ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCE

SCHOOL OF PUBLIC HEALTH

ASSESSMENT OF DUST EXPOSURE AND CHRONIC RESPIRATORY SYMPTOMS AMONG WORKERS IN MEDIUM SCALE WOODWORK FACTORIES IN AKAKI KALITY SUB CITY, ADDIS ABABA

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Acronyms and Abbreviations

ACGIH: American Conference of Governmental Industrial Hygienist

AIOH: Australian Institute of Occupational Hygienists

AM: Arithmetic Mean

ANOVA: Analysis of Variance

AOR: Adjusted Odds Ratio

ASTM: American Society for Testing and Materials

BMRC: British Medical Research Council

CI: Confidence Interval

COPD: Chronic Obstructive Pulmonary Disease

COR: Crude Odds Ratio

CFC: Closed Filter Cassette

DECOS: Dutch Expert Committee for Occupational Standards

EOH: Environmental and Occupational Health

EU: European Union

GM: Geometric Mean

GSD: Geometric Standard Deviation

HSE: Health and Safety Executive

IARC: International Agency for Research on Cancer

IIAC: Industrial Injuries Advisory Council

ILO: International Labour Organization

IOM: Institute of Medicine

IPM: Inhalable Particulate Matter

ISO: International Organization for Standardization

NIOSH:	National Institute for Occupational Safety and Health
OEL:	Occupational Exposure Limit
OSH	Occupational Safety and Health
OR:	Odds Ratio
PNOS:	Particles Not Otherwise Specified
PPEs:	Personal Protective Equipment's
PVC:	Polyvinyl Chloride
RPE:	Respiratory Protective Equipment's
SD:	Standard Deviation
SEGs:	Similar Exposure Groups
SKC:	Scientific Kit Corporation
SPSS:	Statistical Package for Social Sciences
TD:	Total Dust
TLV:	Threshold Limit Value
TWA:	Time-Weighted Average
UK:	United Kingdom
USA:	United States of America
VIF	Variance Inflation Factor
WHO:	World Health Organization

Abstract

Background: Wood dust is known to generate a wide variety of airborne wood dusts. Wood dust in a form of inhalable particulates can penetrate the lung tissues and affect respiratory health. There is limited study in chronic respiratory symptoms and wood dust exposure studies in Ethiopia.

Objective: This study aims to assess prevalence of chronic respiratory symptoms among workers, identify associated factors with chronic respiratory symptoms and measure the concentration of personal total wood dust exposure level in medium woodwork factories in Akaki Kality Sub City, Addis Ababa.

Method: An institutional based cross-sectional study was conducted among a sample of 506 randomly selected woodworkers in Akaki Kality Sub City, Addis Ababa in 12 randomly selected medium scale woodwork factories using British Medical Research Council respiratory symptoms questionnaire with a few modifications from March 14 –May 23, 2019. Epi-Info v.7.2 and SPSS v.21 were used for data entry and analysis, respectively. Descriptive statistics were used, and data were presented using tables and figures. A binary logistic regression model was used to determine the odds ratio of chronic respiratory health symptoms for each predictor. Forty personal dust measurements among 20 randomly selected woodworkers were done from the two randomly selected medium scale woodwork factories by fixing dust samplers around the breathing zone. The dust samples were analyzed gravimetrically using a standard microbalance scale. The dust level was described and compared with the threshold limit value of American conference of governmental industrial hygienist recommendation (10 mg/m^3).

Results: The prevalence of chronic respiratory health symptoms among woodworkers was 69.8% (95% CI: 66.0-73.8) with prevalence of cough (54.6%), phlegm (52.2%), wheezing (44.6%), breathlessness (42.1%) and chest pain (42.9%). None of woodworkers had any proper respiratory protective devices. Chronic respiratory health symptoms among woodworkers was significantly associated with past occupational dust exposure history (AOR = 2.09, 95% CI; 1.09-4.01), work experience (AOR = 9.18, 95% CI; 5.27-16.00), energy used for cooking (AOR = 2.42, 95% CI; 1.44-4.07), and occupational safety and health training (AOR = 3.38, 95% CI; 1.20-9.49). The geometric mean (GM) of dust exposure level among woodworkers was 10.27 mg/m^3. Out of the total samples, 22(55%) exceeded the threshold limit value of American conference of governmental industrial hygienist recommendation (10 mg/m^3).

Conclusion and recommendations: Chronic respiratory health symptom was highly prevalent among the woodworkers. The woodworkers were exposed to wood dust level above the recommended occupational exposure level. There is a need to improve dust control measures in medium scale woodwork factories in Akaki Kality Sub City.

1. Introduction

1.1. Background

Woodwork is an occupation related to sawing and sanding of woods and readies woods for other activities like furniture production and production of household items (doors and windows). Woodworkers are at risk of several occupational diseases ranging from chronic respiratory symptom, allergy, asthma and cancer (1).

Wood dust is a general term covering a wide variety of airborne wood dusts. It is a light brown or tan fibrous powder-like substance generated when timber is processed: chipped, sawed, turned, drilled, or polished. Wood dust generated in work place because of cutting, grinding, sanding and polishing. Operations such as sawing, turning and routing produce relatively coarse dust, while sanding and assembly operations generate fine dust (2, 3). Wood processing results in the formation of wood chips and dust. The dust is partially suspended in the air and may then be inhaled by the workers (4).

Wood processing from woodwork factories caused wood dust and other health hazards including chemicals, bacteria and mold. The dust are divided into two groups according to their size, the first is called “Total dust” which particle are larger than 10 micron (PM10), mainly are soft dust that could enter the upper respiratory tract and excreted by coughing or sneezing. Another type is “Respirable dust” that has particle smaller than 10 micron (PM<10), mainly from hardwood which could enter the lower respiratory tract to alveoli, the disposition of these particles is limited and tends to accumulate in the lung tissues that leads to chronic bronchitis and impairs lung function (1) .

One of the major health problems of woodworkers is chronic respiratory health symptom, which usually results from breathing in noxious or toxic chemicals such as wood dust and exposure to various allergenic, immunotoxic and carcinogenic substances originating from wood itself and from bacteria and fungi growing on timber (5).

Exposure to wood dust has long been associated with a variety of adverse health effects, including dry cough, shortness of breath, and chest pain (3). The international Agency for Research on Cancer classifies wood dust as a human carcinogen (6, 7). Respiratory, nasal and eye symptoms are the most common symptoms reported by woodworkers (8).

1.2. Statement of the Problem

Occupational respiratory diseases are major global public health problems that account for up to 30% of all registered work related diseases with up to 50% prevalence among workers in high risk sectors such as mining, construction and dust generating works and 10–20% of deaths are caused by respiratory problem (9, 10). All countries of the world experienced serious public health problems due to chronic respiratory diseases (11). Among 2.34 million work related fatalities, 8% accounts from respiratory diseases (10). According to ILO (2011), deaths from respiratory diseases accounted 8% from annual work-related deaths (9). WHO reported that deaths from respiratory diseases in Ethiopia were 4% in 2011 and 3% in 2014 (12, 13).

It is estimated that at least 2 million people are exposed to wood dusts every day around the world (6). Workers in medium woodwork industries are exposed to many hazards, including exposure to wood dust and specific agents. Workers exposed to wood dust also have an increased risk of developing occupational asthma, lung function deficits and respiratory symptoms (14).

A study conducted in Addis Ababa in small and medium scale woodwork enterprises indicated that significantly higher geometric mean of dust level among woodworkers (GM=6.82 mg/m^3 and GSD=1.82) as compared to EU OEL but it is lower as compared to ACGIH TLV recommendation for total dust (10 mg/m^3) (15). However, this study did not investigate chronic respiratory symptoms among woodworkers and associated factors with chronic respiratory symptoms.

Another recently conducted unpublished study in Ethiopia, Tigray Region, Maichew among chip wood factory workers also reported that higher prevalence of Cough, Phlegm, Wheeze and Breathlessness for chip wood factory than unexposed subjects. The result of this study showed higher prevalence of chronic respiratory symptoms of exposed respondents compared to unexposed respondents (16). However, this study did not investigate personal dust exposure concentration and associated factors with chronic respiratory symptoms.

Another recently published study in Jimma town, south-west Ethiopia also investigated chronic respiratory symptoms among woodworkers. This study found higher prevalence of dry cough (41.4%), cough with phlegm (34.3%), chest pain (32.9%), breathlessness (21.9%) and wheezing (12.9%) (17). Nevertheless, this study did not investigate dust concentration

and associated factors with chronic respiratory symptoms, conducted with small sample size and did not include female woodworkers.

Another recently published study among particleboard workers in Ethiopia also investigated chronic respiratory symptoms among woodworkers and measured dust concentration. This study found higher prevalence of cough (39%), cough with sputum production (31%), phlegm (27%), breathlessness (24%) and wheezing (45%) (18). Nevertheless, this study also did not identify factors associated with chronic respiratory symptoms and conducted in male workers only.

Previous studies conducted in Ethiopia investigated prevalence of chronic respiratory symptoms and personal wood dust concentration level of workers in chip wood, particleboard and small-scale woodwork enterprises (15, 17-19). However, they did not investigate prevalence of chronic respiratory symptoms, factors associated with chronic respiratory symptoms and concentration of personal total dust exposure level among workers in medium scale woodwork factories in Ethiopian context in comprehensive manner.

Therefore, this study aimed to assess prevalence of chronic respiratory health symptoms, to identify factors associated with chronic respiratory health symptoms and to estimate the total wood dust exposure level among workers in medium woodwork factories in Akaki Kality Sub City, Addis Ababa.

1.3. Rationale of the Study

Evidence describing links between health and work suggested that the right type of work is generally good for both physical and mental health of all peoples, while unemployment or not working was the most dangerous. The study was mainly aiming to generate the overall information's regarding medium scale woodworker's prevalence of chronic respiratory symptoms, factors associated with chronic respiratory symptoms and personal total wood dust concentration level. Despite the fact that woodworkers were categorized among risk groups for different work-related hazards and works under high-risk conditions, few studies explored yet the influence of dust and chronic respiratory symptoms. Little is known about factors influencing or enabling chronic respiratory symptoms.

The following main reasons were motivating factors to deal with the subject matter. The first one was medium scale woodwork factories are source of employment and income generating means for young workers (20). They are growing at an alarming rate and tens of thousands

are employed in this sector (21-23) . The second reason was Ethiopian government is highly relaying on manufacturing sector including medium scale woodwork factories and giving priorities for its development in the second GTP. The third reason was urgent need and concerns for addressing this marginalized large human workforce engaged in woodwork factories. Assessing this gap, the present study discussed how dust and other associated factors influence work related health problems i.e. chronic respiratory health symptoms.

1.4. Significance of the Study

The findings from this study will benefit woodworkers to create awareness about the importance of use and consequently demand of PPEs, how to protect themselves from other factors which contribute to a risk of getting a disease. It will help Addis Ababa city Administration Bureau of Labor and Social Affairs (AACA BOLSA) to develop appropriate workplace intervention measures to protect the health of woodworkers. Governmental and non-governmental organizations, factories, authorities, and policy makers also use the recommendation from this study in developing strategies and enforce legislation for further improvement.

Recommendations from this study would guide law enforcement authorities and other concerned bodies that would ensure improvement of inspection activities, protection of employees from wood dust related occupational diseases and compliance to safety standards among employers and employees in the study area. Data generated from this study would help in policy making, planning, implementation and strategizing intervention programmes that would curb occupational hazard at workplace outlets.

2. Literature Review

2.1. Magnitude of Chronic Respiratory Symptoms among Woodworkers

Respiratory symptoms are the most common symptoms reported by woodworkers (8). A study by Tobin et al. (2016) found that higher prevalence of chronic respiratory symptoms of Cough, Phlegm, Wheeze and Breathlessness, which ranged from 48% to 58% for exposed respondents and 10% to 32% for control subjects. In relation to the comparison group, respondents in the study group had a significantly (p=0.00) higher prevalence of all symptoms. (24).

Higher prevalence of chronic respiratory symptoms was observed in studies conducted in Ethiopia among exposed woodworkers than controls. The prevalence of chronic respiratory symptoms ranged from to 12.9% for wheezing among woodworkers in Jimma town, south west Ethiopia to 58% for cough among in Maichew chip wood factory workers Tigray Regional State Ethiopia (16-18).

An increased prevalence of chronic respiratory symptoms was also observed in exposed woodworkers than non-exposed office workers in Benin city of Nigeria with higher prevalence of sputum production (54.7%) (25) and Osun State, Nigeria with higher prevalence of 53 % cough (26). The majority (87.6%) of sawmill workers in Benin city of Nigeria reported at least one chronic respiratory symptom compared with 18.7% among the controls (P< 0.05) (25).

2.2. Factors Associated with Chronic Respiratory Symptoms in Woodwork Factories

2.2.1. Socio-Demographic Characters and Chronic Respiratory Symptoms in Woodwork Factories

Diseases because of age and not the age itself may cause increased sensitivity with elderly people. Characteristics that have been shown to influence susceptibility include pre-existing respiratory or cardiovascular disease, diabetes, medication use, age, gender, race, socioeconomic status and health care availability, educational attainment, housing characteristics and genetic differences, but still there are gaps in the knowledge about who is most at risk or susceptible to smallest dust particles (27). Indoor wood dust exposure was a hidden cause of asthma in adults older than 40 years (28).

There was evidence on significant association between age and occurrence of chronic respiratory symptoms among workers in rubber wood sawmill factory in Thailand (P<0.05). Age more than 30 years had significant positive association with upper respiratory tract symptoms among workers in rubber wood sawmill factory in Thailand (OR=1.8, 95% CI: 1.5-2.0) (29).

Pulmonary diseases affect women with a greater degree of severity than men (30). Female gender had significant positive association with lower reparatory tract symptoms among workers in rubber wood sawmill factory in Thailand (OR=1.8, 95% CI: 1.5-2.1) (29).

2.2.2. Socio-Economic Status and Chronic Respiratory Symptoms in Woodwork Factories

Low education and low household income were associated with respiratory health problems. As educational level is low, the risk of asthma and Chronic Obstructive Pulmonary Disease (COPD) increased. Also, low household income increased the risk of asthma and COPD (31). Workers whose education level was grade 8 or below were more likely to developed chronic respiratory symptoms than workers whose education level was diploma and above (AOR = 4.07, 95 % CI = 1.86-8.92) (32).

2.2.3. Duration of Employment and Chronic Respiratory Symptoms among Woodworkers

Duration of employment is an important epidemiological factor that determines the occurrence of chronic respiratory symptoms in workers. Workers employed in industries longer than 20 years reported higher chronic respiratory symptoms than workers worked in industries from 10 to 19 years and less than 10 years and allergic symptoms increased on starting and during work and improve after leaving the workplace, during weekends and on holidays (33). The presence of at least one chronic respiratory symptom among sawmill subjects in South-South Nigeria was significantly associated with duration of employment (p=0.04) (24). However, study from Abakaliki, Nigeria reported that there was no significant difference in prevalence of chronic respiratory symptoms between sawmill workers who had worked for 5 years or less and those who had worked for 6 years or more (34).

The study from Ghana identified a strong association between the duration of working and the odds of developing chronic respiratory symptoms among sawmill workers. Respondents

who have worked for more than ten years were more likely to develop chronic respiratory symptoms than those who have worked for less than ten years. Those who have worked for more than ten years were more than twenty eight time more likely to develop cough (OR=28.50), six times more likely to develop cold (OR=6.21), four times more likely to develop shortness of breath (OR=3.51), three times more likely to produce phlegm (OR=3.31) and twice likely to experience wheezing (OR=1.72) (5). Study from South Africa also reported that the prevalence of chronic respiratory symptoms of workers exposed to wood dust increased with the increase in the number of years of employment (35).

2.2.4. Working Department, Dust Exposure and Chronic Respiratory Symptoms among Woodworkers

Study from Ghana, Accra on sawmills Workers at the Timber Market identified that the prevalence of work related-symptoms was different in different work categories. It identified that subjects working in the initial processing and board-processing departments had a higher prevalence of cough than workers employed in the varnishing department. The prevalence of skin, eyes and nose symptoms was higher in board processing and varnishing departments. Symptoms also depended on different types of woods (5).

Occupational exposure to wood dust may increase the prevalence of chronic respiratory symptoms and expose workers to a higher risk of developing pulmonary disorders (24). Furthermore, different studies have shown relationship between dust exposures level and respiratory health effect of workers and its prevalence was reported to be higher (5, 35-37). A positive and linear relationship was found between dust exposure and number of cases of respiratory ailments in wood manufacturing industries. A strong statistical correlation ($r=0.973$, $P<0.05$) showing a positive relationship between wood dust exposure and chronic respiratory symptoms was seen among furniture workers in Malaysian study. This study identified that the number of cases of respiratory ailments increased as wood dust exposure increases (38). Significant correlation between mean personal wood dust exposure and chronic respiratory symptoms were also seen among joinery, sawmill and chip mill workers after controlling for age and smoking in New South Wales, Australia. The probability of getting work-related symptoms increased with increasing levels of personal wood dust exposures in these workers (39).

