in week and safety training.

Table 3 Prevalence of Chronic respiratory symptoms among metal worker and office workers in, AKaki Kality, Addis Ababa, Ethiopia

| **Response** | **Metal Workers** | **Office Workers** | **AOR (95%CI)** | **P value** |
|---|---|---|---|---|
| | **n (%)** | **n (%)** | | |
| **Cough** | | | | |
| Yes | 41 (18.1) | 17 (7.8) | 2.05 (1.06-3.96) | **0.032*** |
| No | 185 (81.9) | 200 (81.9) | | |
| **Phlegm** | | | | |
| Yes | 21 (5.5) | 12 (9.3) | 3.24 (1.20-8.17) | **0.02*** |

| | | | | |
|---|---|---|---|---|
| No | 205 (94.5) | 205 (90.7) | | |
| **Breathlessness** | | | | |
| Yes | 14 (6.2) | 4 (1.8) | 3.52 (1.14-10.85) | 0.02 |
| No | 212 98.2) | 212 (93.8) | | |
| **Chest tightness** | | | | |
| Yes | 11 (4.9) | 5 (2.3) | 2.17 (0.74-6.35) | 0.148 |
| No | 215 (95.1) | 212 (97.7) | | |
| **Chronic Respiratory Symptoms** | | | | |
| Yes | 54 (23.9) | 20 (9.2) | 2.82 (1.51-5.26) | **0.001*** |
| No | 172 (76.1) | 197 (90.8) | | |

### 5.3. Behavioral Character

Majority respondents were wearing respiratory protective equipment like face mask due to the corona virus. Among 204 (90.3%) of metal workers claimed they use RPE while they are at work. On providing respiratory protective equipment 170 (75.2%) metal workers given to them by their employers. Coming to the protectiveness of the respiratory protective equipment used by the metal workers 128 (59%) of metal workers claimed that they use a flame and fume proof hand held face shield, while the other 88 (40.5) responded they only use face mask made from clothes and surgical mask. On smoking status of the study participant 31 (10.6%) of metal worker and 23 (10.6%) of office workers were ever smokers (Current smokers and Ex-Smokers). Similarly, about 45 (20.7%) of office workers were alcohol Consumers. When we come to work related medical checkups 99 (43.8%) of metal workers and 79 (36.4%) of office workers had a work-related medical checkup.

Table 4 Behavioral Character of metal workers and office work in Akaki Kality, Addis Ababa, Ethiopia

| **Response** | **Metal workers** | **Office workers** | **Total** | **P value** |
|---|---|---|---|---|
| | **n (%)** | **n (%)** | **n (%)** | |
| **RPE Utilization** | | | | |

| | | | | |
|---|---|---|---|---|
| Yes | 204 (90.3) | N/A | 204 (90.3) | |
| No | 22 (9.7) | N/A | 22 (9.7) | |
| **Providing of RPE** | | | | |
| Yes | 171 (75.2) | N/A | 171 (75.2) | |
| No | 56 (24.8) | N/A | 56 (24.8) | |
| **RPE Used** | | | | |
| Fume proof | 123 (60.3) | N/A | 123 (60.3) | |
| Non fume proof | 81 (39.7) | N/A | 81 (39.7) | |
| **Smoking Status** | | | | |
| Ever Smoker | 31 (10.6) | 23 (10.6) | 54 (12.2) | 0.316 |
| Non-Smoker | 195 (86.5) | 194 (89.4) | 389 (87.8) | |
| **Alcohol Intake Status** | | | | |
| Ever Consumer | 88 (38.9) | 45 (20.7) | 133(30) | 0.001 |
| Non-Consumer | 138 (61.1) | 172 (79.3) | 310 (70) | |
| **Work Related Medical Checkup** | | | | |
| Yes | 99 (43.8) | 79 (36.4) | 178 (40.2) | 0.14 |
| No | 127 (56.2) | 138 (63.6) | 265 (59.8) | |

### 5.4. Administrative Status

Looking in administrative status most metal workers works more than 8 hours a day and 5 days a week compared to office workers (125 (55.3%) and 182 (80.5%)) respectively. On safety supervision 36 (15.9%) of metal workers and 31(14.3%) claimed they were supervised on safety by the concerned body. Additionally, 15.5% of metal workers and 4.3% office workers claimed they took a safety training.

Table 5 Administrative Characters of metal workers and office work in Akaki Kality, Addis Ababa, Ethiopia

| **Response** | **Metal Worker** | **Office Workers** | **Total** | **P value** |
|---|---|---|---|---|
| | **n (%)** | **n (%)** | **n (%)** | |

| | | | | |
|---|---|---|---|---|
| **Working Hours in days** | | | | |
| Up to 8 Hour | 101 (44.7) | 211 (97.1) | 312 (79.4) | <0.001 |
| More than 8 Hour | 125 55.3 | 6 (4.6) | 131 (29.6) | |
| **Working day in Week** | | | | |
| Up to 5 days | 44 (19.5) | 213 (98.2) | 257 (58) | <0.001 |
| More than 5 days | 182 (80.5) | 4 (1.8) | 186 (42) | |
| **Safety Supervision and Follow up** | | | | |
| Yes | 36 (15.9) | 31 (14.3) | 67 (15.1) | 0.764 |
| No | 190 (84.7) | 186 (85.7) | 376 (84.9) | |
| **Safety Training** | | | | |
| Yes | 33 (15.5) | 9 (4.3) | 42 (10) | <0.001 |
| No | 180 (84.5) | 199 (95.7) | 379 (90) | |

### 5.5. Work Place Environment

Considering the work place environment most metal worker used a shielded metal arc welding material while doing their welding task 216 (95.6%). Most of metal workers also claimed that they do their welding task outside the working the establishment 78 (36.6%). Majority of metal workers did not do a periodic welding machine maintenance 139 (61.8). Most of the establishment for micro and small-scale enterprises are built with wider door and open space making the metal workers 213 (93.9%) use a general ventilation mechanism.

Table 6 Work place environment Characters of metal workers and office work in Akaki Kality, Addis Ababa, Ethiopia

| Response | Metal workers |
|---|---|
| | n (%) |
| **Type of Welding Material** | |
| SMAW | 216 (95.6) |
| GMAW | 10 (4.4) |
| **Welding Machine Calibration** | |
| Yes | 87 (38.2) |
| No | 139 (61.8) |

| | |
|---|---|
| **Welding Site** | |
| Outdoor | 58 (25.7) |
| Indoor | 78 (34.5) |
| Both | 90 (39.8) |
| **Ventilation System** | |
| General | 213 (94.2) |
| Local | 13 (5.8) |

## 5.6. Personal dust exposure

All of the study participants were male by sex and with age range of 18-38. The overall daily personal welding fume exposure ranged 3.13-11.08 mg/m$^3$. The Geometric mean of the personal dust exposure was 5.98 mg/m$^3$ (±GSD=1.54). According to the American Conference of Governmental Industrial Hygienists (ACGIH) and Occupational Safety and Health Administration (OSHA), among 30 dust samples 16 (53.3%) sample passed the accepted standard for the exposure of welding fume (which is 5 mg/m$^3$).