Study participants who were exposed to wood dust experienced higher production of chronic respiratory symptoms such as cough, sneezing and phlegm production in the course of working in the wood processing factories in Calabar Municipality, Cross River State, Nigeria

(40). Sawmill workers who were exposed to wood dust in Osun State, Nigeria also shown higher prevalence of chronic respiratory symptoms as compared to controls (26). However, study from Thailand reported that there was no dose-dependent relation between having chronic respiratory symptoms and wood dust levels (29).

Study from Tanzania identified that previous dusty job was three times more likely to have difficulty of breathing and breathlessness as the respiratory health symptoms. It also identified that dusty job was significantly associated with chronic respiratory symptoms and previous dusty job was significantly associated with cough (OR= 1.46, 95% CI: 1.26- 1.69, P<0.05), wheezing (OR= 1.16, 95% CI: 1.01-1.33, P<0.05), and breathlessness (OR= 3.32, 95% CI: 2.61- 4.22, P<0.05) (36). However, a study conducted in Nigeria showed that there was no relationship between history of previous employment in a dusty occupation with occurrence of at least one chronic respiratory symptom (24).

2.2.5. Occupational Safety and Health Training and Knowledge

Many occupational diseases which cause death arise due to workers exposure to dust or particulates at work in many different working conditions depending on the nature of work they are performing and many of these workers develop respiratory complications because of the lack of knowledge of potential hazards posed by industrial dust at their working environment (36). Lack of knowledge and incorrect attitude on preventive measures of wood manufacture workers also associated with abnormality of chronic respiratory symptoms such as wood dust allergy, which was the leading cause of asthma related to their works. Lack of knowledge increased risk of chronic respiratory symptoms in Thai woodworkers by 1.83 times (1). However, Rongo and Leon (2005) reported that 88% of woodworkers were aware of inhalation of wood dust could be hazardous and knew respiratory problem which they resulted from inhalation of wood dust (41).

Training changes the attitude of workers towards chronic respiratory health problems, and provides the skills and knowledge about the means of protecting themselves from health effects associated with dust work environments. Study by Gizaw et al (2016) shown having no training on occupational health and safety was significantly associated with chronic respiratory symptoms. The odds of chronic respiratory symptoms among workers who had no training was 2.73 times that of workers who had training (COR=2.78, 95 % CI: 1.67, 4.62 and AOR= 2.73, 95 % CI: 1.41, 5.29) (32). In addition, lower level of knowledge on dust prevention was also significantly associated with chronic respiratory symptoms (AOR=1.83; 95% CI=1.23-2.73, P<0.05) among wood furniture manufacturing factory workers in the

Northeast of Thailand (1). Safety training played a significant role in increasing knowledge about PPE and health problems in the wood industry (42).

2.2.6. Individual/Behavioral Factors and Chronic Respiratory Symptoms

Significantly higher prevalence of all chronic respiratory symptoms among current and ex-smokers than among non-smokers was found in a study conducted among sawmill workers in Nigeria (24).

Sawmill workers in Benin city, Nigeria who smoke had higher prevalence of chronic respiratory symptoms (sputum production 73.4%, cough 39.1%, breathlessness 12.5%, wheeze 6.3%, and chest pain 100%) than controls that had only sputum production (9.1%) and cough (9.1%) with $P< 0.05$. Sawmill workers who were smokers also had at least one chronic respiratory symptoms when compared to 3.1% of controls ($P<0.05$). Sawmill workers are at an increased risk of developing respiratory disorders compared to control subjects, and this risk is even more pronounced in a situation where the sawmill worker is also a smoker (25). Mandryk et al (1999) also found that woodworkers in New South Wales, Australia who were smokers had higher prevalence of chronic bronchitis (20%) than non-smokers (10%) (43). However, chronic respiratory symptoms do not differ among smokers and non-smokers in woodworkers in Dares Salaam, Tanzania. When smokers were compared to non smokers, there was no significant association between cigarette smoking and development of chronic respiratory symptoms (41).

Workers in wood industries are often exposed to wood dust in various degrees. The extent of exposure related to the extent of respiratory tract damage, depends on a number of factors. Among these factors use of personal protective equipment among workers is the major one (44). In the study by Alwis et al (1999), the majority of workers (roughly 90%) did not wear appropriate respirators approved for wood dust, while the ones who did wear them, used them on average less than 50% of the time (45). Higher use of PPE (72%, 77.2%) was reported in Sawmill Workers in Abakaliki, Nigeria (34) and in Sokoto, Nigeria (46) but reported usage of PPE was very low among sawmill workers in Osun State, Nigeria (26). Rongo and Leon (2005) also reported very low utilization of PPE (26.6%) among small-scale wood industries in Tanzania (41). Non-availability, non-durability, lack of awareness and expensive to purchase were the major reasons of not always using PPE in sawmill workers (26, 34). Not always wearing mask was significantly associated with chronic respiratory symptoms (AOR=2.26;95% CI=1.37-3.72, $P<0.05$) among wood furniture manufacturing factory workers in the Northeast of Thailand (1).

2.3. Wood Dust Exposure

2.3.1. Wood Dust Exposure and Working Department

The overall 8-h TWA inhalable wood dust exposure level among workers in small and medium scale wood processing industries in Addis Ababa, Ethiopia was well beyond the standard OEL set by the EU, i.e. 5 mg/m^3. The GM and GSD were 6.82 mg/m^3 and 1.82, respectively as it varied between 0.24 and 23.3 mg/m^3 and it was also reported that 71.4% (n=257) of the wood dust enterprises had exceeded wood dust exposure limit set by the EU (15). However, lower level of dust exposure, as compared to the OEL set by the EU, i.e. 5 mg/m^3 , were observed in Tanzania (GM=3.3 mg/m^3 and GSD= 2.5 mg/m^3 with a range of 0.45-67.0 mg/m^3) (47), Denmark (GM=0.95 mg/m^3, GSD=2.08) (4) and Ethiopia (GM=4.66 mg/m^3 with a range of 0.47–184 mg/m^3) (17).

Significantly higher exposure of dust for woodworking task (GM=0.95 mg/m^3, GSD=2.08) was seen as compared with any of the non-woodworking task (GM=0.70 mg/m^3, GSD=2.02) in Danish furniture industries (P<0.001) (4). Total suspended and inhalable dust levels were significantly (p=0.000 and 0.012 respectively) higher in woodworkers than comparison groups in Nigerian (24).

High dust exposure level at routing and sanding work stations of wood manufacturing industries was seen in Malaysia (38) and the most significant jobs related to increased dust exposures were machine carving and manual cleaning with geometric mean (GM) dust exposures level of 15mg/m^3 and 10mg/m^3, respectively (47).

A study by Scheeper et al. (1995) emphasized that sanding leads to the highest exposures (48). Study from Denmark also reported that one of the determinants of exposure in the Danish furniture industry was manual sanding (4). However, a study by Rongo et al. (2004) found that carving using wood machine yielded the highest dust exposure. The findings on cleaning operations were the second in dust exposure (47). Rongo and Leon (2005) identified sanding, carving and sweeping as heavily exposed tasks, sawing, milling and planning as moderately exposed tasks and assembling (joining) and gluing as mildly exposed tasks in woodwork industries (41).

Dust exposure level varies within working departments in Danish furniture industry. Within the woodworking task, the highest exposure was found for manual sanding (P<0.001). The exposure for sanding and cutting (GM=1.35 mg/m^3) was larger than cutting (GM=1.10

mg/m^3) in Danish furniture industry (4). Personal dust exposure level among workers in sanding department (GM=9.72 mg/m^3, SD=1.64) was higher than exposure level among workers in sawing department (GM=7.60 mg/m^3, SD=1.52) in small and medium scale wood processing enterprises in Ethiopia (15).

2.3.2. Wood Dust Exposure and Ventilation

The primary engineering control for wood dust is local exhaust ventilation (49). A good supply of ventilation serves readily disperses the dust (24). A study conducted in Thailand recommended that one of the major solutions in preventing and solving respiratory tract problems among wood furniture manufacturing factory workers should be dust reduction by improving air ventilation in the factory (1). Hall et al (2002) identified that lumber mills with greater natural ventilation and that were not enclosed had lower mean dust exposure level than that of mills with lower natural ventilation and that were not enclosed (50).

2.3.3. Wood Dust Characteristics and Measurement

Wood dust, generated in the processing of wood for a wide range of uses, is a complex substance. Its composition varies considerably according to the species of tree being processed. Wood dust is composed mainly of cellulose (approximately 40–50%), polyoses, lignin, and a large and variable number of substances of lower relative molecular mass, which may significantly affect the properties of the wood. These include non-polar organic extractives (fatty acids, resin acids, waxes, alcohols, terpenes, sterols, steryl esters, and glycerides), polar organic extractives (tannins, flavonoids, quinones, and lignans) and water-soluble extractives (carbohydrates, alkaloids, proteins, and inorganic material). The extractives represent 5% to 30% of the wood on a mass basis (6, 51). Softwoods and hardwoods generally differ both in cellular structure and in chemical composition. Gymnosperms usually have longer fibers, slightly less polyoses, slightly more lignin, a higher non-polar (e.g. terpene), and lower polar (e.g., tannin) content than angiosperms, but there is considerable variability between species (6). Examples of biologically active compounds include terpenes, lignans, and stilbenes, which are primarily found in softwoods; tannins, flavinoids, and quinones which are primarily found in hardwoods; and phenols, which are found in both (51).

Total dust is defined as a fraction of airborne dust < 100 μm sampled with a specially designed monitor and using v=1.25m/s at the inlet (4). The parameter most commonly used to characterize exposures to wood dust in air is total wood dust concentration, in mass per unit

volume (usually mg/m^3) (6). Standard gravimetric methods for measuring total dust concentrations, such as NlOSH Method 0500 (52), have been used routinely. In this general method, a known volume of air is drawn through a special membrane filter contained in a plastic cassette with a sampling pump. The dust concentration is calculated from the change in weight of the filter divided by the volume of air sampled, with a detection limit for personal sampling of wood dust of about 0.1 mg/m3. Polyvinyl chloride filters are preferred for sampling wood dust because of its highly variable moisture content. Filters are environmentally equilibrated before and after sampling to avoid spurious effects from differential moisture uptake (6, 52).

The cassette holding the filter is either open- or closed-faced during sampling. In the closed-faced mode, a cap with a 4-mm hole is placed over the 37-mm cassette face to protect the filter. Closed-faced operation is usually recommended when total suspended particulates are being measured (53). Beaulieu et al. (1980) reported, however, that the open-faced filter collected 30-60% more dust (by weight) than the closed-faced filter, and they suggested that particles larger than about 10 μm are collected very inefficiently in the closed-faced configuration (54). NIOSH (1994) recommended 37-mm PVC, 2 to 5 μm pore size membrane or equivalent hydrophobic filter and supporting pad in 37-mm cassette filter holder (55).

The work process includes Sawing (circular saws, straight line edgers, dimension saws, band saws), cutting (planning, thicknessers, shapers, mortisers, tenoners, spindle, moulders, copy lathes, drilling, borers etc), sanding (paper and block, portable hand sanding machines as well as all sanding machines) and other tasks including edge banding, assembly (gluing, hammering, nailing, stapling), debarking and chip making (**Figure 1**)

Dust exposure level varies within working departments in woodwork factories. Within the woodworking task, the highest exposure was found for manual sanding ($P<0.001$). The exposure for sanding and cutting was larger than cutting in woodwork factories (4). Personal dust exposure level among workers in sanding department was higher than exposure level among workers in sawing department in small and medium scale wood processing enterprises in Ethiopia (15).

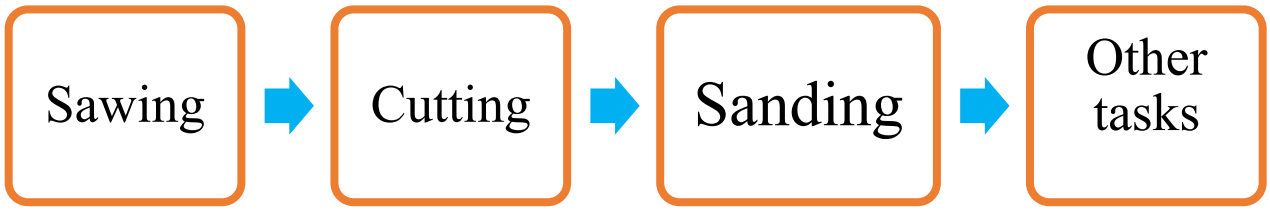

Figure 1: The Work Process in Medium Scale Woodwork Factories in Akaki Kality Sub City, Addis Ababa.

All tasks are tasks for possible exposure but highest exposure tasks are sawing (15) and sanding (4, 15, 38, 48). However, cutting was lower exposure task (4).

Summary of the review

All the literature showed how exposure to dust could cause chronic respiratory health symptoms among woodworkers. They also emphasized how the associated factor (age, sex, education, duration of employment, level of exposure with respect to their task, past dust exposure, working hour, RPE use and smoking habit) were highly correlated with workers chronic respiratory health symptoms. Some literatures suggested that it is important to understand the individual dust exposure level to link with the chronic respiratory health symptoms of workers. Although the literatures used different method, design and setup, they agree with the hypothesis that workers exposed to high wood dust with high duration of working time without using RPE can develop chronic respiratory health symptoms. Most of the literatures verify as age increase the occurrence of chronic respiratory symptoms among woodwork factory workers also increases and males are more exposed than females but there is a discrepancy in other studies showing that females were more likely to develop chronic respiratory health symptoms than males. This is due to individual behavior variability. Most of the findings from the literatures show that the maximum exposure to wood dust was seen in the sawing and sanding section and workers with a longer duration of employment reported a significantly higher prevalence of chronic respiratory symptoms than those with shorter duration.

Conceptual Framework

Conceptual framework for this study shows how the particular variables in study connect with each other and identifies the variables required in the research investigation. This was developed after reviewing different literature. To identify the factors associated with chronic respiratory symptoms in the study setting, it is necessary to use conceptual framework. The complex hierarchical interrelationship between determinant factors for the outcome variable is best managed with the use of conceptual framework (56). Conceptual framework provides guidance for the use of multivariate techniques and aids the interpretation of their results in light of appropriate knowledge. It is also used as a road map in pursuing the investigation.

As shown below in **figure 2**, A number of factors determine chronic respiratory symptoms. The factors can be socio-demographic factors (age, sex, marital status, education status, income); behavioral factors (like smoking, use of RPE), work place characteristics (duration of employment, duration of working hours per week, past occupational dust exposure history, energy used for cooking, previous history of respiratory illnesses, occupational safety and health training and working department) and Wood dust exposure. These factors directly or indirectly influence the development of chronic respiratory symptoms. Wood dust exposure is hypothesized as proximal factor directly influence the development of chronic respiratory symptoms. Work place characteristics and behavioral factors are hypothesized as immediate factors that directly or indirectly influence the development of chronic respiratory symptoms. Socio-economic and demographic factors are distal factors which directly and indirectly influence the development of chronic respiratory symptoms.