Table 7 Personal Dust Exposure level among metal workers in Akaki Kality, Addis Ababa, Ethiopia

| **Establishment** | **Average Dust Exposure (mg/m$^3$)** | **Average Sampling time (min)** | **Mean(±SD) (mg/m3)** | **GM (±GSD) (mg/m3)** | **Samples Exceeding ACGIH & OSHA (5mg/m3) n (%)** |
|---|---|---|---|---|---|
| Establishment 01 | 5.54 | 535 | 7.09 (±3.38) | 6.38 (±1.67) | 3 (60) |
| | 4.53 | 536 | | | |
| | 11.075 | 512 | | | |
| | 3.555 | 492 | | | |
| | 10.775 | 537 | | | |
| Establishment | 8.895 | 510 | 5.11 (±2.15) | 4.76 (±1.48) | 1 (20) |

| | | | | | |
|---|---|---|---|---|---|
| 02 | 4.98 | 543 | | | |
| | 4.62 | 530 | | | |
| | 3.125 | 501 | | | |
| | 3.9 | 468 | | | |
| Establishment 03 | 9.545 | 543 | 7.34 (±2.37) | 6.94 (±1.45) | 4 (80) |
| | 9.365 | 536 | | | |
| | 4.245 | 542 | | | |
| | 8.345 | 542 | | | |
| | 5.205 | 523 | | | |
| All establishment | 3.13-11.08 | 468-543 | 6.51 (± 2.80) | 5.98 (±1.54) | 16 (50) |

## 5.7.Associated factors

### 5.7.1. Bivariate analysis

**Socio demographic**

On socio demographic status metal workers with age of more than 25 were 2 times more likely to develop chronic respiratory symptoms (COR: 2.29, 95%CI: 1.12, 4.66). Metal workers who attended only primary and secondary educational were 5 more likely to develop chronic respiratory symptoms than those who attended college education (COR: 5.25, 95%CI: 1.42, 19.36) and Metal workers with work experience more than 5 years were 3 times more likely to develop chronic respiratory symptoms than those who has less 5 years work experience (COR: 1.6 95%CI:0.89, 3.16) and had a P value <0.2 on the bivariate logistics regression and retained for multivariate analysis. While other variables like sex, marital status, religion and marital status did not show an association (Table 8).

Table 8 Bivariate analysis for Factors associated with the occurrence of chronic respiratory symptoms among metal workers, Akaki Kality, Addis Ababa, Ethiopia

| **Variables** | **Chronic respiratory Symptoms** | | **COR (95% CI)** | **P. value** |
|---|---|---|---|---|
| | **Yes** | **No** | | |

| | | | | |
|---|---|---|---|---|
| **Sex** | | | | |
| Male | 49 | 164 | 0.21 (0.15-1.53) | 0.21 |
| Female | 5 | 8 | 1.00 | |
| **Age Group** | | | | |
| Less than 25 | 12 | 42 | 1.00 | |
| More than 25 | 68 | 146 | 2.29 (1.12-4.66) | **0.02*** |
| **Marital Status** | | | | |
| Not Married | 34 | 116 | 1.00 | |
| Married | 20 | 56 | 1.22 (0.64-2.31) | 0.54 |
| **Religion** | | | | |
| Christian | 48 | 145 | 1.00 | |
| Muslim | 6 | 27 | 0.67 (0.26-1.72) | 0.41 |
| **Educational Status** | | | | |
| Primary and secondary | 47 | 169 | 5.25 (1.42-19.36) | **0.013*** |
| College education | 6 | 4 | 1.00 | |
| **Work Experience** | | | | |
| Less than 5 Years | 19 | 82 | 1.00 | |
| More than 5 Years | 35 | 90 | 1.6 (0.89-3.16) | **0.11*** |
| **Monthly Income** | | | | |
| Less than 4000 ETB | 12 | 32 | 1.00 | |
| More than 4000 ETB | 42 | 140 | 4.22 (1.01-19.32) | 0.48 |

COR= Crude odds ratio, CI= Confidence Interval, 1.00= reference, *= eligible variables for multivariate analysis at P=<0.2

**Behavioral Characters**

On behavioral characters metal workers who used non fume proof respiratory equipment were 2 times more likely to develop chronic respiratory symptoms than those who used fume proof respiratory equipment (COR: 2.97, 95% CI: 1.45, 6.03). Metal workers who were ever smokers were 4 times more likely to develop chronic respiratory symptoms (COR: 4.41, 95%CI:2.0, 9.70). Metal workers who were alcohol consumer 2 times more likely to develop chronic

respiratory symptoms than metal workers who did not consume alcohol (COR: 2.58, 95% CI: 1.38, 4.82). Metal workers who did not had a regular work-related medical checkup were 2 time more likely to develop a chronic respiratory symptoms (COR: 2.06 95%CI: 1.11, 3.82) and had a P value <0.2 on bivariate logistics regression and retained for multivariate analysis. While Usage of RPE did not had an association (Table 09).

Table 9 Bivariate analysis for Factors associated with the occurrence of chronic respiratory symptoms among metal workers, Akaki Kality, Addis Ababa, Ethiopia

| Variables | Chronic respiratory Symptoms | | COR (95% CI) | P. value |
|---|---|---|---|---|
| | Yes | No | | |
| **RPE Utilization** | | | | |
| Yes | 50 | 154 | 1.00 | |
| No | 4 | 18 | 0.68 (0.22-2.12) | 0.51 |
| **RPE used** | | | | |
| Fume proof | 41 | 90 | 1.00 | |
| Non fume proof | 13 | 82 | 2.97 (1.45-6.03) | **0.003*** |
| **Smoking Status** | | | | |
| Ever Smoker | 16 | 15 | 4.41 (2.0-9.70) | **<0.001*** |
| Non-Smoker | 38 | 157 | 1.00 | |
| **Alcohol Intake Status** | | | | |
| Consumer | 31 | 59 | 2.58 (1.38-4.82) | **0.003*** |
| Non-Consumer | 23 | 113 | 1.00 | |
| **Work Related Medical Check ups** | | | | |
| Yes | 31 | 68 | 1.00 | |
| No | 23 | 104 | 2.06 (1.11-3.83) | **0.02*** |

COR= Crude odds ratio, CI= Confidence Interval, 1.00= reference, *= eligible variables for multivariate analysis at P <0.2

**Administrative Factors and Work Place Environment Factors**

On administrative factors metal workers who worked for more than 8 hours in day were 2 times more likely to develop chronic respiratory symptoms (COR: 1.68, 95%CI: 0.89, 3.16). Metal workers who did not get a safety training were 2 time more likely to develop chronic respiratory symptoms (COR: 2.41, 95%CI: 1.11, 5.25). On work place environment factors metal workers who used a non-calibrated welding machine were 2 time to develop a chronic respiratory symptom than those used a calibrated welding machine (COR: 2.2, 95%CI: 1.18, 4.11) and metal workers who did their welding task only indoor were 6 time more likely to develop chronic respiratory symptoms than those who did outdoor (COR: 6.0, 95%CI: 2.21, 16.29) and had a p value <0.2 on bivariate logistics regression and retained for multivariate analysis. While working days in week, safety supervision, welding materials did not have an association (Table 10).

Table 10 Bivariate analysis for Factors associated with the occurrence of chronic respiratory symptoms among metal workers, Akaki Kality, Addis Ababa, Ethiopia

| Variables | Chronic respiratory Symptoms | | COR (95% CI) | P. value |
|---|---|---|---|---|
| | Yes | No | | |
| **Working Hours In day** | | | | |
| Up to 8 Hour | 19 | 82 | 1.00 | |
| More than 8 Hour | 35 | 90 | 1..68 (0.89-3.16) | **0.11*** |
| **Safety Supervision** | | | | |
| Yes | 7 | 29 | 1.00 | |
| No | 47 | 143 | 1.36 (0.56-3.31) | 0.49 |
| **Safety training** | | | | |
| Yes | 13 | 20 | 1.00 | |
| No | 41 | 152 | 2.41 (1.11-5.25) | **0.03*** |
| **Welding Material** | | | | |
| SMAW | 53 | 163 | 1.00 | |

| | | | | |
|---|---|---|---|---|
| GMAW | 1 | 9 | 0.34 (0.42-2.76) | 0.34 |
| **Welding machine Calibration** | | | | |
| Yes | 28 | 59 | 1.00 | |
| No | 25 | 144 | 2.2 (1.18-4.11) | **0.01*** |
| **Welding Site** | | | | |
| Outdoor | 19 | 38 | 1.00 | |
| Indoor | 6 | 72 | 6.0 (2.21-16.29) | **<0.001*** |
| Both | 29 | 62 | 1.06 (0.52-2.16) | 0.853 |
| **Type of Ventilation Used** | | | | |
| General | 52 | 163 | 1.00 | |
| Local | 2 | 9 | 1.408 (0.295-6.728) | 0.688 |

COR= Crude odds ratio, CI= Confidence Interval, 1.00= reference, *= eligible variables for multivariate analysis at P <0.2 GMAW= Gas Metal Arc Work, SMAW= Shielded Metal Arc Work

### 5.7.2. Multivariate Analysis

The multivariate logistic regression was performed to identify factors associated with the occurrence of chronic respiratory symptoms among metal workers. Metal Workers who were above the age of 25 were 2 times more likely to develop chronic respiratory symptoms than those who were less 25 years (AOR: 2.12, 95%CI: 1.12, 4.46). Compared to metal workers who attended college education, those attended primary and secondary educations were 5 times more likely to develop a chronic respiratory symptom (AOR: 5.11, 95% CI: 1.35, 19.33). The odds of metal workers who don not used a dust protective respiratory protective equipment were 3 times more likely to develop chronic respiratory symptoms compared to those who used (AOR: 3.33, 95% CI: 1.52, 7.31). Metal workers who were ever smokers were 3 times more likely to develop a chronic respiratory symptom than those who were nonsmokers (AOR: 3.57, 95%CI: 1.54, 8.23). Metal workers who were an alcohol consumer were 2 times more likely to develop chronic

respiratory symptoms than those who did not consume alcohol (AOR:2.04, 95%CI: 1.04, 3.99). Metal workers who did not have history of work-related medical checkups were 3 time more likely to develop a chronic respiratory symptom than who did (AOR: 3.12, 95% CI:1.50, 6.48). Metal workers who do not get a safety training were 2 times more likely to develop chronic respiratory symptoms than those who did (AOR: 2.41, 95% CI: 1.10, 5.28). Metal workers who did not calibrate or maintained their welding machines were almost 2 times more likely to develop chronic respiratory symptoms than those who did (AOR: 1.87, 95% CI: 1.01, 3.59). Compared to metal workers who did their welding task outdoor, metal workers who did their welding task were 6 times more likely to develop chronic respiratory symptoms (AOR: 6.85. 95% CI: 2.36, 19.89) (Table 12).

Table 11 Multivariate analysis for Factors associated with the occurrence of chronic respiratory symptoms among metal workers, Akaki Kality, Addis Ababa, Ethiopia

| Response | Chronic respiratory Symptoms | | AOR (95% CI) | P. value |
|---|---|---|---|---|
| | Yes | No | | |
| **Age Group** | | | | |
| less than 25 | 12 | 42 | 1.00 | |
| More than 25 | 68 | 146 | 2.12 (1.12-4.46) | **0.04*** |
| **Educational Status** | | | | |
| Primary and secondary | 47 | 169 | 5.11 (1.35-19.33) | **0.016*** |
| College education | 6 | 4 | 1.00 | |
| **Work Experience** | | | | |
| Less than 5 Years | 19 | 82 | 1.00 | |
| More than 5 Years | 35 | 90 | 1.35 (0.69-2.63) | 0.38 |
| **Respiratory Protective Equipment used** | | | | |
| Fume proof | 41 | 90 | 1.00 | |
| Non fume proof | 13 | 82 | 3.33 (1.52-7.31) | **0.03*** |
| **Smoking Status** | | | | |
| Smoker | 16 | 15 | 3.57 (1.54-8.23) | **0.003*** |

| | | | | |
|---|---|---|---|---|
| Non-Smoker | 38 | 157 | 1.00 | |
| **Alcohol Intake Status** | | | | |
| Consumer | 31 | 59 | 2.04 (1.04-3.99) | **0.037*** |
| Non-Consumer | 23 | 113 | 1.00 | |
| **Work Related Medical Check ups** | | | | |
| Yes | 31 | 68 | 1.00 | |
| No | 23 | 104 | 3.12 (1.50-6.48) | **0.002*** |
| **Working hour in day** | | | | |
| Up to 8 hours | 19 | 82 | 1.00 | |
| more than 8 hours | 35 | 90 | 1.63 (0.88-3.18) | 0.16 |
| **Safety training** | | | | |
| Yes | 13 | 20 | 1.00 | |
| No | 41 | 152 | 2.41 (1.10-5.28) | **0.03*** |
| **Welding machine Calibration** | | | | |
| Yes | 28 | 59 | 1.00 | |
| No | 25 | 114 | 1.87 (1.01-3.59) | **0.04*** |
| **Welding Site** | | | | |
| Outdoor | 19 | 38 | 1.00 | |
| Indoor | 6 | 72 | 6.85 (2.36-19.89) | **<0.001*** |
| Both | 29 | 62 | 1.13 (0.55-2.32) | 0.74 |

AOR= Adjusted odds ratio, CI= Confidence Interval, 1.00= reference, *= Statistically significant at P <0.05

### 5.8. Observational Findings

Among the selected 15 metal workers for personal dust measurement from 3 establishments 8 metal workers were wearing fume and flame proof hand held face shield while doing their welding tasks. Among those eight metal workers 3 of them were additionally wearing surgical masks. The other 3 were wearing only sun glassed while welding. The other 4 were not using any personal protective equipment. Additionally, none of the establishments have any written procedure for selection, usage and maintenance of PPE and a warning sign of PPE in the area where it requires utilization of PPE.

All the selected metal working establishments were mostly doing their welding take both indoor and outdoor. But mostly out door. Unlike establishment No. 3 establishment 1 and 2 have enough working space compared to their workers. Additionally, all of them used a general ventilation mechanism with wide opened doors. In establishment No.1 presence of thrown metal and other trashes were making only 1 side of the door to be opened. Genitors in establishment 01 clean the shed every other day before the work begins early in the morning. Establishment 2 the genitor cleaned the work place twice a day (early in the morning and on lunch break). In establishment 3 a small broken and unused metal were thrown all over the place which make it difficult for genitors to clean the working place every day. Metal workers in establishment 01 and 02 used a newer welding machine while in establishment 02 they used an older welding machine.

# 6. Discussion

The overall prevalence of respiratory symptoms among metal workers and office workers was 23.9% and 9.2% respectively. The prevalence of chronic respiratory might be higher than the recent finding but duet to the COVID-19 pandemics some the respondents were afraid to admit that they experiencing Respiratory symptoms. Among the specific respiratory symptoms cough (18.1%), Phlegm (5.5%), Breathlessness (6.2%) and Chest tightness accounts (4.9%). The overall geometric mean value of the personal dust exposure among metal worker which were taken from the breathing zone was 5.95 mg/$m^3$ and 53.3% of the sample found to be above the American Conference of Governmental Industrial Hygienists (ACGIH) and Occupational Safety and Health Administration (OSHA) standard (2).

The prevalence of chronic symptoms in the current study is consistent with study conducted in Tanzania, Malaysia and India and with 24.5%, 21.4% and 21.6% respectively (20, 30, 31). In addition, prevalence of cough and breathlessness were similar with studies in India and Iran (15.5% cough and 3.9 % Breathlessness) and (17.8% Cough, and 2.35% Breathlessness) respectively (21, 31).