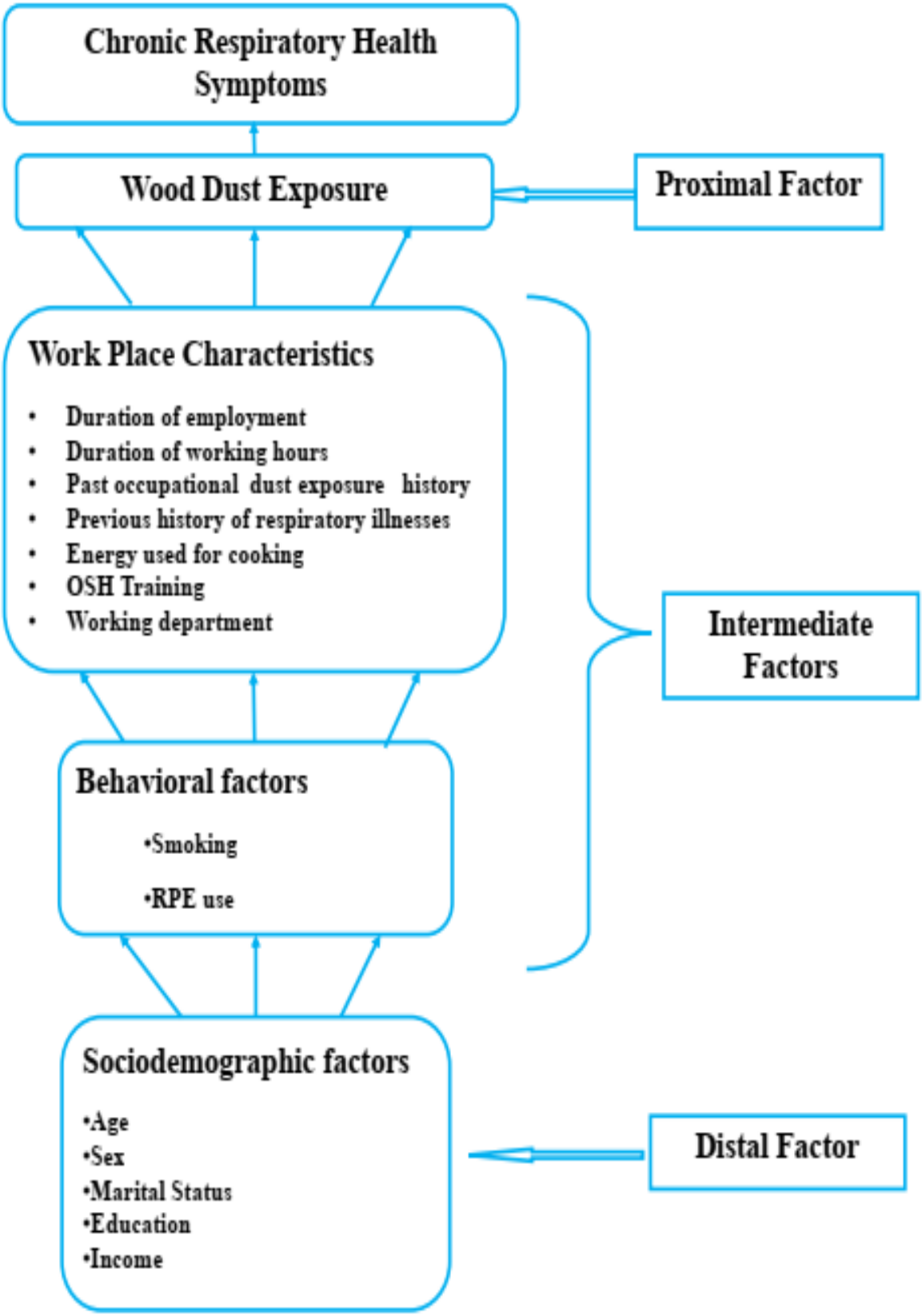

Figure 2: Conceptual framework for dust exposure and prevalence of chronic respiratory symptoms among workers in medium scale woodwork factories in Akaki Kality sub city, Addis Ababa, 2019 adopted from literature review.

3. Objectives

3.1. General objective

- To assess prevalence of chronic respiratory symptoms, identify factors associated with respiratory symptoms and estimate concentration of total wood dust exposure among workers in medium scale woodwork factories in Akaki Kality Sub City, Addis Ababa in 2019.

3.2. Specific objectives

- To assess the prevalence of chronic respiratory health symptoms among workers in medium scale woodwork factories in Akaki Kality Sub City, Addis Ababa.
- To identify factors associated with chronic respiratory health symptoms among workers in medium scale woodwork factories in Akaki Kality Sub City, Addis Ababa.
- To estimate concentration of total wood dust exposure level among workers in medium scale woodwork factories in Akaki Kality Sub City, Addis Ababa.

4. Methods

4.1. Study Design

An institutional based cross-sectional study design was conducted from 14th March, 2019 to 22nd May, 2019 Akaki Kality Sub City, Addis Ababa.

4.2. Study Area

The study area is Akaki-Kality Sub City of Addis Ababa as the great majority of woodwork factories are found in this area. Addis Ababa is the capital city of Ethiopia and the African Union and is often called the "African Capital" due to its historical, diplomatic and political significance for the continent. Addis Ababa is located in the foothills of the Entoto Mountains and standing 7,726 feet (2,355 meters) above sea level. It is the third highest capital in the world and located in the geographic center of the country. With a population of 3,627,934 as of 2007, Addis Ababa is the world's largest city that is in a landlocked country. Currently the city has 10 sub cities and 119 woredas (57).

Among these sub cities Akaki-Kality sub city is the biggest sub city with 13 woredas. The sub city has a total area of 118.08 square kilometer with a population size of 195273; 95558 males and 99715 females, and has 47,373 households and 46092 housing units. Small, medium and large factories, which produced various products, are placed in the sub city. Among these factories, 40 medium scale woodwork factories are found in the sub city. The medium woodwork factories are with permanent shelters and processed woods to be used for other purposes. The tasks commonly performed in these factories are sawing and sanding. Workers in sawing department sawed the raw woods and delivered them to the sanding department. The sanding department smoothed or polished the woods received from the sawing department and readies them to be used for other purposes.

4.3. Source and Study Population

All medium scale woodwork factories and workers engaged in these factories in Akaki Kality sub city were the source population. The study population were selected medium scale woodwork factories and workers engaged in sawing and sanding activities and who had worked for more than one year in these factories in Akaki-Kality Sub City of Addis Ababa.

4.4. Eligibility Criteria

4.4.1. Inclusion Criteria

For the study groups workers who had worked in woodwork activities for one year and above in medium scale woodwork factories were included in the study.

4.4.2. Exclusion Criteria

Workers who had heart failure, chronic cough for more than two weeks, recent surgery of thorax, abdomen, and any acute illness before employed as woodworker were excluded from the study. Participants on treatment for known chronic respiratory diseases such as TB, asthma, chronic bronchitis etc. before employed as woodworkers were also excluded from the study.

4.5. Sample Size

4.5.1. Sample size for the First Objective (Prevalence of Chronic Respiratory Symptoms)

The sample size to assess the prevalence of chronic respiratory symptoms among woodworkers was determined using a single population proportion formula with the following assumptions:

- P: 45%, prevalence of chronic respiratory symptoms (wheezing) among particle board workers (18)
- d: Margin of error or level of precision or maximum error to commit = 5 %
- Zα/2: Critical value at 95% confidence interval = 1.96.
- n: Required sample size

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

$$\boldsymbol{n = \frac{(1.96)^2 * 0.45 * (1 - 0.45)}{(0.05)^2} = 381}$$

By considering 10% for non-response rate, the final sample is **419**.

4.5.2. Sample Size for the Second Objective (associated factors)

Sample size was determined using double population proportion formula using Epi Info Version 7.2 software considering the following assumptions: P_1: 60.4% of wood workers who worked for 10 years and above developed at least one chronic respiratory symptoms (24) with OR=1.86, 95% confidence interval, 85% power, margin of error (5%), 1:1 ratio of exposed to unexposed. The sample size becomes 460 (n=460). Adding 10% for non-response rate, a total of **506** study participants were included in this study.

4.5.3. Sample Size for the Third Objective (Dust Exposure Level)

For personal wood dust samples, the sample size was determined based on Rappaport and Kupper's recommendations for exposure studies. According to Rappaport and Kupper, 5 to 10 randomly selected individuals with 10-20 measurements of exposure per similar exposure groups (SEGs) are adequate to estimate the exposure level for dust sampling (58). Two working activities, i.e. sawing and sanding, were constitute two similar exposure groups (SEGs) and 10 randomly selected workers for sawing and 10 randomly selected workers for sanding, a total of 20 randomly selected workers with repeated measurement constituted the sample. Forty dust measurements, 20 from sawing and 20 from sanding, were undertaken for dust measurement as this amount of sample is believed to be adequate to estimate the exposure level in a similar exposure group (58).

Since the sample size for the second specific objective was higher than the sample size for the first specific objective, the sample size for the second specific objective i.e. **506** was taken as a sample size for the first and second specific objectives. For the third specific objective 40 dust measurements from woodworkers, 20 from sawing and 20 from sanding, were undertaken from 20 (10 from sawing department and 10 from sanding department) randomly selected workers.

Table 1: Summary of Sample Size Determination

Variables	**Prevalence of chronic respiratory symptoms**		**Confidence Interval (CI)**		**Calculated sample size**	**Non-response rate (10%)**	**Total sample size**
Respiratory symptoms	45%		95%		381	38	419
Factors	**Prevalence of chronic respiratory symptoms**	**Odds Ratio**	**CI**	**Power**	**Calculated sample size**	**Non-response rate (10%)**	**Total sample size**
Work Experience (≥ 10 years)	60.4%	1.86	95%	85%	460	46	**506**
Parameter	**Rappaport recommendation**		**No. of factories**	**No. departments**	**Number of workers**	**Total number of workers**	**Total number of dust measurement**
Total dust measurement	5-10 from SEG		2	2	5 workers from each department per factory	20	**40**

4.6. Sampling Procedure

4.6.1. Sampling Procedure for exposed group

Data found from Addis Ababa City Administration Trade Bureau and Akaki Kality sub city Administration Trade Office shown that 40 medium scale woodwork factories were found in Akaki Kality sub city. Twelve woodwork factories were selected randomly. The samples from each factory were allocated proportionally and by using the attendance sheet from the factories as a sampling frame, the selection of study participants who fulfilled the inclusion criteria was done by simple random sampling. (Figure 3)

Three thousand one hundred eighty five workers were engaged in all medium scale woodwork factories. Of which, 890 of them were engaged in the twelve medium scale woodwork factories which were involved in this study. Factory 1 had 55 workers, factory 2 had 72 workers, factory 3 had 44 workers, factory 4 had 92 workers, factory 5 had 63 workers, factory 6 had 81 workers, factory 7 has 92 workers, factory 8 had 100 workers, factory 9 had 38 workers, factory 10 had 67 workers, factory 11 had 99 workers and factory 12 had 87 workers.

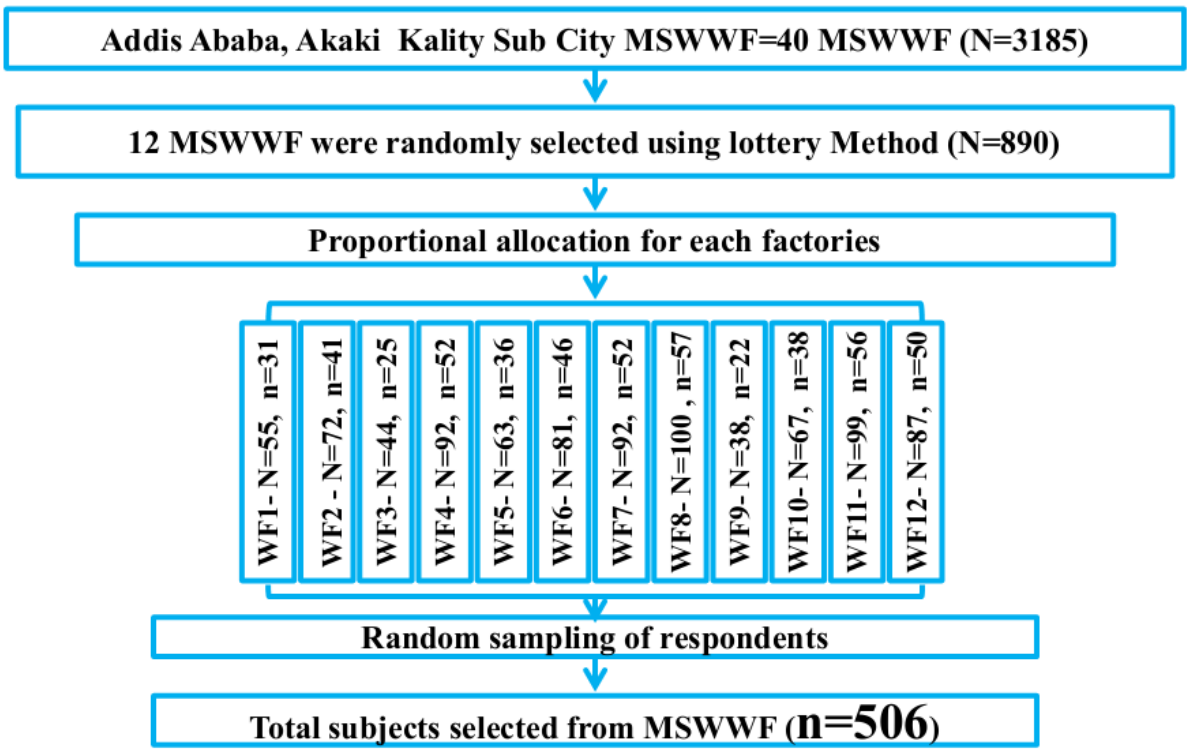

Figure 3: Schematic presentation of sampling procedures for questionnaire of medium scale woodwork factories in Akaki Kality Sub City, Addis Ababa.

N-total number of workers

n-sample size

MSWWF- Medium Scale Woodwork Factories

WF- Woodwork Factory

4.6.2. Sampling Procedure for Personal Dust Measurement

Data found from Addis Ababa City Administration Trade Bureau and Akaki Kality sub city Administration Trade Office shown that a total of 40 medium scale woodwork factories were found in Akaki Kality sub city. From Twelve randomly selected woodwork factories for questionnaire, two woodwork factories were selected using simple random sampling method for personal dust measurement. A total of 20 workers (10 workers from each factory) from similar exposure group (SEG), i.e. 10 from sawing (5 from each industry) and 10 from sanding (5 from each industry), were selected randomly. A total of 40 dust measurements, 20 from each industry, were selected to determine the level of dust exposure among workers in medium scale woodwork factories. (**Figure 4**)

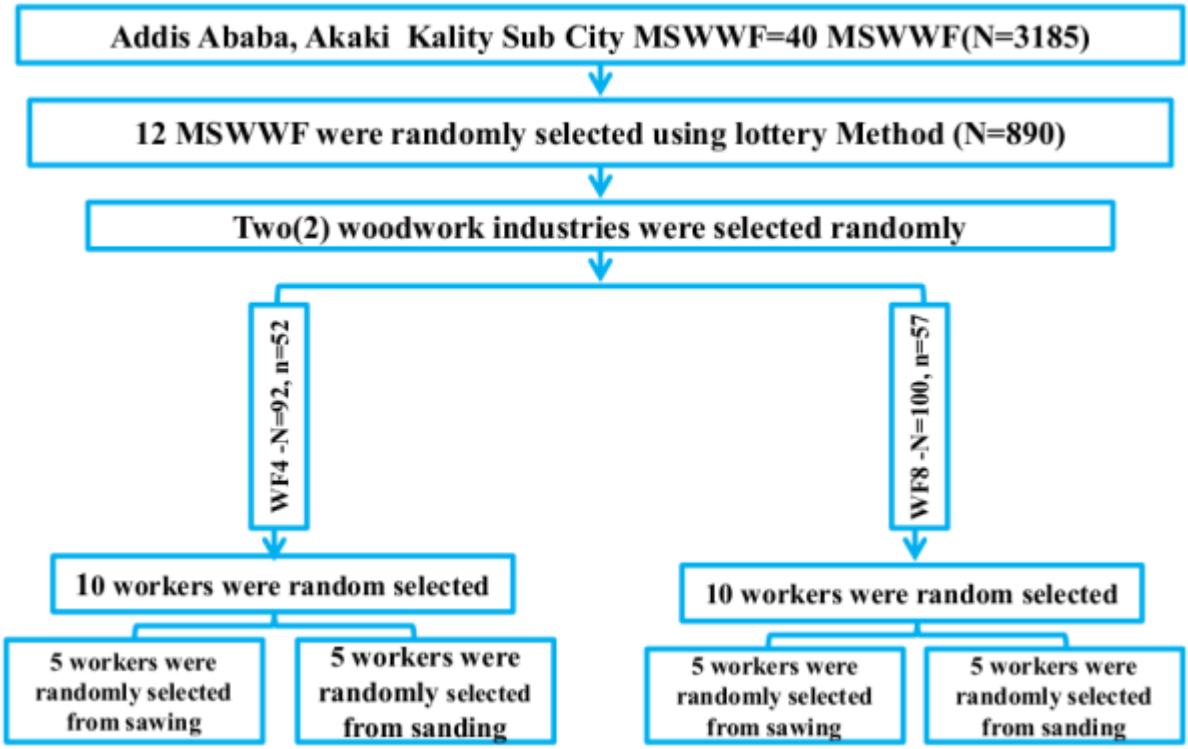

Figure 4: Schematic presentation of Sampling Procedure for Personal Dust Measurement Akaki Kality Sub City, Addis Ababa.