The finding on personal dust exposure also showed some similarities with the study conducted in Saudi Arabia in 2010 that showed the mean value of personal dust exposure among welders (was 6.3 mg/$m^3$) (19). Another study conducted in 2018 in Dar es Salaam, Tanzania shows that the mean personal dust exposure among small scale metal workers was 6.57 mg/$m^3$ (20). Additionally, a study from Iran, Tehran in 2009 shows the personal dust exposure among welder was 6.37 mg/$m^3$ (32).

In the present study the prevalence of chronic respiratory symptoms was higher among study participant who only attended primary and secondary education than those who attended college education (AOR: 5.11, 95% CI: 1.35, 19.33). This finding was in agreement with findings from Tanzania that showed high proportion of respiratory symptoms with statistically significant association (p=0.019) among metal worker who attended only lower education (20). This might be because of less awareness about the health effect of welding on respiratory problem.

In this study metal workers who were not using protective respiratory protective were more likely to develop chronic respiratory symptoms (AOR: 3.33, 95% CI: 1.52, 7.31). Study from

Tanzania showed that welders who did not use RPE properly are more likely to develop respiratory symptoms than those who used them properly (p 0.017, OR: 3.80) (20). A study conducted in India in 2017 on Occupational hazard among welders showed that not using an appropriate respiratory protective equipment like face shields shows that a significant association with occurrence of work related hazard like respiratory symptoms (P=0.027, AOR: 4.88) (31). This could be because welders who are using a piece of cloths or surgical mask are not that much protective against dust.

In this study about 99 (43.8%) of visited a physician for work related problems and also the odds of having a chronic respiratory symptom were higher among those metal workers who did not visited a physician for work related medical checkup (AOR: 3.12, 95% CI: 1.50, 6.48). This might be because metal workers those who visited physician are taking all the necessary precautions in order to prevent themselves developing a chronic respiratory problem and other work-related health problems.

Metal workers who did not get a training on occupational safety were more likely to develop a chronic respiratory symptom than who did not (AOR: 2.41 95%CI: 1.10, 5.28). This might be because metal workers are utilizing RPE effectively after the training.

In this study odds of developing a chronic respiratory symptom were higher among metal workers who did not get calibrated or maintained their welding machine timely (AOR: 1.87, 95% CI: 1.01, 3.59). As it was seen in the observation while doing personal dust exposure metal workers who were using older welding machine produces more fume than those who used a new one. This might lead to excess exposure to welding fume and leading to developing a chronic respiratory symptom.

Compared to metal workers who did their welding task outdoor, the odds of developing a chronic respiratory symptom were higher among metal workers who worked indoor (AOR: 6.85. 95% CI: 2.36, 19.89). this might be because there is no enough air ventilation in the working area.

# 7. Strength and Limitations

## 7.1. Strengths

To find a strong evidence on Chronic respiratory symptoms among metal workers relatively a good study design was used. A representative sample size used for study population within the study area. An adjustment was done in assessing the prevalence of chronic respiratory symptoms to avoid possible confounders. The data collection was also collected by an Environmental health professional rather than self-administered questionnaires.

On personal dust exposure measurement, a two consecutive days personal and full working hours personal dust exposure sampling were conducted in order to obtain valid and reliable result. And, in the two days dust sampling close result were obtained.

## 7.2. Limitations

Because of the COVID-19 pandemics some the respondents were afraid to admit that they experiencing Respiratory symptoms in both metal and office workers. There might be possibilities of recall bias on respondents on answering their ages, work experience and monthly income which might affect the outcome.

On dust measurement using a closed faced cassette the dust particles might stick to the interior part of the cassette and this might cause an underestimation of the results.

# 8. Conclusions and recommendations

## 8.1. Conclusions

The overall prevalence of chronic respiratory symptoms among metal and office workers were 23.9% and 9.2% respectively. The overall Geometric mean personal dust exposure among welders were 5.98 mg/$m^3$ (±GSD= 1.54). This were above the accepted level daily welding fume exposure which was set by ACGIH) and OSHA. On observational finding, there was no any written procedure for selection, usage and maintenance of RPE and a warning sign of RPE in the area where it requires utilization of RPE were not observed in all metal working establishments.

A significance association were seen between welding fume exposure and occurrence of chronic respiratory symptoms in Age educational status, usage of respiratory protective equipment, Smoking Status, Alcohol intake safety training, welding machine maintenance and welding site.

## 8.2. Recommendations

The Addis Ababa City Administration Job Opportunity Creation office should make mandatory that Micro and small-scale metal working establishments owners should post of warning sign of PPE and a written procedure in areas where require PPE utilization. The sub-city job opportunity Creation office should give a safety training on utilization and personal protective equipment workers with collaboration of the sub city labor and social affairs, food and medicine administrative and control and health offices. Additionally, the regional work opportunity creation bureau should give a safety training for metal workers.

The owner of metal working establishment should provide metal worker with a proper respiratory protective equipment. They should also have a periodicity for regular welding machine calibrations and maintenance or changing of older welding machine with a new one. And, they should also create a clean and enough space for metal workers with a good ventilation mechanism. Metal workers should use a fume protective respiratory protective equipment effectively while doing their welding task. As mentioned in the statement of the problem there a research gap in this area. So, other researchers should do furthermore more investigation on welding fume exposure and respiratory symptoms to influence policy makes to set a standard.

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# Annexes

## Annex 1Questionnaires in English

### Addis Ababa University, College of health science, School of Public Health, Environmental and Occupational Health Track

### I. Participant information sheet for respiratory symptoms and associated factors

Greeting my name is Hager Badima. I came from Addis Ababa University, College of Health Science, School of Public Health to Conduct an investigation on welding fume exposure and prevalence of chronic respiratory symptoms among welders working in micro and small scale enterprise metal work welders. The objective of this questionnaire is to gather appropriate information about welding fume exposure and chronic respiratory symptoms among micro and small scale enterprise metal workers in Akaki kality, Addis Ababa, Ethiopia. The study focuses on the exposure level of exposure to welding fumes, chronic respiratory symptoms and factors that are associated for the occurrence of chronic respiratory symptoms. So, the investigation will try to bring out a better strategic solution to solve the problems that encounter on the exposure to welding fume and respiratory problems.

A face to face interview will be conducted with the respondents to gather the necessary information about welding fume exposure and factors that are associated with the occurrence of respiratory symptoms. While doing this interview there is no any risk that will encounter no you. However, there is no any direct benefits to the study participants. The study has an ethical approval form the School of Public Health Ethical Committee. By assuring that information that you provide will be treated with strict confidentiality and honesty, the interview is totally based on your willingness to be part of the study. If you feel any kind of discomfort during the interview, please feel free to withdraw at any time you want.

Whom to contact: If you have any question about the research you may contact

- Hager Badima (PI): +251-910-8044-63
- Dr, Samson Wakuma: +251-923-9409-98
- Dr. Abera Kumie: +251-911-8829-12

## II. Participant information sheet for the personal dust measurement

Greeting my name is **Hager Badima**. I came from Addis Ababa University, College of Health science, School of public Health to conduct an investigation. The objective of this study to gather appropriate and more reliable information on how much welding fume will welders inhale during the working hour. You are selected to be included in this study because you have the highest risk to be exposed to welding fume compare to other worker in this organization. There is no any potential harm that could happen to you while participating in this study. You are only expected to do your daily welding activities.

**The procedure that are to be performed:** The sample will be collected a total dust measuring device. The device contains a sampler pump and a sampler a close faced cassette containing filter paper called 37mm Millipore. The sampling filter paper will be measured at black lion BRHD core laboratory using calibrated Mittler Toledo Weighting Scale prior to the data collection. The side kick pump sampler filter rate will be calibrated on 2 liters per minute. The total dust exposure will be measured using Sample sidekick pump and putting Millipore closed faced 37mm containing 5µm Polyvinyl chloride (PVC) filter on 300mm hemisphere around the nose and mouth area. The measuring device will be on the volunteer participant thought their working time. After collecting the data, the filter paper containing cassette will be transported back to the laboratory and post filter weight will be measured.