MSWWF- Medium Scale Woodwork Factories, **WF**-Woodwork Factory

4.7. Data Collection

4.7.1. Use of Questionnaire

A modified version of British Medical Research Council (BMRC) questionnaire (59) was used to assess the prevalence of chronic respiratory symptom and factors associated with chronic respiratory symptoms among workers in woodwork factories in Akaki Kality, Sub City, Addis Ababa. The standardized questionnaire includes questions about socio-demographic information, duration of employment, length of working hours per a day, length of working days per a week, type of fuel used for cooking, past dust occupational exposure history, smoking habits, previous history of respiratory illnesses, and chronic respiratory symptoms like a cough, phlegm, wheezing, breathlessness, and chest pain. The trained data collectors and the principal investigator performed face-to-face interview in Amharic.

All the questionnaires were first prepared in English, then translated from English into the local language (Amharic) and back translated to English for consistency, and making no changes in the text. Five Environmental Health Professionals with B.Sc. degree were engaged

in the interview as a data collector and one senior Environmental Health Professional with B.Sc. degree was engaged as supervisor. Two days training was given for the five data collectors on the questionnaire and method of interview. A pre-test was conducted in five woodwork factories outside the study area; i.e. Kirkos Sub-City.

4.7.2. Observation

An observational checklist was used to assess the availability and utilization of respirable personal equipment (RPE) and working environment (ventilation, and dust accumulation).

4.7.3. Personal Total Dust Sampling

Personal total dust was sampled using pre-weighed polyvinyl chloride (PVC) filter membranes with a pore size of 5.0µm placed on a Millipore plastic closed face 37mm filter cassette (CFC) connected to Side Kick Casella (SKC) pump through which air was pumped by a rechargeable battery powered motor at a constant flow rate of 2.0 l/min (55). The sampling cassettes situated on shoulder straps as close to the breathing zone (30 cm from nostril) as possible. Samplers were adjusted in front of either the right or the left shoulder randomly in order to reduce bias comes from their position.

Figure 5: Total Dust sampling process in medium scale woodwork factories in Akaki Kality Sub City, Addis Ababa, 2019.

Before starting measurement, the blank filter was exposed for one second to the atmosphere in clean area. Flow rates were adjusted and controlled in the field before and after sampling by Rota meter that was calibrated against certified primary references.

Filters and cassettes were conditioned for at least 24 hours in the weighing room both before and after sampling an environmentally controlled weighing area. Gravimetric (filter weight) technique was used to weigh the filters. Weighing was performed on Microbalance (Mettler Toledo XPE105) capable of weighing to 0.01 mg at Environmental and Occupational Health (EOH) section of core laboratory of College of Health Sciences, Addis Ababa University. Prior to weighing, the microbalance was waited until it became zero. Standard balance (100 mg) was used periodically to check the reliability and validity of the microbalance. The weighing room was conditioned to an air temperature of 20 ± 1°C and a relative humidity of 50 ± 5% (55).

As a minimum, one field (site) blank was kept for every five samples collected, with a minimum of three blanks for each batch of samples. Field blanks were used to correct for any weight changes caused by atmospheric conditions and the handling of the media during sampling. For this reason, it is essential that field blanks were exposed to the same conditions as the samples apart from the period of sampling (60).

Wood dust samples from workers were taken from 9 a.m. to 12 p.m. to make sure that the sampling was not result in an overload of the filters. The selection of this sampling duration is consistent with NIOSH manual on occupational exposure strategy. The NIOSH manual makes consideration of using either day long or using a portion of time with the assumption that the exposure levels are similar (61).

The sequence to be followed during dust sampling is described as follows:

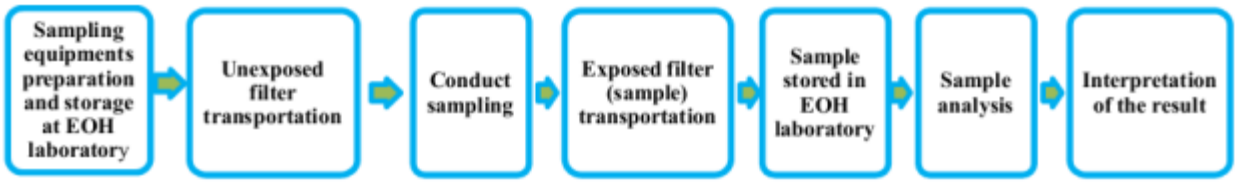

Figure 6: Sequence of Dust Sampling among Woodwork factories in Akaki Kality sub city, Addis Ababa.

4.8. Variables

4.8.1. Dependent Variables

- Respiratory health symptoms
- Wood dust exposure

4.8.2. Independent Variables

- Socio-demographic factors: age, sex, marital status, educational status, income
- Behavioral factors: utilization of RPE and smoking.
- Workplace characteristics: duration of employment, duration of working hours/day, working days per week, working department, energy used for cooking, previous respiratory illnesses, training and knowledge and past history of dust exposure.

4.9. Operational Definition

Chronic Respiratory Health Symptoms:- is defined as the development of one or more of the symptoms of a cough, phlegm, breathlessness, wheezing and chest pain that lasts at least three months in one year (32).

Medium scale woodwork factory: is a factory which engages from 31 to 100 workers including the owner, his family members and other employees (62).

Breathlessness:- is defined as getting short of breath when walking hurriedly with other people of same age on level ground or when climbing up a low hill (24).

Wheeze:- is defined as whistling breathing (24).

A non-smoker:- is defined as workers who used no cigarette (32).

An ex-smoker:- is defined as workers who had quit at least 1 year before the survey (32).

A current smoker:- is defined as workers who smoked at the time of the study or had stopped smoking less than one year before (32).

Chest pain:- is defined as a condition of experiencing any pain or discomfort in your chest when hurrying on level ground or climbing up a hill (24).

Cough: is defined as 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**.**

Phlegm: is defined as 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

Cough with phlegm/sputum: is said to be present when the subject had the symptoms either during the day or at night for 5 or more days each week (24).

Duration of exposure: -is defined as the working hours of workers in the factory per day (63).

Duration of employment:- is defined as continuous employment in the factory for at least one year preceding the study (24).

Previous dust exposure history:- is defined as workers experience in the dusty environment before the current working position (63).

Total dust:- is defined as a fraction of airborne dust < 100 μm sampled with a specially designed monitor (4).

Dust on the work place: is defined as a deposition of fine particles can either be seen on the work piece or can be detected by wiping (4).

Respiratory Protective Equipment (RPE):- is utilization of the worker-specialized clothing or equipment worn by employees for protection against health and safety hazards.

Occupational safety and health training:- is a process that aims to provide the workforce with knowledge, skills and information on the safety and health aspects of the work so as to perform their work in a way that is safe and healthy for them and their co-workers and on ways to prevent or minimize exposure to hazards (64).

Energy used for cooking:- is the type of fuel used by study participants for cooking their foods. It includes either bio-fuel (wood, gas and cool) or electricity.

4.10. Data Management

Exposure data were recorded in an excel spreadsheet and were exported into SPSS Version 21 for descriptive analysis. Collected data for chronic respiratory symptoms were organized

and entered in Epi info version 7.2 and cleaning was done to avoid missing values, outliers and other inconsistencies. For data cleaning, frequency, sort and list were used. Cleaned data were exported to SPSS version 21 for analysis.

Hosmer-Lemeshow test was used to assess the overall goodness of fit of the fitted model. An insignificant chi-square (P> 0.05) indicates a good fit to the data and, therefore, good overall model fit. In addition to Hosmer-Lemeshow test, R^2 was also used to check the model fitting.

Variance Inflation Factor (VIF) and Pearson Correlation Coefficient (r) were also used to check multicollinearity of independent variables. If Variance Inflation Factor (VIF) was less than 10 /VIF < 10/ and the absolute value of Pearson Correlation Coefficient (r) was less than 0.7 / r < 0.7/. There was no problem of multicollinearity between independent variables because all the VIF values of all independent variables were below 10 /VIF < 10/ and all the absolute values of Pearson correlation coefficient (r) of independent variables were less than 0.7 / r < 0.7/

4.11. Data Analysis

4.11.1. Dust Analysis

The exposed filter membranes were weighed quantitatively by gravimetric analysis using a standard Mettler Toledo XPE105 microbalance scale with a detection limit of 0.01 mg at Environmental and Occupational Health (EOH) laboratory of College of Health Sciences, Addis Ababa University. The weighing of the sampling filter before and after sampling was carried out by trained laboratory Technologist.

The result of the dust concentration was described by using descriptive statistics such as measures of central tendency (GM) and a measure of dispersion (GSD). One-way Analysis of variance (ANOVA) was used to assess variation between and within groups (days, factories, and tasks). The concentration of dust was calculated using the following equation:

$$\text{Concentration (mg/m}^3\text{)} = \frac{\text{(Post weight of filter- Pre-weight of filter, mg) - Blank weight (mg)}}{\text{Flow rate (lit per min)* Sampling duration (min)* 1000 lit/m}^3}$$

The average dust concentration was compared with the threshold limit values (TLV) for total dust (also denoted as nuisance dust or Particles Not Otherwise Specified (PNOS)),

recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) for 8-hours exposure (10 mg/m^3) (65).

4.11.2. Analysis of Chronic Respiratory Symptoms

Descriptive statistics was used to describe the study populations using frequency distribution, measures of central tendency and dispersion that were displayed using tables and figures.

4.11.3. Analysis of Associated Factors with Chronic Respiratory Symptoms

Descriptive statistics was used to describe the study populations using frequency distribution, measures of central tendency and dispersion that was displayed using tables and figures. Due to the binary nature of the outcome variable, binary logistic regression analysis was run to determine the COR and 95% CI that is used to check the association between dependent and independent variables individually. Variables that had an association with the dependent variable in the bivariate logistic regression at $p < 0.2$ were entered into multivariate logistic regression to control the possible effect of confounders. Based on AOR with 95% CI, variables with $p < 0.05$ were considered as significant independent factors.

4.12. Data Quality Assurance

Standardized questionnaire modified from BMRC was used to assure data quality. Prior to data collection, two days training was given to the data collectors and supervisors in order to fill the questionnaire appropriately and to reduce bias. Additionally, the questionnaires were first translated from English to Amharic and back translated to English using standard procedure to check its validity. Each data collector was checked the questionnaires frequently for completeness and consistency. At the end of the day, the supervisor was checked all the filled questionnaires. The principal investigator was cautiously observed and followed the overall activities of the study. To improve recall, questions on presence of symptoms were limited to occurrence within three months prior to the conduct the study.

For dust sampling; the air flow rates in the sampling pumps was measured/checked and recorded before and after each sampling event by using Rota-meter (i.e., flow rates more than ±10% different from the target flow rate of 2.0 lit/min was dropped) (66). Each series of sampling was controlled and corrected towards one field blank samples daily. Prior to fieldwork, one-day training was given to the investigator by the senior expert. At the end of sampling, the filter cassettes was separated from the tubing and sampling pumps, then covered, and carefully handled in a labeled container to prevent damage and transported to

the lab for analysis. Prior to weighing, the microbalance was waited until it became zero. Standard balance (100 mg) was used periodically to check the reliability and validity of the microbalance.

The position of the sampling head was checked every 30 minutes by the principal investigator and one supervisor. Workers were strictly observed from starting to end of sampling. After sampling was completed, the sampling head was capped and transported to the laboratory for post-weighing. PVC filters were not taken out of the cassettes until weighing was made at the laboratory. The samples and blanks were transported in the same way to the laboratory in a labeled container suitable to prevent damage or disturbance and kept for 24 hours (relative humidity between 37-55%, and temperature between 20.1-21.7℃) before weighing of the dust to remove external factors and to prevent the movement of instruments. The standard operative procedure (SOP) was followed to ensure the quality of weighing using the microbalance. All the necessary records (pump serial number, starting and end flow rate, starting and end time, and pre weight of each filter) were strictly recorded.

Pilot study or pre-testing was carried out a week before the actual data collection in Kirkos sub-city in order to check the competency of the data collectors, and the reliability and validity of the data collection tools.

4.13. Ethical Consideration

Ethical clearance was taken from Addis Ababa University, College of Health Sciences, School of Public Health ethical review committee with a project number of 0037. An official letter was written to Addis Ababa City Administration Labor and Social Affairs Bureau, Trade and Industry Bureau and Food, Medicine and Health Care Administration and Control Authority and their respective offices in the sub city. Permission was also obtained from the above sectors requesting facilitation to conduct a research.

The aim and method of the study and importance of their participation were clearly explained to each study participants. The study participants who fulfilled the criteria for the study and agreed to participate were given Amharic written consent and signed before data collection started. Verbal consent from respondents was also obtained for photo taking to show the dust sampling method. Issues of rights, privacy, and confidentiality were ensured during data collection period. Confidentiality was kept by making anonymous and assuring information was not being accessible to anyone except the research personnel. Privacy was maintained by arranging a silent and comfortable place to the interviewer and study participants.

Participants had the right to participate or not and to withdraw at any time when they feel discomfort. The study participant did not get a direct benefit like money but they become a beneficiary in the future from the study, as the study will help policy makers to prepare policies to prevent the prevention of dust control in woodwork factories. For those who were found affected by dust and developed respiratory health symptoms were advised to seek more clinical diagnosis to health facilities during data collection period.

The average (Arithmetic mean and geometric mean) of dust concentration was promised to provide to the managers or owners on request.

4.14. Dissemination of the Results

The result of this study will be submitted to School of Public Health, Addis Ababa University, Addis Ababa City Administration Labour and Social Affairs Bureau and Labour and Social Affairs Office of Akaki-Kality Sub City Administration. In addition, the finding of the research will be presented on seminar and publication in peer review journal. The findings will also be disseminated via publication.

5. Results

A total of 506 wood workers from 12 medium scale woodwork factories were selected to participate in this study, of which 496 were involved with a response rate of 98.02%. Ten individuals were unwilling to participate and exclude from the study. Twenty workers were involved in dust measurement.

5.1. Socio-demographic characteristics of respondents

Out of 496 respondents, 419 (84.5%) were males, the median age of respondents was 30 years and 253 (51.0%) were at the age of 30 years and above. The median age of the respondents was 30. Two hundred thirty nine (48.2%) respondents were married and 232 (46.8%) of the respondents attended secondary education. The median income of the respondents was 2500.00 ETB (**Table 2**).

Table 2: Socio-demographic characteristics woodworkers in medium scale woodwork factories in Akaki Kality sub city, Addis Ababa, 2019.

Variable		Frequency	Percentage
Sex	Male	419	84.5
	Female	77	15.5
Age in years	< 30	243	49.0
	≥ 30	253	51.0
Marital Status	Single	207	41.7
	Married	239	48.2
	Divorced	35	7.1
	Widowed	15	3.0
Educational Status	Illiterate	21	4.2
	Primary Education	192	38.7
	Secondary Education	232	46.8
	Certificate and above	51	10.3
Monthly Income in ETB	≤ 2500	286	57.7
	> 2500	210	42.3

5.2. Workplace characteristics and Behavioral factors of respondents

Out of 496 respondents, 275 (55.4%) of respondents had greater than five years (> 5) work experience in woodworking and 88 (17.7%) of the study participants worked above forty-t hours (> 40) per a week. One hundred thirty (26.2%) woodworkers had past occupational history in dusty areas before they were employed in woodworking, and 62(12.5%) respondents had past history of respiratory illnesses. Sixty-nine (13.9%) study participants had history of cigarette smoking behavior. Nearly equal number of respondents worked in sanding (49.2%) and sawing (50.8%) departments (**Table 3)**

Table 3: Work place characteristics and behavioral factors of woodworkers in medium woodwork factories Akaki Kality sub city, Addis Ababa, 2019.

Variables		Frequency	Percentage
Working Department	Sawing	247	49.8
	Sanding	249	50.2
Work experience	> 5 years	275	55.4
	1-5 years	221	44.6
Working hours per week	> 40 hours	88	17.7
	≤ 40 hours	408	82.3
Past Occupational dust exposure history	Yes	130	26.2
	No	366	73.8
Previous respiratory illness	Yes	62	12.5
	No	434	87.5
Energy used for cooking	Bio-fuel	210	42.3
	Electricity	286	57.7
Cigarette smoking	Yes	69	13.9
	No	427	86.1

5.3. Prevalence of chronic respiratory symptoms

Three hundred forty six (69.8%) [95% CI: 66.0-73.8] of woodworkers ever had at least one chronic respiratory problem (AOCRS). Chronic respiratory symptoms were cough (54.6%) [95% CI: 50.8-58.9], followed by phlegm (52.2%) [95% CI: 48.0-56.6], wheezing (44.6%) [95% CI: 40.1-49.1], chest pain (42.9 %,) [95% CI: 39.1-47.2] and breathless (42.1%) [95% CI: 38.1-46.7] as shown in Figure 7**.**

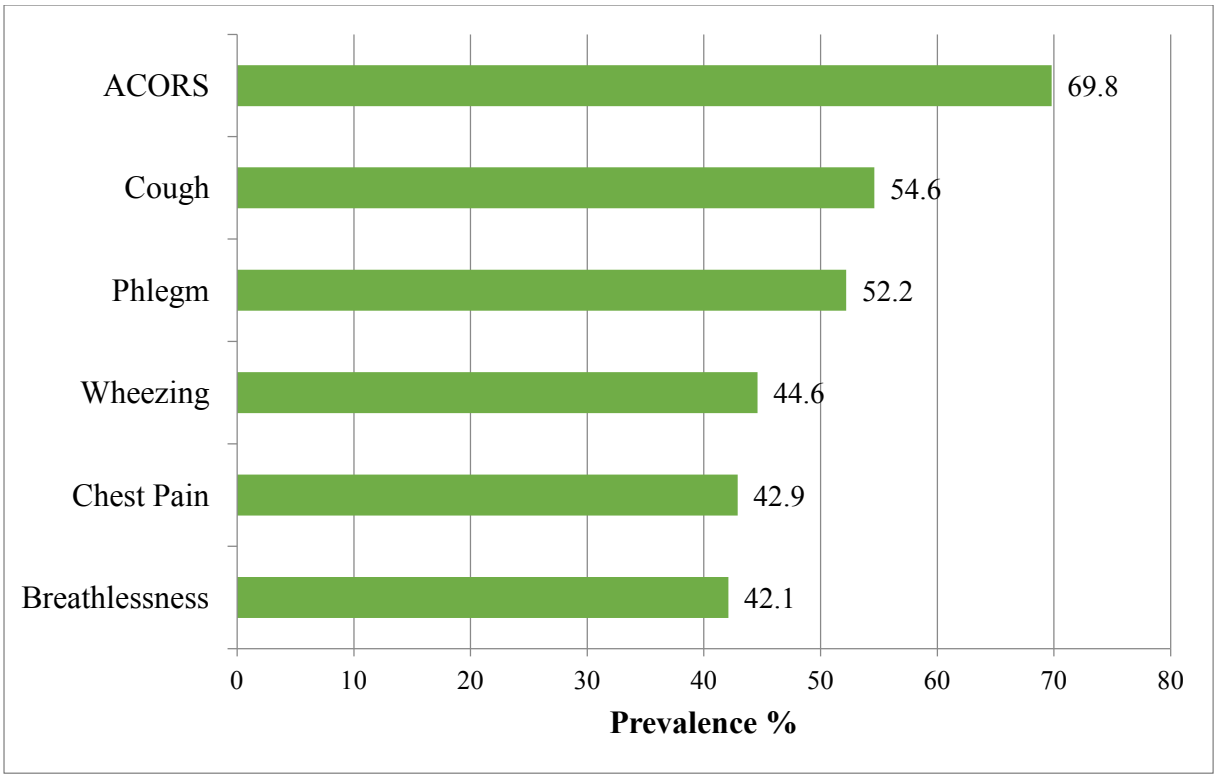

Figure 7: Prevalence of chronic respiratory symptoms of woodworkers in medium scale woodwork factories in Akaki Kality sub city, Addis Ababa, 2019. (n=496)

5.4. Past Occupational dust exposure history among woodworkers

The study reported that 130 (26.2%) of woodworkers had dust exposure before they started woodworking. The most dusty job workers engaged before they started woodworking were welding (56.2%) followed by crusher (29.2%). The mean ± SD working years was highest in flourmills (3.24±2.14) and lowest in mining (1.40±0.55) **(Table 4).**

Table 4: Past dust exposure among woodworkers in medium scale woodwork factories in Akaki Kality sub city, Addis Ababa, 2019 (n=130)

Variables	Frequency*	Percentage	Average Experience in Years ± SD
Welding	73	56.20%	2.35±2.45
Crusher	38	29.20%	2.04±1.32
Mining	5	3.80%	1.40±0.55
Flour mill	19	14.60%	3.24±2.14
Street sweeping	9	6.90%	2.56±2.07
Others**	35	26.90%	2.57±1.98

*- multiple response. **Others include coble stone (0.8%), coffee processing (5.4%), construction (18.5%), Garage (0.8%), Painting (0.8%) and Polypropylene bag factory (0.8%).

5.5. Previous history of respiratory illnesses among woodworkers

This study reported that 62(12.5%) woodworkers had a previous history of respiratory illnesses before they have started woodworking. Among 62 workers had a previous history of respiratory, 10 (18.2%) had chronic bronchitis, 1(1.6%) had emphysema, 32 (51.6%) had asthma 2(3.2%) had lung cancer, 34 (54.8%) had Tuberculosis (TB) and 26 (41.9%) had pneumonia (**Figure 8**).

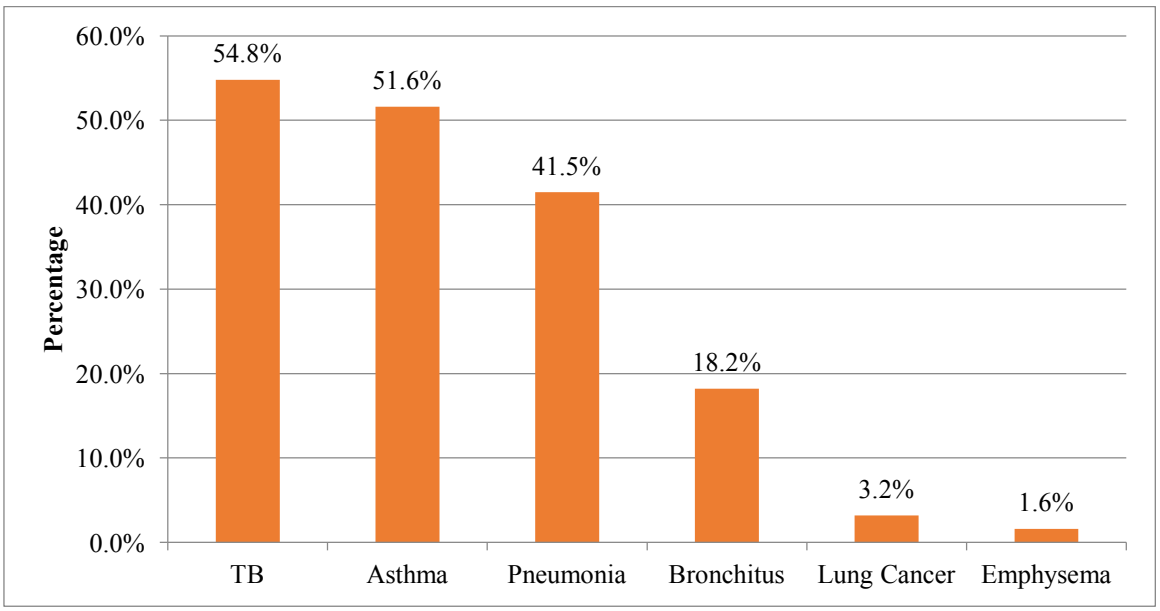

Figure 8: Previous histories of respiratory illnesses of woodworkers in medium scale woodwork factories in Akaki Kality sub city, Addis Ababa, 2019. (n=62)

5.6. Respiratory protective equipment

None of the workers used proper respiratory protective equipments. One hundred fifty three (30.8%) used pieces of clothes as respiratory protective equipment. The main reasons mentioned by the respondents for none use of PPE were not comfortable to wear 176 (51.3%) and not available 148 (43.1%). Sixty-eight (19.8%) believed that no harmful dust particles in wood work factories (**Table 5).**

Table 5: Respiratory protective equipments availability and utilization in medium scale woodwork factories in Akaki Kality sub city, Addis Ababa, 2019.

Variables		Frequency	Percentage
Used pieces of cloth as RPE while at work (n=496)	Yes	153	30.8
	No	343	69.2
Reasons for not using PPE/RPE* (n=295)	Not available	148	43.1
	Not comfortable for work	176	51.3
	Not comfortable to wear	90	26.2
	Not provided by institution	113	32.9
	The dust is not harmful	68	19.8
	Others**	6	1.7

Others**- Asphyxiate/suffocate (0.9%), It has side effect (0.3%), It has bad smell (0.3%), and not giving attention (0.3%).

5.7. Occupational Safety and Health Training and Supervision and Support

Only five percent (25) and 3.4% (17) of the respondents had occupational safety and health (OSH) training and supervision and support concerning issues of occupational health and safety from concerned bodies, respectively (Figure 9).

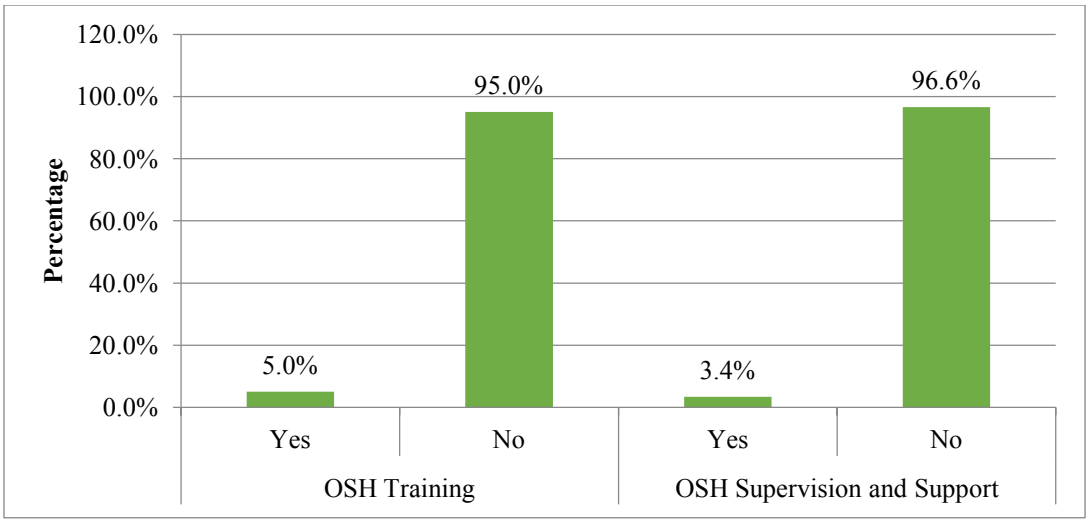

Figure 9: Occupational safety and health training and supervision on occupational safety and health issues among workers in medium scale woodwork factories in Akaki Kality sub city, Addis Ababa 2019 (n=496).

5.8. Workplace Observation

Observational findings of the study showed that wood dusts were accumulated on the walls and floors of different working sections, and especially high in the sawing sections of the factories due to lack of dust absorber, artificial and natural ventilation. Regarding personal protective equipment usage, organization did not provide respiratory protective device for woodwork factory workers. None of the factories had written procedures for selection, use and maintenance of respiratory protective equipments. None of the factories had also written safety signs posted on walls to protect workers from injury.

Figure 10: Dust accumulation on the wall (Photograph by Tegegnework Yitayew)

5.9. Factors associated with respiratory health symptoms among woodworkers: Bivariate Analysis

5.9.1. Socio-demographic factors and respiratory health symptoms of woodworkers

Age of participants, marital status and income had p-value less than 0.2 ($p < 0.2$) in the bivariate analysis with chronic respiratory health symptoms in bivariate analysis. But sex of participants and educational status had p-value greater than 0.2 ($p > 0.2$) with chronic respiratory health symptoms respiratory in bivariate analysis (**Table 6**)

Table 6: Bivariate analysis: socio-demographic and chronic respiratory Symptoms among workers in medium scale woodwork factories in Akaki Kality Sub City, Addis Ababa, 2019. (n=496)

Socio-demographic Variables		At least one chronic respiratory symptom		COR (95%CI)	P-value
		Yes n(%)	No n(%)		
Sex	Male	290(83.8)	129(86.0)	0.84 (0.49-1.45)	0.537
	Female	56(16.2)	21(14.0)	1.00	-
Age in Years	< 30	130(37.6)	113(75.3)	1.00	-
	≥ 30	216(62.4)	37(24.7)	5.07 (3.30-7.80)	**0.001***
Marital Status	Single	120(34.7)	87(58.0)	1.21 (0.42-3.45)	0.726
	Married	192(55.5)	47(31.3)	3.57 (1.23-10.35)	**0.019***
	Divorced	26(7.5)	9(6.0)	2.53 (0.71-8.97)	**0.151***
	Widowed	8(2.3)	7(4.7)	1.00	-
Monthly income in ETB	≤ 2500	190(54.9)	96(64.0)	0.68 (0.46-1.08)	**0.061***
	> 2500	156(45.1)	54(36.0)	1.00	-
Educational Status	Illiterate	16(4.6)	5(3.3)	1.00	-
	Primary education	139(40.2)	53(35.3)	0.82 (0.29-2.35)	0.711
	Secondary education	151(43.6)	81(54.0)	0.58 (0.21-1.65)	0.308
	Certificate and above	40(11.6)	11(7.4)	1.14 (0.34-3.79)	0.835

Note: 1.00 = reference value *-variables which were included in Multivariable analysis

5.9.2. Work place characteristics and respiratory health symptoms of Woodworkers

Among work place characteristics past occupational dust exposure history, previous respiratory illnesses, work experience, energy used for cooking and occupational safety and health training had p-value less than 0.2 ($p < 0.2$) with chronic respiratory health symptoms in bivariate analysis. However, working hours per week and working department had p-value greater than 0.2 ($p > 0.2$) with chronic respiratory health symptoms respiratory in bivariate analysis **(Table 7).**

Table 7: Bivariate analysis: work place characteristics and respiratory health symptoms among woodworkers in medium scale woodwork factories in Akaki Kality Sub City, Addis Ababa, 2019.

Work place Variables		At least one chronic respiratory symptom		COR (95%CI)	P-value
		Yes n(%)	No n(%)		
Past Occupational dust exposure history	Yes	113(32.7)	17(11.3)	3.79 (2.18-6.59)	**0.001***
	No	233(67.3)	133(88.7)	1.00	-
Previous respiratory illnesses	Yes	56(16.2)	6(4.0)	4.63 (1.95-11.01)	**0.001***
	No	290(83.8)	144(96.0)	1.00	-
Work experience	> 5 years	250(72.2)	25(16.7)	13.02 (7.98-21.25)	**0.001***
	1-5 years	96(27.8)	125(83.3)	1.00	-
Working hours per week	> 40 hours	71(20.5)	17(11.3)	2.02 (1.14-3.57)	**0.015***
	≤ 40 hours	275(79.5)	133(88.7)	1.00	-
Working department	Sawing	175(50.6)	72(48.8)	1.11 (0.76-1.63)	0.598
	Sanding	171(49.4)	78(52.0)	1.00	-
Energy used for Cooking	Bio-fuel	178(51.4)	32(21.3)	3.91 (2.51-6.09)	**0.001***
	Electricity	168(48.6)	118(78.7)	1.00	-
OSH Training	Yes	13(3.8)	12(8.0)	1.00	-
	No	333(96.2)	138(92.0)	2.23 (0.99-5.00)	**0.052***

Note: 1.00 = reference value, *-variables which were included in Multivariable analysis, Bio-fuel (wood, coal and gas)

5.9.3. Behavioral factors and respiratory health symptoms of woodworkers

Cigarette smoking had p-value less than 0.2 ($p < 0.2$) with chronic respiratory health symptoms in bivariate analysis.

Table 8: Bivariate Analysis: Behavioral factors and respiratory health symptoms among workers in medium scale woodwork factories in Akaki Kality Sub City, Addis Ababa, 2019.

Behavioral Factors		At least one chronic respiratory symptom		COR (95%CI)	P-value
		Yes n(%)	No n(%)		
Cigarette Smoking	Yes	64(18.5)	5(3.3)	6.58 (2.59-16.71)	**0.001***
	No	282(81.5)	145(96.7)	1.00	

Note: 1.00 = reference value *-variables which were included in Multivariable analysis

5.9.4. Multivariate Analysis

After controlling the possible confounders, four variables, past occupational dust exposure history, work experience, energy used for cooking, and occupational safety and health training became statistically significant in the final model ($p < 0.05$).

Past occupational dust exposure history was significantly associated with respiratory symptoms among woodworkers. The odds of respiratory health symptoms among woodworkers who had past occupational dust exposure history was 2.09 times that of workers who did not have previous dust exposure (AOR = 2.09, 95% CI; 1.09 – 4.01, p = 0.026).

Work experience was significantly associated with chronic respiratory symptoms among woodworkers. The odds of chronic respiratory health symptom among workers who had above five (> 5) years experience was 9.18 times that of workers who had work experience from one to five years of service (AOR = 9.18, 95% CI; 5.27-16.00, p = 0.001).