Whom to contact: If you have any question about the research you may contact

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**Informed consent form**

Taking the above information into consideration, I kindly ask you to take part in the study.

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

1. If you your response is yes, please continue to the following questions
2. If no please No, provide a gratitude and skip to the next participant

Participant signature: _____ Date: _____

Name of data collector: _____ Singature: _____ Date: _____

**Identification**

Questionnaire code: _____ Woreda of the establishment: _____

Metal work establishment code: _____

| **Part I: Socio demographic factors** | | | |
|---|---|---|---|
| Sn | Questions | Response | Skips |
| 1. | Sex | 1. Male<br>2. Female | |
| 2. | Age in year | _____ years old | |
| 3. | Marital status | 1. Unmarried<br>2. Married<br>3. Divorced<br>4. Widowed/er | |
| 4. | Religion | 1. Orthodox<br>2. Muslim<br>3. Catholic | |

| | | | |
|---|---|---|---|
| | | 4. Protestant<br>5. Other (specify) | |
| 5. | Educational status | 1. No formal education<br>2. Primary<br>3. Secondary<br>4. Diploma<br>5. Degree<br>6. Above | |
| 6. | Working experience | _____ year | |
| 7. | Monthly income | _____ ETB | |
| **Part II: Behavioral factors** | | | |
| 1. | Do you use personal protective equipment while welding to prevent inhaling the welding fume | 1. Yes<br>2. No | If "No" skip to Q No. 3 |
| 2. | Do you smoke cigarette? | 1. Yes<br>2. Used to<br>3. No | If "used to" skip to Q No. 6<br>If "No" skip to Q No. 8 |
| 3. | How many cigarettes do you smoke per day? | _____ cigarette per day | |
| 4. | How long you have been smoking cigarette? | _____ year | |
| 5. | Since when do you quit smoking cigarette? | Before _____ ago | |
| 6. | Before quitting smoking for how | _____years | |

| | | | |
|---|---|---|---|
| | long do you smoke cigarette? | | |
| 7. | Do you drink Alcohol | 1. Yes<br>2. Used to<br>3. No | If "used to" skip to Q No. 15<br>If "No" skip to Q No. |
| 8. | How frequent do you drink alcohol? | 1. Daily<br>2. Once in a week<br>3. Once in month<br>4. Other_____ | |
| 9. | Since when you quit drinking alcohol? | _____ ago | |
| 10. | Before quitting for how long do you drink alcohol | _____ years | |
| 11. | Do you ever visit a physician for a checkup related to your work? | 1. Yes<br>2. No | |
| 12. | When was the last time you had the checkup? | _____ ago | |
| 13. | What was the purpose of the checkup? | 1. Eye checkup<br>2. Skin checkup<br>3. Respiratory checkup<br>4. Cardiac checkup<br>5. Other _____ | |
| **Part III: Administrative factors** | | | |
| 1. | How much time do you work in day? | 1. Less than 8 hours<br>2. 8 hours | |

| | | | |
|---|---|---|---|
| | | 3. More than 8 hours | |
| 2. | How many day in week do you work? | 1. Less than 5 days<br>2. 5 days<br>3. More than 5 days | |
| 3. | You even been supervised on health and safety | 1. Yes<br>2. No | If "No" skip to Q No. 6 |
| 4. | By whom is the supervision conducted | 1. By the government officials<br>2. By the owner<br>3. Other_____ | |
| 5. | How frequent is the supervision conducted | 1. Every month<br>2. Every 3 month<br>3. Every 6 month<br>4. Every 1 year | |
| 6. | Is PPE is provided to you by your employer? | 1. Yes<br>2. No | |
| 7. | Is there a first aid kit at your work place | 1. Yes<br>2. No | |
| 8. | Is there a safety training given to you? | 1. Yes<br>2. No | |
| **Part IV: Working environment factors** | | | |
| 1. | What kind of welding material do you use mostly? | 1. SMAW<br>2. GMAW | |
| 2. | What types of protective material do you use | 1. Mask Respirator<br>2. Face shield<br>3. Piece of close | |

| | | | |
|---|---|---|---|
| | | 4. Other_____ | |
| 3. | Do your machines that used calibrated timely | 1. Yes<br>2. No | |
| 4. | Where do you perform your welding activity mostly? (prove while observing) | 1. Indoor<br>2. Outdoor | |
| 5. | What of ventilation system does you use at work place (prove while observing) | 1. General<br>2. Local<br>3. None | |
| Part V: Respiratory Symptoms Questions | | | |
| Cough | | | |
| 1. | Do you usually cough? | 1. Yes<br>2. No | If "Yes" for Q 1,2,3 and 4 please answer Q 5 and 6 |
| 2. | Do you usually cough as much as 4 to 6 time a day? | 1. Yes<br>2. No | |
| 3. | Do you usually cough at all on getting up or first thing in the morning? | 1. Yes<br>2. No | |
| 4. | Do you usually cough at all during the rest of the day or at night? | 1. Yes<br>2. No | |
| 5. | Do you usually cough like this on most days for l. 3 consecutive months or more during the year? | 1. Yes<br>2. No | |
| 6. | For how many years have you had this cough? | _____ years | |

| | | | |
|---|---|---|---|
| Phlegm | | | |
| 1 | Do you usually bring up phlegm from your chest? | 1. Yes<br>2. No | If "Yes" for Q 1,2,3 and 4 please answer Q 5 and 6 |
| 2 | Do you usually bring up phlegm like this as much as twice a day, 4 or more days out of the week? | 1. Yes<br>2. No | |
| 3 | Do you usually bring up phlegm at all on getting up first thing in the morning? | 1. Yes<br>2. No | |
| 4 | Do you usually bring up phlegm at all during the rest of the day or at night? | 1. Yes<br>2. No | |
| 5 | Do you bring up phlegm like this on most days for 3 consecutive months or more during the year? | 1. Yes<br>2. No | |
| 6 | For how many years have you had trouble with phlegm? | _____ years | |
| Breathlessness | | | |
| 1 | Are you troubled by shortness of breath when hurrying on the level or walking up a slight hill | 1. Yes<br>2. No | |
| 2 | Do you have to walk slower than people of your age on the level because of breathlessness | 1. Yes<br>2. No | |
| 3 | Do you ever have to stop for breath after walking at your own pace on | 1. Yes<br>2. No | |

| | | | |
|---|---|---|---|
| | the level | | |
| 4 | Do you ever have to stop for breath after walking about 100 yard (or after few minutes) on the level | 1. Yes<br>2. No | |
| 5 | Are you to breathless to leave, the house or breathless on dressing on undressing | 1 Yes<br>2 No | |
| Chest Illness | | | |
| 1 | If you get a cold, does it usually go to your chest? | 1. Yes<br>2. No | If "Yes" please answer Q 3 and 4 |
| 2 | During the past 3 years, how many such illness , have you had any chest illness that have kept you off work, ,in door at home, or on bed? | 1. Yes<br>2. No | |
| 3 | Did you produce phlegm with any of those chest illness | 1. Yes<br>2. No | |
| 4 | In the last 3 years, how many such illness, with (increase) phlegm, did you have which lasted a week or more? | _____ number of illness<br>_____ No such illness | |