Energy used for cooking was also significantly associated with chronic respiratory symptoms among woodworkers. The odds of chronic respiratory health symptoms among workers who used bio-fuel for cooking was 2.42 times that workers who used electricity for cooking (AOR = 2.42, 95% CI; 1.44-4.07, p = 0.001).

Having no occupational safety and health training (OSH training) was significantly associated with chronic respiratory symptoms among woodworkers. The odds of chronic respiratory health symptoms among workers who did not have occupational safety and health training was 3.38 times that of workers had occupational safety and health training (AOR = 3.38, 95% CI; 1.20-9.49, p = 0.021).

Table 9: Multivariate analysis: Chronic Respiratory Symptoms and associated factors among workers in medium scale woodwork factories in Akaki Kality Sub City, Addis Ababa, 2019. (n=496)

Variables		At least one chronic respiratory symptom		AOR (95%CI)
		Yes	No	
Age in Years	< 30	130	113	1.00
	≥ 30	216	37	1.55 (0.90- 2.66)
Marital Status	Single	120	87	1.60 (0.51-5.04)
	Married	192	47	2.75 (0.88-8.63)
	Divorced	26	9	1.98 (0.51-7.53)
	Widowed	8	7	1.00
Monthly income in ETB	≤ 2500	190	96	1.09 (0.69-1.71)
	> 2500	156	54	1.00
Past Occupational dust exposure history	Yes	113	17	**2.09 (1.09-4.01)***
	No	233	133	1.00
Previous respiratory illnesses	Yes	56	6	2.05 (0.74-5.66)
	No	290	144	1.00
Work experience	> 5 years	250	25	**9.18 (5.27-16.00)***
	1-5 years	96	125	1.00
Working hours per week	> 48 hours	71	17	0.85 (0.41-1.78)
	≤ 48 hours	275	133	1.00
Working Department	Sawing	175	72	0.83 (0.51-1.33)
	Sanding	171	78	1.00
Energy used for Cooking	Bio-fuel	178	32	**2.42 (1.44-4.07)***
	Electricity	168	118	1.00
OSH Training	Yes	13	12	1.00
	No	333	138	**3.38 (1.20-9.49)***
Cigarette Smoking	Yes	64	5	2.11 (0.73-6.09)
	No	282	145	1.00

Note: 1.00 = reference value, Bio-fuel (wood, coal and gas) * significant at p<0.05

Model Fitting

Hosmer-Lemeshow test was computed to assess the overall goodness of fit of the fitted model. An insignificant chi-square indicates a good fit to the data and, therefore, good overall model fit. Since the p-value was 0.326 (>0.05), which was insignificant, therefore my fitted logistic regression model is good fit. The R and R^2 values of the model summary were 0.884 and 0 .781, respectively. The value of R^2 shown 78.1% of the variation of dependent variable was explained by independent variables in a linear model.

5.10. Level of dust exposure among woodworkers

A total of 20 woodworkers were included in dust exposure measurement. The majority (90 %) of workers were males.

5.10.1. Observations related to dust exposure

Two operations were performed in woodworking i.e. sawing and sanding. Woodworkers did not perform their task with rotation and the position of the sampling cassettes did not affect the exposure result as the woodworkers uses both hands (right or left) as needed to accomplish their operation (personal observation).

5.11. Personal wood dust exposure

The arithmetic mean (AM) (± SD) and geometric mean (GM) (± GSD) of the overall personal wood dust concentration was 11.75 (± 6.11) mg/m^3 and 10.27 (± 1.71), respectively with a range varying from 4.28 - 26.24 mg/m^3. Out of the total samples, 22 (55%) of the samples were above 10 mg/m^3 of the ACGIH recommendation (**Table 10**). Woodworkers who were working in sawing department were exposed to relatively high dust exposure [AM (±SD) of 12.06(6.72) and GM (±GSD) 10.40 ± 1.76] mg/m^3 **(Table 11).**

Regarding dust exposure concentration, there was no variation between sampling days (df= 7, F = 0.578, p = 0.769). The post hoc test (Bonferroni) also indicated that there was no significant difference in mean exposure levels between sampling days.

Comparing dust exposure concentration with task operation, there was no significant difference between the two tasks (df = 1, F = 0.098, p = 0.756). Comparing dust exposure concentration with company, there was no significant difference between the two companies (df = 1, F = 0.342, p = 0.562). Comparing dust exposure concentration with measurement level (first and second measurement), there was no a significant difference between the two measurement levels (df = 1, F = 3.463, p = 0.079).

6. Discussion

The finding of this study revealed that the overall prevalence of chronic respiratory health symptoms among woodworkers was high. This finding was consistent with studies done in different countries which indicated higher prevalence of chronic respiratory symptoms among woodworkers (14, 16, 17, 24, 26, 67) but relatively higher than the study conducted in North East of Thailand in which 29.9% of woodworkers had at least one chronic respiratory health symptoms (1). This finding is also higher than the prevalence of chronic respiratory symptoms at community level in Ethiopia (68). High prevalence of chronic respiratory health symptoms found in the present study might be due to lack of proper respiratory protective equipment's, longer duration of exposure to wood dusts and lack of occupational safety and health trainings.

On the frequency of utilization of respiratory protective devices (RPE), not all workers used proper respiratory protective equipments when working. This is in agreement with a study conducted in particle board workers in Ethiopia (18). But the present study was not in line with previous studies in Nigeria (34, 46). This is due to lack of OSH training of woodworkers in the present study. A similar study conducted by Osagbemi et al., (2010) on Awareness of Occupational Hazards, Health Problems and Safety Measures among Sawmill Workers in North Central Nigeria also identified that the use of RPE was very low, 56.9% of respondents in their study never used devices at all while only 15% always use protective devices when working (69). Some of the reasons given for not using the devices in the present study were that the devices were not comfortable to use (51.3%) and the devices were not available (43.1%). The finding of the present study was consistent with the findings of the study in Nigeria (69). The finding of the present study was also consistent with the study conducted in Ghana which identified 69% of woodworkers never used RPEs while at work and some of their reasons given for not using the devices were that the devices were not available (53.3%) and also the devices were not comfortable to use (46.7%) (5). However, the present study was inconsistent with the study conducted in Ethiopia that identified some of the reasons given for not using the devices were not comfortable (3.9%) and lack of access (59%) (42).

Past occupational dust exposure history in the woodwork factory was a major factor in the development of chronic respiratory symptom. Having past occupational dust exposure history increased significantly woodworkers risk of developing chronic respiratory symptoms. This study is in line with a study conducted in Tanzania (36). The reason for significant association of past occupational dust exposure history with development of at least one

respiratory symptom might be due to misunderstanding and lack of training and knowledge on RPE utilization as well as workers who had experience on dust exposure may ignore in using RPE as they consider themselves adapting the dust. However, this finding was not in line with a study conducted among woodworkers in South-South Nigeria (24). This might be due to large sample size in the present study than in South-South Nigeria.

Duration of employment or work experience in the woodwork factory was a major factor in the development of chronic respiratory symptoms as illustrated in the result. Working for more than five years increased significantly one's risk of developing chronic respiratory symptoms. This result was in line with previous studies that have reported similar findings (5, 24, 29, 32). The reason might be due to increased dust accumulation in respiratory system associated with prolonged exposure at work places.

The finding of the present study revealed that energy used for cooking was also significantly associated with chronic respiratory symptoms among woodworkers. This result was in agreement with previous study conducted in Nepal (70). The reason might be due to higher risk for serious health outcomes of biofuels for cooking and heating as compared with those who use cleaner energy for cooking.

Only five percent of woodworkers had occupational safety and health (OSH) training. Lack of training on OSH has been reported in previous studies (46, 67, 71). This finding was consistent with study conducted in Ethiopia among particle board workers that identified only 10 % of workers attended safety and health training (42). Lack of Occupational safety and health training was significantly associated with the development of chronic respiratory symptoms among woodworkers. Having no occupational and safety training increased significantly one's risk of developing chronic respiratory symptoms. This result was in line with previous study that have reported similar finding (32). The main reason for this result might be that training changes the attitude of workers towards chronic respiratory health symptoms and provides the skills and knowledge about the means of protecting themselves from work place hazards especially wood dust.

The geometric mean (±GSD) of the overall personal wood dust concentration for the selected two woodwork factories was 10.27 (± 1.71) with a range varying from 4.28 - 26.40 mg/. From this finding, I observed that the overall personal total dust concentration was higher than that of the previous study conducted in Tanzania (47) and Ethiopia (15). This discrepancy might be due to the seasonal variation, i.e., the data collection time in the present study was somewhat dry season hence the dust might be dispersed and lack of proper natural

and artificial ventilations as well as lack of local exhaust ventilation in the woodwork factories. The result of this study (GM) was also exceeded the ACGIH TLV recommendation (10 mg/m^3) (72) .This high level of dust exposure might result from the absence of natural as well as artificial ventilation as well as lack of local exhaust ventilation in the factories which creates a condition that generated and suspended the dust around the breathing area of the workers.

This study revealed that there was no statistical difference in dust exposure concentration between the eight measurement days (df= 7, F = 0.578, p = 0.769). This might be due to the similarity in weather conditions of the days that the samples were conducted. This study revealed that there was no significant difference in dust exposure concentration between the two companies (df = 1, F = 0.342, p = 0.562). This might be due to absence of natural and artificial ventilation as well as lack of local exhaust ventilation in the two factories. It also revealed that there was no statistical difference in dust exposure concentration between the departments or tasks (df = 1, F = 0.098, p = 0.756). This is probably due to the same room used as working area for the two tasks.

7. Strength and limitations of the study

7.1. Strengths

Three tools i.e. interview, observational checklist and dust exposure measurement, were used for data collection and using these tools resulted to get relatively sufficient amount of data. Using interview as data collection tool also resulted to get high response rate (98.02%) than other studies that used self-administered questionnaire.

Two experienced Environmental Health Professionals were involved in personal wood dust exposure measurement that leaded to proper monitoring of the measurement and get good quality of data.

7.2. Limitations

Respondents recall bias was possibly introduced during interviewing the study participants that may affect the outcome of interest.

The 37mm Millipore plastic sampling head (CFC) or total dust sampler has inherent characteristics in underestimating the coarse particles in the inhalable dust fraction. Wood dust contains a wide range of particle sizes including coarse particles with aerodynamic diameters > 50 μm. Since the sampling head used in the present study was 37mm Millipore plastic sampling head (CFC), it significantly underestimated these coarse particles (30 – 100 μm).

Covering the whole working time is the best way to measure exposure to dust. However, in this study, it was assumed that the tasks were similar in the morning and therefore considered using half of the work time in the morning shift. This was decided because the dust sampling head used in the study had inherent characteristics of becoming overloaded. This decision did not interrupt the sampling.

Sample losses may occur because of adhering to the interior part of the cassette walls that leads to underestimation of dust concentration was also considered as a limitation.

Only few woodwork factories and few woodworkers were sampled for personal dust exposure assessment. Hence, this makes difficult to look at the association of respiratory health symptoms with the wood dust concentration.

Other factors like alcohol addiction, drug addiction and chat chewing were not included in this study, which may affect the outcome of interest.

8. Conclusion and recommendation

8.1. Conclusion

The overall prevalence of chronic respiratory health symptoms among wood workers was high. None of the respondents had proper type of respiratory protective equipment and few woodworkers had occupational safety and health training. All the factories lack dust absorber, artificial and natural ventilation. Work-experience, energy used for cooking, past occupational dust exposure history and occupational safety and health training were significantly associated with chronic respiratory health symptoms. Out of the total measurement samples (n = 40), 55% of the woodworkers were exposed to wood dust concentration that was exceeded the occupational exposure limit recommended by the ACGIH TLV guideline (10 mg/m^3).

8.2. Recommendations

Based on study findings, the following important measures are recommended.

For factory owners

They should implement control measures and improve the ventilation of their factory to reduce the dust and workers should be educated and trained about the health effects and control measures of dust, and workers should be provided with proper respiratory protective equipments during duty hours. Engineering control measures like local exhaust ventilation or local absorber shall also be implemented to reduce the concentration of dust.

For workers

Workers should have to use personal protective devices which supplied by woodwork factory owners.

For Addis Ababa City Administration Bureau of Labour and Social affairs and Akaki Sub City Administration Labour and Social affairs Office

- There should be regular monitoring to ensure the implementation of these rules and regulations.
- The bureau and the office shall give Occupational safety and health training for workers in collaboration with owners of the factories.

Finally, further studies shall be conducted for future by using pulmonary function test, areal dust measurement and strong study design. A longitudinal study shall be undertaken in order to characterize the association between dust exposure and chronic respiratory symptoms.

Reference

1. Soongkhang I, Laohasiriwong W. Respiratory Tract Problems among Wood Furniture Manufacturing Factory Workers in the Northeast of Thailand. Kathmandu University Medical Journal. 2015;13(50):125-9.
2. Health and Safety Executives (HSE). EH40/2005 Workplace Exposure Limits. Health and Safety Executive (HSE books) [Internet]. Norwich (GB).2011 [cited 2017 July 7]. Available from: www.hse.gov.uk.
3. Meo SA. Effects of Duration of Exposure to Wood Dust on Peak Expiratory Flow Rate among Workers in Small Scale Wood Industries. International Journal of Occupational Medicine and Environmental Health. 2004;17(4):451-5.
4. Mikkelsen A, Schlunssen V, Sigsgaard T, Schaumburg I. Detrrminants of Wood Dust Exposure in the Danish Furniture Industry. Ann Occup Hyg. 2002;46(8):673-83.
5. Mumuni M. Respiratory Health Problems among Sawmill Workers at the Timber Market, Accra [MSc thesis]: University of Ghana; 2015.
6. International Agency for Research on Cancer (IARC). IARC monographs on the evaluation of carcinogenic risks to humans. Wood dust and formaldehyde. Lyon, France: International Agency for Research on Cancer; 1995.
7. International Agency for Research on Cancer (IARC). Arsenic, Metals, Fibres, andDusts: AReviewof HumanCarcinogens. Lyon, France: IARC; 2012. 527 p.
8. Holness DL, Sass-Kortsak AM, Pilger CW. Respiratory function and exposure effect relationships in wood dust exposed and control workers. J Occup Med. 1985;27:501-6.
9. International Labor Organization (ILO). Action towards prevention of occupational non-communicable diseases.2011. Available from: http://www.worldpsi.org/sites/default/files/attachment/news/ilo_presenation.pdf.
10. Fedotov I. ILO Action towards prevention of occupational non-communicable diseases. PSI Forum & Federation Symposia Geneva, Switzeralnd2011. p. 25.
11. World Health Organization (WHO). Global action plan for the prevention and control of noncommunicable diseases 2013-2020. Geneva, Switzerland: WHO Document Production Services; 2013. Available from: www.who.int.
12. World Health Organization (WHO). Noncommunicable Diseases Country Profiles 2011 [Internet]. France: World Health Organization; 2011 [cited 15 Sept 2018. Available from: www.who.int/nmh/publications/ncd-profiles-2011/en.

13. World Health Organization (WHO). Noncommunicable disease country profile 2014 [Internet]. Geneva, Switzerland: WHO Document Production Services; 2014 [cited 15 Sept 2018. Available from: www.who.int/nmh/publications/ncd-profiles-2014/eng.
14. Rongo LM, Besselink A, Douwes A, Barten F, Msamanga G, Dolmans WMV, et al. Respiratory Symptoms and Dust Exposure among Male Workers in Small-Scale Wood Industries in Tanzania. J Occup Environ Med. 2002;44:1153-60.
15. Ayalew E, Gebre Y, Karolien D. A Survey of Occupational Exposure to Inhalable Wood Dust Among Workers in Small- and Medium-Scale Wood-Processing Enterprises in Ethiopia. Ann Occup Hyg. 2014;59(2):253-7.
16. Abreha N. Pulmonary Function Test and Pulseoximetry in Chipwood Factory Workers of Maichew, Tigray Region [MSc. Thesis]: Addis Ababa University 2014.
17. Fentie D, G/mariam T, Mulat E, Reta W. Assessment of Respiratory Symptoms among Woodworkers in Jimma Town, Southwest Ethiopia, A Comparative Cross-Sectional Study. Biomedical Journal of Scientific and Technical Research 2019;18(2):1-6.
18. Asgedom AA, Bråtveit M, Moen BE. High Prevalence of Respiratory Symptoms among Particleboard Workers in Ethiopia: A Cross-Sectional Study. International Journal of Environmental Research and Public Health 2019;16(2158):1-10.
19. Nigatu AW. Respiratory Health and Acute Pesticide Intoxication among Workers in Flower Farm Industry in Ethiopia [PhD thesis]. Ait/Bjerch/University of Bergen: University of Bergen; 2017.
20. Muchie M, Bekele E. Promoting micro, small and medium enterprises (MSMEs) for sustainable rural Livelihood. Denmark: Aalborg; 2009.
21. Federal Democratic Republic of Ethiopia Central Statistics Agency (FDRE CSA). Report on Large and Medium Scale Manufacturing and Electricity Industry Survey. Addis Ababa: CSA; 2008. Available from: http://www.csa.gov.et/survey-report/category/50-lmmis-2008.
22. Federal Democratic Republic of Ethiopia Central Statistics Agency (FDRE CSA). Report on Small Scale Manufacturing Industries Survey. Addis Ababa: CSA; 2010. Available from: http://www.csa.gov.et/survey-report/category/268-ssis-2010.
23. Federal Democratic Republic of Ethiopia Central Statistics Agency (FDRE CSA). Report in Large and Medium Scale Manufacturing and Electricity Industries Survey. Addis Ababa: CSA; 2012. Available from: http://www.csa.gov.et/survey-report/category/54-lmmis-2012.

24. Tobin E, Ediagbonya T, Okojie O, Asogun D. Occupational Exposure to Wood Dust and Respiratory Health Status of Sawmill Workers in South-South Nigeria. Pollution Effects & Control. 2016;4(1):1-6.
25. Ugheoke AJ, Ebiomoyi MI, I IV. Influence of smoking on respiratory symptoms and lung functions indices in sawmill workers in Benin City,Nigeria. Nigerian Journal of Physiological Sciences. 2009;21(3):49-54.
26. Adeoye OA, Adeomi AA, Abodunrin OL, Olugbenga-Bello AI, Abdulsalam ST. Awareness of occupational hazards and health problems among sawmill workers in Osun state, Nigeria. International Journal Of Research and Review 2015;2(1):1-14.
27. Merja K, Tuula V, Tarja L, Markku H, Pekka J, Seppo S. Low socioeconomic status is associated withchronic obstructive airway diseases. Respiratory Medicine. 2011;105(8):1140-6.
28. Gonzalez-Garcia M, Caballero A, Jaramillo C, Maldonado D, Torres-Duque CA. Prevalence, risk factors and underdiagnosis of asthma and wheezing in adults 40 years and older:A population-based study. Journal of Asthma. 2015;52(8):823-30.
29. Chaiear N, Ngoencharee J, Saejiw N. Respiratory Symptoms and Pulmonary Function amongWorkers in a Rubber Wood Sawmill Factory in Thailand. 2018;6(2):65-71.
30. Pinkerton K, Harbaugh M, Han M, Jourdan Le Saux C, Van Winkle L, Martin W, et al. Women and Lung Disease. Sex Differences and Global Health Disparities. American journal of respiratory and critical care medicine. 2015;192(1):11-6.
31. Kanervisto M, Vasankari T, Laitinen T, Helio¨vaara M, Jousilahti P, Saarelainen S. Low socioeconomic status is associated with chronic obstructive airway diseases. Respiratory Medicine. 2011;105:1140-6.
32. Gizaw Z, Yifred B, Tadesse T. Chronic respiratory symptoms and associated factors among cement factory workers in Dejen town, Amhara regional state, Ethiopia. Multidisciplinary Respiratory Medicine 2016;11(13):1-9.
33. Ajeel NA, Al-Yassen A. Work-related-allergic-disorders-among-flour-mill-workers. The Med JJ of Basrah UNIV. 2007;25(1):29-32.
34. Agu AP, Umeok onkwo CD, Nnabu RC, Odusanya OO. Health Problems among Sawmill Workers in Abakaliki and Workplace Risk Assessment. Journal of Community Medicine and Primary Health Care. 2016;28(2):1-10.
35. Shamssain M. Pulmonary function and symptoms in workers exposed to wood dust. Thorax. 1992;47:84-7.

36. Buliga V, Rongo LM, Mamuya SH. Dust Exposure and Respiratory Symptoms among Workers in Small Scale Sun Flower Oil Industry in Singida, Tanzania. International Journal of Research - Granthaalayah. 2017;5(12):452-64.
37. Bartley DL. Inhalable aerosol sampling. Appl Occup Environ Hyg. 1998;13:274-8.
38. Ratnasingam J, Ramasamy G, Ioras F, Thanesegarane G, Mutthiah N. Assessment of Dust Emission and Working Conditions in the Bamboo and Wooden Furniture Industries in Malaysia. bioresourcescom. 2016;11(1):1189-201.
39. Alwis KU. Occupational Exposure to Wood Dust [PhD Thesis]. New South Wales, Australia: The University of Sydeny; 1998.
40. Nelson CO, Easter CO, Jimmy EE, Otareh OO. Occupational Exposure to Wood Dust in Calabar Municipality, Cross River State, Nigeria. International Journal of Science and Research (IJSR). 2015;4(5):1415-20.
41. Rongo LM, Leon B. Qualitative method for assessing dust exposure in small-scale wood industries in the informal sector. East African Journal of Public Health. 2005;2(1):32-8.
42. Asgedom AA, Bråtveit M, Moen BE. Knowledge, attitude and practice related to chemical hazards and personal protective equipment among particleboard workers in Ethiopia: a cross-sectional study. BMC Public Health. 2019;19(440):1-10.
43. Mandryke J, Alwis KU, Hocking AD. Work related symptoms and dose response relationship for personal exposure and pulmonary function among wood workers. . Am J Ind Med. 1999;35:481-90.
44. Rongo LM, Barten F, Msamanga GI, Heederik D, Dolmans WM. Occupational exposure and health problems in small-scale industry workers in Dar es Salaam, Tanzania: a situation analysis. . Occup Med (Lond) 2004b;54(1):42-6.
45. Alwis KU, Mandryk JM, Hocking AD, Lee J, Mayhew T, Baker T. Dust Exposures in the Wood Processing Industry. Amer Ind Hyg Assoc J. 1999;60(641):646.
46. Awosan KJ, Ibrahim MTO, Yunusa EU, Isah BA, Ango UM, Michael A. Knowledge of Workplace Hazards, Safety Practices and Prevalence of Workplace-related Health Problems among Sawmill Workers in Sokoto, Nigeria. International Journal of Contemporary Medical Research. 2018;5(10):5-12.
47. Rongo LM, Msamanga GI, Burstyn I, Barten F, Dolmanns WM, Heederik D. Exposure to wood dust and endotoxin in small-scale wood industries in Tanzania. Journal of Exposure Analysis and Environmental Epidemiology. 2004a;14:544-50.
48. Scheeper B, Kromhout H, Boleij JSM. Wood-dust exposure during wood-working processes. Ann Occup Hyg. 1995;39:141-54.

49. Hampl V, Johnston OE. Control of wood dust from horizontal belt sanding. American Industrial Hygiene Association Journal 1985;46(10):567-77.
50. Hall A, Teschke K, Davies H, Demers P, Marion S. Exposure Levels and Determinants of Softwood Dust Exposures in BC Lumber Mills, 1981–1997. American Industrial Hygiene Association Journal. 2002;63:709-14.
51. Dutch Expert Committee for Occupational Standards (DECOS). Health –based recommended occupational exposure limit for wood dust. Directorate–General van de Arbeid, Den Haag, The Netherlands: 1992 Report no:RA 8/91.
52. Eller PM. NIOSH Manual of Analytical Methods. 3rd Ed ed. Washington DC: US Government Printing Offce; 1989.
53. United States Occupational Safety and Health Administration. Air Contaminants. US Code Fed Regul, Title 291993. p. 6-19.
54. Beaulieu HJ, Fidino AV, Arlington KLB, Buchan RM. A comparison of aerosol sampling techniques: 'open' versus 'closed-face' filter cassettes. Am ind Hyg Assoc J. 1980;41:758-65.
55. National Institute for Occupational Safety and Health (NIOSH). Particulates not otherwise regulated, total method 0500.1994; (2). Available from: www.cdc.gov/niosh/docs.
56. Cesar GV, Sharon RH, Sanddra CF. The role of Conceptual Frameworks in Epidemiological Analysis: A Hierarchal Approach. International journal of Epidemiology. 1997;26(1):224-7.
57. Federal Democratic Republic of Ethiopia Central Statistics Agency (FDRE CSA). Population and Housing Census of Ethiopia. Addis Ababa2007.
58. Rappaport S, Kupper L. Quantitative exposure assessment. El Cerrito, Calif.: S. Rappaport; 2008.
59. Tennant S, Szuster F. Nationwide monitoring and surveillance question development: Asthma Working Paper Series No 2. Public Health Information Development Unit: Adelaide 2003.
60. Health and Safety Executives (HSE). General methods for sampling and gravimetric analysis of respirable, thoracic and inhalable aerosols:MDHS14/4 [Internet]. Liverpool, UK: HSE; 2014 [cited 2018 July 9]. Available from: www.hse.gov.uk.
61. Kumie A, Wakuma S, Bråtveit M, Deressa W, Mamuya S, Teshome B, et al. Dust exposure levels among street sweepers in Bole Sub-City, Addis Ababa, Ethiopia. Ethiop J Health Dev 2017;31(4):236-43.

62. Federal Small and Medium Manufacturing Industry Development Agency Establishment Council of Ministers Regulation No. 373/2016, (2016).
63. Ashuro Z. Comparative Cross sectional Study on Chronic Respiratory Symptoms and Pulmonary Function and Associated Factors among Flour and Pepsi Factory Workers in Hawasa City, Southern Ethiopia: Addis Ababa University; 2017.
64. Alli BO. Fundamental Principles of Occupational Health and Safety. Geneva: International Labor Organization (ILO); 2008. Available from: www.ilo.org/publns.
65. Casserly D. Threshold Limit Values for Chemical Substances (TLV®-CS): University of Houston at Clear Lake; 2006.
66. Australian Institute of Occupational Hygienists (AIOH). Air Sampling Pumps: Equipment Calibration Requirements. AIOH Exposure Standards Committee; 2018. p. 8.
67. Oluwatosin AA, Adeleye AA, Adenike IO, James OB, Olugbemiga LA, Olukemi AS. Respiratory symptoms and peak expiratory flow among sawmill workers in South Western Nigeria. Journal of Environmental and Occupational Science. 2014;3(3):141-6.
68. Garedew GW, Basazin AM, Gensa TG. Prevalence of chronic obstructive pulmonary disease (COPD) and its associated factors among adults in Abeshge District, Ethiopia: a cross sectional study. BMC Pulmonary Medicine. 2019;19(181):1-9.
69. Osagbemi GK, La-Kadri RT, Aderibigbe SA. Awareness of occupational hazards, health problems and safety measures among sawmill workers in north central Nigeria. TAF Prev Med Bull. 2010;9:325-8.
70. Lal Shrestha I, Lal shrestha S. Indoor Air Pollution from Biomass Fuels and Respiratory Health of the Exposed Population in Nepalese Households. Int J Occup Environ Health. 2005 11:150-60.
71. Bello SR, Mijinyawa Y. Assessment of ınjuries in small scale sawmill ındustry of South Western Nigeria. Agric Eng Int: CIGR J Sci Res Dev 2010;12:1-11.
72. American Conference of Governmental Industrial Hygienist (ACGIH). TLVs and BEIs. Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. Cincinnati, OH: ACGIH; 2015. p. 17.

Annexes

Annex I: Participants Information Sheet for Interview

Greetings

My name is _____. I am working as a data collector for the study conducted in this industry/factory by Tegegnework Yitayew who is studying for his Master's degree at Addis Ababa University, Collage of Health Science, and School of Public Health. I kindly request you to give me your attention to explain you about the study and study participant.

The title of this study is assessment of dust exposure and prevalence of chronic respiratory symptoms among workers in medium scale factories in Akaki Kality sub city, Addis Ababa. The main objective of this study is to assess the prevalence of chronic respiratory symptoms, to identify factors associated with chronic respiratory symptoms and to estimate total dust exposure level, among workers in medium scale factories in Akaki Kality Sub City, Addis Ababa in 2019.

I will be assessing chronic respiratory symptoms by using Questionnaires that needs your full cooperation and this may take about 30 to 45 minutes, and the procedures will take place in your working environment.

Risk of participating in this study is nil since the study does not need collecting any samples that create risks on participants. There would have no any direct benefits for being study participant but indirectly the findings from this research will important for improving occupational health safety practice, information for the factory and for scientific knowledge.

All information forwarded will be kept confidential and names will not be written. Giving permission for this study is voluntary. You have the right to permit or not for this study. If you decide to permit the study, you have the right to terminate the study at any time if you consider something related to the study is wrong.

If you have any question about the research you may contact Tegegnework Yitatew (Principal Investigator) Addis Ababa University, College of Health Sciences, School of Public Health (Tel +251-913-22-75-83) or Dr. Abera Kumie (Tel +251-911-88-29-12) or Mr. Worku Tefera (Tel +251-9-13-62-05-14) (supervisors) Addis Ababa University, College of Health Sciences, School of Public Health or School of Public Health ethical review committee (Tel +251-11-515-77-01).

Annex II: Information Sheet for Dust Measurement

Greeting

My name is _____. I come from Addis Ababa University School of Public Health. I am Masters Degree student. I am doing my research paper on the title assessment of dust exposure and prevalence of chronic respiratory symptoms among workers in medium scale woodwork factories in Akaki Kality sub city, Addis Ababa. The main objective of this study is to assess the prevalence of chronic respiratory symptoms, to identify factors associated with chronic respiratory symptoms and to estimate total dust exposure level, among workers in medium scale factories in Akaki Kality Sub City, Addis Ababa in 2019.

This study will have a great role in the control and prevention of chronic respiratory symptoms among workers in woodwork factory. Further, I believe that this study will help governmental and stakeholders to focus in this area to solve the problems faced among the workers. During the study period, standard dust measurement will be conducted. The study has ethical approval from School of Public Health. You will be requested for the willingness after I provide you the required information about the study.

The procedure how to perform: you will be requested to fix the tools of dust samplers on your body for quantifying the wood dust that is probably to be inhaled by you. A small sampling head will be attached to your breathing zone that is used to trap the wood dust. A 0.5 kg hand pump will be mounted on your waist. The pump draws air through a connecting tube passing the sampling head. The tool has no any interference with your health as well as your work except a bit of sound since it works with a battery. The sampling duration is assumed to cover the whole working hours. The principal investigator will help you in fixing the tool, start and stop the hand pump. This study will not provide any direct benefit to the study participants. However, the information obtained from this study will help to generate data in order to design an appropriate intervention. In addition to that, we will inform you exposure level you will have during the exposure assessment. This study will not have any harm to the study participants except spending time for the exposure measurement over the whole working hours. Your participation is voluntary and you have the right to be involved or not after being fully informed. Nothing will happen if you say "No". If you feel discomfort with the measurement, please be free to withdraw or discontinue at any time you want. The exposure data will not be accessible to anybody other than the study members. Any personal information given by you will be kept anonymously.

If you have any question about the research you may contact Tegegnework Yitatew (Principal Investigator) Addis Ababa University, College of Health Sciences, School of Public Health (Tel +251-913-22-75-83) or Dr. Abera Kumie (Tel +251-911-88-29-12) or Mr. Worku Tefera (Tel +251-9-13-62-05-14) (supervisors) Addis Ababa University, College of Health Sciences, School of Public Health or School of Public Health ethical review committee (Tel +251-11-515-77-01).

Annex III: Informed Consent

Detail information about the study was explained to me. I have understood that the main objective of this study is to assess the prevalence of chronic respiratory symptoms, to identify factors associated with chronic respiratory symptoms and to estimate total dust exposure level, among workers in medium scale factories in Akaki Kality Sub City, Addis Ababa in 2019.In addition, I understand about how the data collection is proceeding and the time it takes to complete the data collection. I also understand that the research imposes no risk on me. I assured that there would be confidentiality of my response and collected data used only for the study.

It also explained to me that I have the right to stop participation at any time.

In addition, I understood that participating in this study is important for scientific knowledge and base for further study. Therefore, I have now consented to participate in the study by signing this form.

Signature of participants_____date_____

Name and signature of data collectors_____date_____

Annex IV: English Version Questionnaire

Addis Ababa University Health Science Collage, School of Public Health

A questionnaire designed to assess the prevalence of chronic respiratory symptoms, to identify factors associated with chronic respiratory symptoms and to estimate total dust exposure level, among workers in medium scale factories in Akaki Kality Sub City, Addis Ababa in 2019.Date of data collection_____

Questionnaire code_____

Please encircle the correct answer and write a correct number in the space provided, example age in years using pen (Blue).