**Annex 2 Questionnaires in Amharic**

**አዲስ አበባ ዩኒቨርስቲ ፣ ጤና ሳይንስ ኮሌጅ፣ የህብረተሰብ ጤና ትምህረት ክፍል**

**ለመተንፈሻ አካል ምልክቶች ጥናት መጠይቆች ለተሳታፊዎች መረጃ መስጫ**

ጤና ይስጥልኝ ስሜ **ሐገር ባድማ** ይባላል፡፡ ከአዲስ አበባ ዩኒቨርሲቲ ፣ ጤና ሳይንስ ኮሌጅ፣ የህብረተሰብ ጤና ትምህረት ክፍል ጥናት ለማድረግ ነው የመጣሁት፡፡ የዚህ ጥናት መጠይቅ ዓላማ በኢቃቂ ቃሊቲ ክፍለ ከተማ ስር በሚገኙ ጥቃቅን እና አነስተኛ የብረታ ብረት ተቋማት ውስጥ ብየዳ የሚሰሩ ሰራተኞች በሚበይዱበት ወቅት ለሚጋለጡበት የብያጅ ብናኝ እና በሱም ምክንያት ሊከሰቱ የሚችሉ የመተንፈሻ አካላት የጤና ችግሎች እና ተያያዥ በሆኑ ጉዳዮች ዙሪያ አስፈላጊ የሆኑ መረጃዎችን ለመሰብሰብ ነው፡፡ ይህ ጥናት አዲስ አበባ ዩኒቨርስቲ የህብረተሰብ ጤና ሳይንስ ትምህርት ክፍል የሳይንሳዊ ጥናት ስነ ምግባር ማረጋገጫ አጊንቷል፡፡

ጥናቱ በያጆች በሚበይዱበት ወቅት ምን ያህል ለብያጅ ብናኞች ተጋላጭ እንደ ሚሆኑ፣ ምን ያህል የመተንፈሻ አካል የጤና ችግር ምልክቶች አንሚያሳዩ እና ለጤና ችግሮች ተያያዥ የሆኑ ጉያዮች ዙሪያ የሚያተኩር ነው፡፡ ስለዚህ፣ ጥናቱ በበያጆች ላይ ሊደርስ የሚችሉ የመተንፈሻ አካል የጤና ችግሮች ዙሪያ የተሻለ የመፍትሔ ሃሳቦችን ለማምጣት ነው፡፡ ከጥያቄ ምላሽ ሰጪዎች ጋር ፊትለፊት ቃለ- መጠይቅ የሚደረግ ይሆናል፡፡ ቃለ መጠይቁ በእርሶ ሙሉ ፍቃደኝነት ላይ የተመሠረተ ነው ፤ ስለዚህ ቃለ መጠይቁ በሚካሄድበት ወቅት ማንኛውም አይነት አለመመቸት፣ አለመግባባት ቢከሰት አራሶትን ከጥናቱ የማግለል ሙሉ መብት አሎት፡፡

የሚሰጡን ምላሾች በክፍለ ከተማው ባሉ የጥቃቅን እና አነስተኛ የብረት ብየዳ ስራ ውስጥ በሚሰሩ በያጆች ላይ የሚደርሰው የጤና ችግሮች በትክክል ለመለየት ይረዳል፡፡ የሚሰጡን መረጃ በጥብቅ አመኔታ እና ምስጢር ይሆናል፡፡

ስለ ጥናቱ ላሎት ማንኛውንም ጥያቄዎች በሚከተሉት ሰልክ ቁጥሮች ደውለው መጠየቅ ይችላሉ ፡፡

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2. **የተሳቲዎች የመበየጃ አቧራ/ብናኝ መጠን አለካክ መረጃ መስጫ**

ጤና ይስጥልኝ ስሜ **ሐገር ባድማ** ይባላል፡፡ ከአዲስ አበባ ዩኒቨርሲቲ አዲስ አበባ ዩኒቨርስቲ ፣ ጤና ሳይንስ ኮሌጅ፣ የህብረተሰብ ጤና ትምህረት ክፍል ጥናት ለማድረግ ነው የመጣሁት፡፡ የዚህ ጥናት ዓላማ በያጆች በስራ ላይ ሳሉ ለምን ያህል የብያጅ ብናኞች በመተንፈሻ አካላቸው ይገባል ሚለውን ለማወቅ ነው፡፡ አርሶ ከሌላው የተቋሙ ሰራተኞች በበለጠ መልኩ ለብያጅ ብናኞች ተጋላጭ ስለሆኑ ለዚህ ጥናት ተመርጠዋል፡፡ የዚህ ጥናት ተሳታፊ ስለሆኑ ምንም አይነት ጉዳት አይደርስብዎትም ፤ ከእርስዎ የሚጠበቀው የእለት ተእለት የብየዳ ተግባርዎትን እንዲያከናውኑ ብቻ ነው፡፡

**የናሙናው አወሳሰዱ ቅድመ ተከቶሎች፡** ናሙናው የሚወሰደው ብናኞችን በሚለካ መሳሪያ ነው ሲሆን፣ መሳሪያው ፓምፕ፣ ድፍን የሆነ ማጣሪያ ወረቀት 37ሚ.ሚ ፤ ናሙናው ከመወሰዱ በፊት በጥቁር በሚገኝ ላብራቶሪ የማጣሪያው ወረቀት ተመዘኖ እና ቁጥሩ ተመዝገቦ ይመጣል፡፡ ከጎኖ ላይ የሚደረገው ፓምፕ በደቂቃ 2 ሊትው ፓንፕ እዲስብ ተደርጎ ይስተካላል፡፡ ሲለዚህ የማካሪያ ወረቀቱን የያዘው ካሴት ከፓንፑ ጋር በማገናኘት እና የመተንፈሻ ከባቢ 37 ሚሊሜትር በትሻዎት ላይ በማስቀመጥ የናሙና መውሰድ ስራ የሚከናወን ይሆናል፡፡ የናሙና መውሰጃው መሳሪያዎች በጎ ፍቃደኛ በሆኑ ሰራተኞ አማካኝነት ሲሆን፣ ከነሱም የሚጠበቀው የተለመደውን የለትለት ስራቸው ብቻ እንዲሰሩ ነው፡፡ ናሙናው ከተወሰደ ብኋላ ብናኙን የያዘው ወረቀት በተቀመጠበት ካሴት ውስጥ እንዳለ ተመልሶ ወደ ጥቁር አንበሳ ሆስፒታል በመውሰድ የድህረ-ናሙና ምዘና ይኪሄዳል፡፡

ስለ ጥናቱ ላሎት ማንኛውንም ጥያቄዎች በሚከተሉት ሰልክ ቁጥሮች ደውለው መጠየቅ ይችላሉ ::

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**ስምምነት ማሳወቂያ ፎርም**

ከላይ ያሉትን መረጃዎች ከግምት ውስጥ በማስገባት የጥናቱ ተሳታፊ እንዲሆኑ በትህትና እጠይቃለሁ ፡፡ የጥናቱ አላማ በሚገባኝ እና በምረዳው ቋንቋ በአግባቡ ተብራርቶልኝ እንዲሁም በማንኛውም ሰዓት ቃለመጠይቁን ማቋረጥ እንደምችል ተረድቼ የጥናቱ ተሳታፊ ለመሆን ወስኜ ከታች በተቀመጠው ስፍራ ላይ ፊርማዬን አስቀምጫለሁ፡፡

3. በጥናቱ ለመሳተፍ ፈቃደኛ ከሆኑ እና መልስዎ አዎ ከሆነ እባክዎን ወደ ቀጣዩ ጥያቄ ይለፉ
4. በጥናቱ ለመሳተፍ ፈቃደኛ ካልሆኑ አመስግነው ወደ ቀጣይ ተሳታፊ ይለፉ

የተሳታፊ ፊርማ : _____ ቀን: _____

መረጃ ሰብሳቢው ስም : _____ መረጃ ሰብሳቢው ፊርማ: _____ ቀን: _____

***መለያ***

የመጠይቁ ኮድ : _____ ስራ ቦታው የሚገኝበት ወረዳ: _____

የብረታ ብረቱ ባታው ኮድ: _____

| ክፍል 1፡ ማህበራዊ መጠይቆች | | | |
|---|---|---|---|
| ተ.ቁ | መጠይቆች | መልስ | መዝለያ |
| 1 | ፆታ | 1. ወንድ<br>2. ሴት | |
| 8. | እድሜ | _____ | |
| 9. | የትዳር ሁኔታ | 5. ያላገባ/ች<br>6. ያገባ/ች<br>7. የተፋታ/ች<br>8. የሞተበት/ባት | |
| 10. | ሃይማኖት | 6. ኦርቶዶክስ<br>7. ሙስሊም<br>8. ካቶሊክ<br>9. ፕሮቴስታንት<br>10. ሌላ ካለ ይግለጹ | |
| 11. | የትምህርት ሁኔታ | 7. ያልተማረ/ች<br>8. የመጀመሪያ ደረጃ<br>9. የሁለተኛ ደረጃ | |

| | | | |
|---|---|---|---|
| | | 10. ዲፕሎማ<br>11. ዲግሪ<br>12. ከዛ በላይ | |
| 12. | የስራ ልምድ | _____ ዓመት | |
| 13. | ወርሃዊ ገቢ | _____ የኢትዮጵያ ብር | |
| **ክፍል 3፡ የባህር ይዘት ያላቸው መጠይቆች** | | | |
| 14. | ራስዎን ከ ብየዳ ብናኝ ለመጠነቅ ራስን መጠነቂያ ቁሳቁስ ይጠቀማሉ? | 3. አዎ<br>4. አልጠቀምም | መልስዎ አልጠቀምም ከሆነ ወደ ጥያቄ 3 ይሂዱ |
| 15. | ምን አይነት ራስን መጠበቂያ መሳሪያ ይጠቀማሉ?<br>What types of protective material do you use | 5. Mask Respirator<br>6. Breathing apparatus<br>7. Piece of close<br>8. Other_____ | |
| 16. | ሲጋራ ያጨሳሉ? | 4. አጨሳለሁ<br>5. አጨስ ነበር<br>6. አላጨስም | መልስዎ “አጨስ ነበር ከሆነ ወደ ጥያቄ 6 ይሂዱ<br>መልስዎ አላጨስም ከሆነ ወደ ጥያቄ 8 ይሂዱ |
| 17. | በቀን ስንት ሲጋራ ያጨሳሉ? | _____ በቀን | |
| 18. | ለምን ያህል ጊዜ ሲጋራ አጭሰዋል? | _____ዓመት | |
| 19. | ሲጋራ ማጨስ ያቆሙት ከመቼ ጀምሮ ነው? | _____ | |
| 20. | ሲጋራ ማጨስ ከማቆምዎ በፊት ለምን ያህል ጊዜ አጭሰዋል? | _____ዓመት | |
| 21. | የአልኮሆል መጠጥ ይጠጣሉ ? | 4. አዎ<br>5. እጠጣ ነበር<br>6. አልጠጣም | መልስዎ እጠጣ ነበር ከሆነ ወደ ጥያቄ 15 ይሂዱ<br>መልስዎ አልጠጣም ከሆነ ወደ ጥያቄ 15 ይሂዱ |

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| 22. | ምን ያህል ጊዜ መጠጥ ይጠቀማሉ? | 1. በቀን<br>2. በሳምንት አንድ<br>3. በወር አንድ ጊዜ<br>4. ሌላ_____ | |
| 23. | መጠጥ ካቆሙ ምን ያህል ጊዜ ይሆንዎታል? | _____ | |
| 5. | መጠጥ ከማቆምዎ በፊት ለምን ያህል ጊዜ ተጠቅመዋል? | _____ ዓመት | |
| 6. | ለ ጠቅላላ ምርመራ ሃኪም ጋር ሄደው ያውቃሉ? | 1. አዎ<br>2. አላውቅም | |
| 7. | ለመጨረሻ ጊዜ ምርመራ ያደረጉት መቼ ነው? | _____ | |
| 8. | የምርመራው ዋና አላማ ምን ነበር? | 6. የአይን ምርመራ<br>7. የቆዳ ምርመራ<br>8. የመተንፈሻ አካል ምርመራ<br>9. የልብ ምርመራ<br>10. ሌላ _____ | |
| **ክፍል 3፡ የአስተዳደሪያዊ ይዘት መጠይቆች** | | | |
| 9. | በቀን ለስንት ሰዓት ይሰራሉ? | 4. ከ8 ሰዓት በታች<br>5. ለ8 ሰዓት<br>6. ከ8 ሰዓት በላይ | |
| 10. | በሳምንት ለስንት ቀን ይሰራሉ ? | 4. ከ 5 ቀን በታች<br>5. ለ 5 ቀን<br>6. ከ 5 ቀን በላይ | |
| 11. | በጤና እና ደህንነት ዙሪያ ክትትል ተደርጎሎት ያቃሉ | 3. አዎ<br>4. አይ | መልሶ አይ ከሆነ ወደ መጠይቅ ቁ.6 ይለፉ |
| 12. | ክትትል በማን የተደረገው | 4. በመንግስት ሳራተኞች<br>5. በድርጅቱ ባለቤት<br>6. ሌላ | |
| 13. | በምን ያህል ጊዜ ውስጥ ነው ክትትሉ የሚደረገው | 1. በየ ወሩ<br>2. በየ3 ወሩ | |

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| | | 3. በየ 6 ወሩ<br>4. በየ 1 ዓመቱ | |
| 14. | አራስ ከአደጋ መከላከያ መሳሪያዎች በቀጣሪች ተሰቶት ያውቃል | 3. አዎ<br>4. አይ | |
| 15. | የመጀመሪያ የህክምና አርዳታ መስጫ መሳሪያ አለ | 1. አዎ<br>2. አይ | |
| 16. | የስራ ጥንቃቄ ዙሪያ ስልጠና ተሰቶት ያውቃል | 1. አዎ<br>2. አይ | |
| ክፍል 4፡ የስራ ቦታ ከባቢን የተመለከተ መጠይቆች | | | |
| 1. | ምን አይነት የመበየጃ መሳሪያ ይጠቀማሉ | 1. የብረት<br>2. የጋዝ | |
| 2. | ምን አይነት የአራስ ከአደጋ መከላከያ መሳሪያ ይጠቀማሉ | 1. የማስክ መተንፈሻ<br>2. የፊት መሸፈኛ<br>3. ቁራጭ ጨርቅ<br>4. ሌላ | |
| 3. | የመበየጃ መሳሪያዎች በወቅቱ ይታደሳሉ | 1. አዎ<br>2. አይ | |
| 4. | የመበየድ ስራዎትን የት ነው የሚያኪያይዱት | 1. ቤት ውስጥ<br>2. ውጭ | |
| 5. | በስራው ቦታ ምን አይነት የአየርማዘዋወሪያ መንገድ ይጠቀማሉ | 1. አጠቃላይ<br>2. አካባቢያዊ<br>3. ምንም | |
| የመተንፈሻ አካልት ችግሮች ምልክት መጠይቆች | | | |
| ሳል | | | |
| 1. | ብዙ ጊዜ ያስላሉ | 1. አዎ<br>2. አይ | ለመጠይቅ ቁ. 1፣ 2፣ 3 እና 4 አዎ ከሆነ መጠይቅ |
| 2. | ብዙ ጊዜ በቀን ከ4-6 ጊዜ ያስላሉ | 1. አዎ<br>2. አይ | |
| 3. | ብዙ ጊዜ ጥዋት ከእንቅልፎ ሲነሱ ያስሎታል | 1. አዎ<br>2. አይ | |
| 4. | ብዙ ጊዜ ቀን እና ማታ ላይ ያስሎታል | 1. አዎ | |

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| | | 2. አይ | |
| 5. | ብዚ ጊዜ አንደዚህ አይነት ሳል ለብዙ ቀናት ለተከታታይ 1-3 አስሎት ያውቃል | 1. አዎ<br>2. አይ | |
| 6. | ለስንት ዓመት እንደዚህ አስሎታል | ዓመት | |
| አክታ | | | |
| 1. | ብዙ ጊዜ ከደረቶ የሚወጣ ወፍራም እና አክታ ያወጣሉ | 1. አዎ<br>2. አይ | ለመጠይቅ ቁ. 1፣ 2፣ 3 እና 4 አዎ ከሆነ መጠይቅ |
| 2. | አንደዚህ አይነት አክታ በቀን ሁለቴ እና በሳምንት 4 እና ከዛ በላይ ያወጣሉ | 1. አዎ<br>2. አይ | |
| 3. | ብዙ ጊዜ እንደዚህ አክታ ጥዋት ከእንቅልፎ ሲነሱ ያወጣሉ | 1. አዎ<br>2. አይ | |
| 4. | ብዙ ጊዜ እንደዚ አይነት አክታ ቀሪውን ቀን ያወጣሉ | 1. አዎ<br>2. አይ | |
| 5. | እንደዚህ አይነት አክታ አብዛኛውን ጊዜ ለተከታታይ 3 ወር እና ከዛ በላይ ያወጣሉ | 1. አዎ<br>2. አይ | |
| 6. | ለስንት ዓመት እንደዚህ አይነት አክታ እያወጡ ነበር | ዓመት | |
| የትንፋሽ ማጠር | | | |
| 1. | ከፍታ በሚወጡበት፣ ቀጥ ባለ መንገድ ወይም በፍጥነት በሚጓዙበት ወቅት መተንፈስ ይአገራሉ | 1. አዎ<br>2. አይ | |
| 2. | በሚራመዱበት ጊዜ ትንፋሽ ማጠር ምክንያት ከእድሜ እኮዮችት በቀስታ ለመራመድ ተቸግረዋል | 1. አዎ<br>2. አይ | |
| 3. | በተለመደው ፍጥነቶ ቀጥ ባለ ስፍራ ላይ በሚጓዙበት ወቅት አየር ለመውሰድ ቆመው ያውቃሉ | 1. አዎ<br>2. አይ | |
| 4. | 96 ሜትር ርቀት ከተጓዙ ብኋላ በአየር እጥረት ምክንያት ለመቆም ተገደው ያውቃሉ | 1. አዎ<br>2. አይ | |

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| 5. | ልብስ በሚለብሱበት ወይም በሚያወልቁበት ወቅት አየር አጥሮት ወይም አየር አጥሮት ከቤት ለመውጣት ተገደው ያውቃሉ | 1. አዎ<br>2. አይ | |
| የደረት ህመም | | | |
| 1. | በቅዝቃዜ ወቅት ብዚ ጊዜ ደረቶት አሞት ያውቃል | 1. አዎ<br>2. አይ | |
| 2. | ላለፉት 3 ዓመታት በእንደዚህ አይነት የደረት ህመም ምክንያት ከስራ ለመቅረት፣ ቤት ውስጥ ለመዋል ወይም አልጋ ላይ ለመዋል ተገደው ያውቃሉ | 1. አዎ<br>2. አይ | |
| 3. | ከእነዚህ የደረት ህመም ጋር ምክንያት አክታ ለማውጣት ተገደው ያቃሉ | 1. አዎ<br>2. አይ | |
| 4. | ባለፉት 3 ዓመታት ውስጥ አካታ የበዛበት እና ሳምንት እና ከሳምንት በላይ እንደዚህ አይነት የደረት ህመም ስንቴ አሞታል፣ | ----------<br>የህመሙ ብዛት<br>---------- እንደዚህ አይነት ህመም አሞኝ አያውቅም | |

**Annex 3 Training Manual**

## 1. Introduction

Welding is gas or oxy-fuel that uses for melting metals to join to metals to be attached together. The type of welding process, the metals used for welding, location where the welding takes place the air movement, use of ventilation control and similar things can be consider as factors that affect welders to be exposed to welding fumes. And, it is one of the most common task associated with respiratory diseases and over a millions workers perform some sort of welding in their job. Each country in the world have more than one percent of labor welder exposed to different types of damages caused by welding. Exposure to welding fume is one among occupational hazard associated with physical and chemical hazards. Which is caused by lack of usage of personal protective equipment and other behavioral factors.

Chronic obstructive pulmonary disease (COPD), Chronic bronchitis, Pneumonia, Phlegm, emphysema and asthma are respiratory cases and symptoms that mostly notice among welders. The for different respiratory symptoms is higher among welder who are smokers. Cigarette smoking and exposure to welding fume have a synergism effect.

In Ethiopia on the study conducted in Addis Ababa city on welders, even if 86.5% welders are aware of the occupational hazard that encounter while welding, 66.8% of the welder complain at least 1 health problem. This is due to lack of training, not using appropriate safety equipment and lack of work shift and supervision.

2. **Objectives the training**
   - Giving an insight for the study purpose study for data collectors
   - Explaining roles and responsibilities of data collectors
   - Explaining ways of data collection
3. **Method of training**
   - Participatory
   - Group discussion
   - Role play/ practice
4. **Training time line**
   - Introduction- 30 minutes
   - Explaining ways of data collection-40-50 minutes
   - Explaining ways of interviewing- 30-40 minutes
   - Role and responsibilities of the participants 15-20 minutes
5. **Materials needed for data collection**

   - Informed consent
   - Questionnaire
   - Observational checklists
   - Dust sampling materials
   - Pencil
   - Pen
   - Mobile phone/ Digital camera

6. **Payment**

Every data collector who will participate in this data collection will be paid 50 Ethiopian birr.

7. **Role and responsibilities of participants**

7.1. **Role and responsibilities data collectors**

   - Attending the training attentively
   - Knowing all the inclusion and exclusion criteria
   - Obtaining the necessary consents
   - Interviewing the study participants properly based on the questionnaire
   - Observing the work place environment based the checklists, taking picture if necessary

- Recording the finding based on the questionnaire and observational checklists

### 7.2. Role and responsibilities of Supervisors

- Giving all the necessary training for data collectors prior to data collection
- Checking the completeness of the questionnaires and observational checklists before giving to data collectors
- Giving all the necessary support and follow up for the data collectors
- Giving all the necessary payment for data collectors based on the agreement
- Coding the entering the collected data properly
- Keeping all the data confidentially

## 8. What is expected from study participants?

- If they are metal workers, they should be engaged in welding activities and have 1year and more than 1-year experience
- If they are metal workers they should not be engaged in painting activities, they should not be sick at the time of data collection
- If they are office workers, they should be working in micro and small scale enterprise office at woreda or sub-city level

## 9. Ways of data collection

- Data collectors must rehearse the questionnaire at home
- Greeting the respondent and a proper self-introduction
- Waiting until a favorable time for conducting the interview comes
- Reading all the necessary information on the consent form for the study participants
- Presenting all the questions on the study questionnaire for respondents politely
- Answering the questions raised by the respondents politely
- Do not force respondents to participate the study
- Getting a signature from study participants before conducting the interview
- Looking around the work place for the ventilation, utilization of PPE, welding site
- Taking pictures of the work place after obtaining verbal consent from the owner or the study participants

## 10. How to fill the questionnaires?

- The close-ended questionnaires must be circled on the appropriate response using pencil only

- The open-ended questionnaires must write respondent's response on the space provided