S/N.	QUESTIONS	RESPONSES	SKIP
PART I. SOCIO-DEMOGRAPHIC CHARACHTERSTICS OF RESPONDANTS			
100	Sex	1. Male 2. Female	
101	Age	_____Years	
102	Marital Status	1. Single 2. Married 3. Separated 4. Divorced 5. Widowed/Widower	
103	Educational level	1. Illiterate 2. Primary education 3. Secondary education 4. Certificate and above	
104	Income per a month	_____ETB	
PART II. PAST OCCUPATIONAL HISTORY			
200	When did you start this job?	_____/_____E.C.	
201	For how long have you been working in this factory?	_____(Years & months)	
202	For how many working hours per day you have been working in this factory?	_____(Hours/day)	
203	For how many working days 'per a week you have been working in this factory?	_____(Day/week)	
204	How long have you been working in woodwork factory, summarizing all periods?	_____(Years and months)	
205	Have you ever worked for any other dusty job?	1. Yes 2. No	If **"No"** go to Q.N. **207**

S/N.	QUESTIONS	RESPONSES	SKIP
206	If **"Yes"** for **Q. No 205** For how long did you work in the areas listed below (Years) (more than one answer is possible)	1. Welding _____ 2. Crusher _____ 3. Mining _____ 4. Flourmill _____ 5. Street sweeping _____ 6. Other (specify) _____	
207	Have you ever worked in other sections in the past in the woodwork factory?	1. Yes 2. No	If "No" go to Q.N. 209
208	If "Yes" for Q. No. 207, indicate which section and for how long? (in years & months) (Multiple answer is possible)	1. Sawing _____ 2. Sanding _____ 3. Carving _____ 4. Cleaning _____ 5. Other (specify) _____	
209	Do you prepare food by yourself?	1. Yes 2. No	
210	If **"No"** for **Q. No 209,** Does food prepared in your home even by other person?	1. Yes 2. No	
211	If **"Yes"** for **Q. No 209 or 210** where is cooking normally taking places in your home?	1. Inside house 2. Outside house in open area 3. In a kitchen	
212	If **"Yes"** for Q. No 209 or 210 What kind of energy source mostly do you use for food preparation? **(more than one answer is possible)**	1. Coal 2. Wood 3. Gas 4. Electric	
PART III. PAST HISTORY OF RESPIRATORY ILLNESSES			
300	Did you have previous chronic lung conditions?	1. Yes 2. No	If **"No"** go to **Q.N. 400**
301	If **"Yes"** for Q. No 300 What type of health problem did you experienced earlier? **(more than one answer possible)**	1. Chronic bronchitis 2. Emphysema 3. Asthma 4. Lung cancer 5. Tuberculosis (TB) 6. Pneumonia 7. Other (specify) _____ _____	
PART IV. CIGARETTE SMOKING BEHAVIOUR			
400	Have you ever smoked cigarettes? (No means less than 20 packets of cigarettes in a lifetime or less than 1 cigarette a day for 1 year).	1. Yes 2. No	If **"No"** go to Q.N. 404 & 500

S/N.	QUESTIONS	RESPONSES	SKIP
401	If "Yes" for Q. 400 do you now smoke cigarettes (as of 1 month ago)?	1. Yes 2. No	If "No" go to Q.N. 500
402	If "Yes" for Q. 401, How many cigarettes do you smoke per day now?	_____ cigarettes/day.	
403	For how long did you smoke cigarette?(in years)	_____ years	
404	Is there any person who smoke cigarette in your home?	1. Yes 2. No	
PART V. CHRONIC RESPIRATORY SYMPTOMS			
A. COUGH			
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)			
500	Do you usually have a cough in the morning?	1. Yes 2. No	If "No" (Q.N.500 & 501) go to 505
501	Do you usually cough during the day or at night?	1. Yes 2. No	
502	Do you usually cough for 4 days or more per a week?	1. Yes 2. No	
503	Do you usually cough for 3 consecutive months or more during the year?	1. Yes 2. No	
504	For how long have you had this cough?	_____(Year)	
B. PHLEGM			
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			
505	Do you usually bring up phlegm from your chest?	1. Yes 2. No	If "No" go to Q.N. 507
506	Do you usually bring up phlegm like this as much as twice a day, 4 or more days out of the week?	1. Yes 2. No	
507	Do you usually bring up phlegm at all on getting up in the morning?	1. Yes 2. No	
508	Do you usually bring up phlegm at all during the rest of the day or at night?	1. Yes 2. No	

S/N.	QUESTIONS	RESPONSES	SKIP
509	If "Yes" to any of the above (505, 506, 507, or 508), Answer the following 2 questions: If No to all skip to Q.No. 511. Do you bring up phlegm like this on most days for 3 consecutive months or more during the year?	1. Yes 2. No	
510	For how many years have you had trouble with phlegm?	_____Year	
C. WHEEZING			
Wheezing: a condition causing a whistling sound of the chest on inspiration/expiration when have cold or occasionally apart from colds or most days/night for at least 3 months in a year			
511	Do you have wheeze/whistling/ sound in your chest?	1. Yes 2. No	If "No" go to Q.N. 514
512	Do you have wheeze/whistling/ sound in your chest in most days or nights?	1. Yes 2. No	
513	For how long has this wheezy sound persisted?	_____(Years)	
D. BREATHLESSNESS			
Breathlessness: a condition occurring when hurrying on the level ground or walking up a slight hill for at least 3 months in a year			
514	Are you troubled with shortness of breath when hurrying or walking uphill?	1. Yes 2. No	If "No" go to Q.N. 517
515	If "Yes" for Q.No.514, Have you had trouble of breathlessness while walking with a person of the same age?	1. Yes 2. No	
516	For how long have you been this short of breath?	_____(Years)	
E. CHEST PAIN			
517	In the past three years, have you experienced any chest illness that kept you off duty, or in bed?	1. Yes 2. No	If "No" go to Q.N. 600
518	If you get a cold, does it usually go to your chest?	1. Yes 2. No	
519	Did you produce phlegm with any of these chest illnesses?	1. Yes 2. No	

S/N.	QUESTIONS	RESPONSES	SKIP
PART VI. PERSONAL/RESPIRATORY/ PROTECTIVE EQUIPMENTS			
600	Do you usually wear respiratory protective devices while at work?	1. Yes 2. No	If "No" go to Q.N. 602
601	Which of the following type of protective devices did you use? (more than one answer is possible)	1. Mask respiratory 2. Full face pieces respiratory 3. Breathing apparatus 4. others_____	
602	If Q 601 answer is "No "Select the most appropriate reasons for not using PPE/RPE	1. Not available 2. Not comfortable for work 3. Not comfortable to wear 4. Not provided by institution 5. The dust is not harmful 6. Others specify_____	
PART VII. OCCUPATIONAL HEALTH AND SAFETY TRAINING AND SUPERVISION			
700	Do you ever have occupational health and safety training?	1. Yes 2. No	
701	Do you ever been supervised at work place on occupational safety issues?	1. Yes 2. No	

Annex V: Observational Checklist

S/N	RPE USAGE	RESPONSES		COMMENTS
		Yes	No	
1	Is required equipment provided, and used?			
2	Is there a written procedure for the selection, use and maintenance of RPE?			
3	Is personal protection utilized only when it is not reasonably practicable to eliminate or control the hazardous substance or process?			
4	Are the areas requiring RPE usage properly identified by warning signs?			
WORKPLACE VENTILLATION				
5	Is the work place well ventilated /free fresh air movements?			
6	Is the ventilation system appropriate for the work performed?			
7	Is there dust absorber in the workplace?			

Annex VI: ለቃለ መጠይቅ የሚሰጥ የመረጃ መስጫ

ጤና ይስጥልኝ!

እንደምን አሉ? ስሜ_____ይባላል፡፡እዚህ የተገኘሁት የአዲስ አበባዩኒቨርስቲ ጤና ሳይንስ ኮሌጅ የህብረተሰብ ጤና ሳይንስትምህርት ቤት የድህረ-ምረቃ ተማሪ የሆኑት ተገኘወርቅ ይታየውን ወክዬ ነው። እሳቸውም በመካከለኛ እንጨት ስራ ፋብሪካዎች ውስጥ በሚሰሩ ሰራተኞች ላይ የሚታዩ ስር የሰደደ የመተንፈሻ አካላት ችግር ምልክቶች ዳሰሳ ማድረግ፣ ስር የሰደደ የመተንፈሻ አካላት ችግርና መንስኤዎቻቸውን ማረጋገጥና በሰውነት ዉስጥ ሊገባ የሚችል የእንጨት ኣቧራ/ብናኝ መጠን መለካት ዙርያ ላይ ጥናት በመስራት ላይ ይገኛሉ። ይህንን ጥናት ለማካሄድ ተሳታፊ የሚሆኑትን በሎቶሪ የናሙና አወጣጥ ምልመላ ሲካሄድ እርሶ በዚህ ጥናት እንዲሳተፉ የተመረጡ ስሆን ጥናቱ በሚካሄድበት ወቅት ስር የሰደደ የመተንፈሻ አካላት ችግርና መንስኤዎቻቸውን ዳሳሳ ለማድረግ ደረጃውን የጠበቀ መጠይቅ እጠቀማለሁ፡፡ መጠይቁንም ለመሙላት ከ30 እስከ 45 ደቂቃዎች የሚወስድ በመሆኑና የእርስዎንም ሙሉ ትብብር የሚጠይቅ በመሆኑ ይህንኑ እንዲያደርጉ በታላቅ ትህትና እጠይቅዎታለሁ፡፡

በጥናቱ ላይ በመሳተፍዎ በእርሶ ላይ የሚደርስ ምንም አይነት የጎንዮሽ ጉዳት የሌለ ሲሆን ከጥናቱም የሚያገኙት ምንም አይነት ቀጥተኛ ጥቅም የለም፡፡ ነገር ግን በተዘዋዋሪም ጥናቱ በእንጨት ስራ ፋብሪካዎች በሚሰሩ ሰራተኞች ላይ የሚታዩ ስር የሰደደ የመተንፈሻ አካላት ችግሮች ለመከላከልናለመቆጣጠር ትልቅ አስተዋፅኦ ይኖረዋል፡፡ በተጨማሪም ለቀጣይ ምርምር መሰረት በመሆን ከማገልገሉም ባሻገር ይህንን ጥናት መሰረት በማድረግ መንግስትና የተለያዩ ባለድርሻ አካላት ትኩረት በመስጠት ችግር ላይ የራሳቸው አስተዋፆ እንዲያደርጉ ይረዳል ብዬ አስባለሁ፡፡

የሚሰጡን መረጃ ሁሉም ምስጢራውነቱ የተጠበቀና ቅፅ ላይ ስም አይሰፍርም፡፡ ስለዚህ በጥናቱ መሳተፍምሆነ አለመሳተፍ የእርሶ መብት ነው፡፡ በጥናቱ ላይ መሳተፍ በሙሉ ፈቃደኝነት የተመሰረተ ነው፤ ስለሆነም በጥናቱ ላይ ለመሳተፍም ሆነ ባልተመቸዎት ግዜ ጥናቱ ኣቋርጦ ለመውጣት መብትዎ የተጠበቀ ነው፡፡ እርስዎ የሰጡንመረጃ ከግል ማንነትዎ ጋር ምንም ዓይነት ግኙኝነት የለውም፡፡

ለበለጠ መረጃ፡ ጥናቱ በተመለከተ ማንኛውም ጥያቄ ካለዎት ተገኘወርቅ ይታየው (የጥናቱ ተመራማሪ) በኣዲስ ኣባበ ዩኒቨርሲቲ ጤና ሳይንስ ኮሌጅ የሕብረተሰብ ጤና ትምህርት ክፍል ስልክ ቁጥር +251-9-13-22-75-83 ወይም ዶ/ር ኣበራ ቁሜ ስልክ ቁጥር +251-9-11-88-29-12 ወይም ኣቶ ወርቁ ተፈራ ስልክ ቁጥር +251-9-13-62-05-14 (የጥናቱ ኣማካሪዎች) በኣዲስ ኣባበ ዩኒቨርሲቲ ጤና ሳይንስ ኮሌጅ የሕብረተሰብ ጤና ትምህርት ክፍል ወይም የሕብረተሰብ ጤና ትምህርት ክፍል የስነ-ምግባር ግምገማ ተቋም ስልክቁጥር +251115157701 ደውለው ማነጋገር ይችላሉ፡፡

እባክዎ ጥናቱ በተመለከተ ማንኛውም ግልፅ ያልሆነ ጥያቄ ካለዎት? በጥናቱ ለመሳተፍፈቃደኛ ነዎት?

Annex VII: ለአቧራ መለካት የሚሰጥ የመረጃ መስጫ

ጤና ይስጥልኝ!

እንደምን አሉ, እኔ _____ እባላለሁ፡፡ ከአዲስ አባባ ዩኒቨርሲቲ፣ ጤና ሳይንስ ኮሌጅ ሕብረተሰብ ጤና ትምህርት ክፍል መረጃ ለመሰብሰብ ነው የመጣሁት፡፡ የዚህ ጥናት ዋና ዓላማ በአዲስ አባባ ከተማ አስተዳደር አቃቂ ቃሊቲ ክፍለ ከተማ ከሚገኙት መካከለኛ የእንጨት ስራ ፋብሪካዎች ሰራተኞች ላይ የሚታዩ ስር የሰደደ የመተንፈሻ አካላት ችግር ምልክቶች ዳሰሳ ማድረግ፣ ስር የሰደደ የመተንፈሻ አካላት ችግርና መንስኤዎቻቸውን ማረጋገጥና በሰውነት ዉስጥ ሊገባ የሚችል የእንጨት አቧራ/ብናኝ መጠን መለካት፣ ነው፡፡ በዚህ መሰረት ይህ ጥናት በእንጨት ስራ ፋብሪካዎች ሰራተኞች ላይ የሚታዩ ስር የሰደደ የመተንፈሻ አካላት ችግሮች በመከላከልና መቆጣጠር ትልቅ አስተዋፅኦ ይኖረዋል፡፡ ስለሆነም ይህንን ጥናት መንግስትና የተለያዩ ባለ ድርሻ አካላት በችግሩ ላይ ትኩረት በመስጠት በነኚህ ሰራተኞች ላይ ሊያጋጥም የሚችል ችግር መፍትሄ እንድያስቀምጡ ይረዳል ብየ አስባለው፡፡ ጥናቱ በሚካሄድበት ወቅት የ እንጨት አቧራ/ብናኝ መለኪያ መሳርያ እጠቀማለው፡፡ ጥናቱ ከሕብረተሰብ ጤና ትምህርት ክፍል የስነ-ምግባር ፈቃድ የተሰጠው ነው፡፡ እርስዎ በጥናቱ ስለተመረጡ ስለጥናቱ አስፈላጊውን መረጃ እንዲሰጡኝ በትህትና እጠይቃለሁ፡፡

የእንጨት አቧራ/ብናኝ መለካት አካሄድ: የእንጨት አቧራ /ብናኝ መለኪያ መሳሪያ በሰውነትዎ ላይ እንድያደርጉ በትህትና ይጠየቃሉ፡፡ መሳርያው በመተንፈሻ አካላት ዙርያ የሚደረግ አቧራ መለኪያ የያዘ ሆኖ ወገብ ላይ የሚደረግ ፓምፕ አለው፡፡ ፓምፑ በአቧራ መለኪያ በኩል መተንፈሻ አካላት አካባቢ ላይ ያለውን አየር ለመሳብ የሚያገለግል ነው፡፡ የእንጨት አቧራ /ብናኝ መለኪያ መሳሪያ ከትንሽ ድምፅ በስተቀር በጤና ይሁን በስራ ላይ የሚያመጣው ተፅዕኖ የለም፡፡ የእንጨት አቧራ /ብናኝ የምንለካው ሙሉ የስራ ሰዓት የሚሸፍን ነው፡፡ የጥናቱ ተመራማሪ መሳርያው በሰውነትዎ በማድረግ፣ ፓምፑ በማስጀምርና በማስቆም ይረድዎታል፡፡

ጥናቱ ለተሳታፊዎች በቀጥታ የሚሰጥ ነገር የለውም፡፡ ነገር ግን ከጥናቱ የሚገኝ መረጃ መሰረት በማድረግ የመስተካከል እርምት እንዲወሰድ ይረዳል፡፡ ከዚህ በተጨማሪ በዳሰሳ ግዜ የተገኘውን የብናኙ ደረጃ እናሳውቅዎታለን፡፡ ጥናቱ አቧራ/ብናኝ ለመለካት ከሚፈጅው ግዜ ዉጭ በተሳታፊዎች የሚያስከትለው አንዳች ጉዳት የለም፡፡ በጥናቱ ላይ መሳተፍ በሙሉ ቃደኝነት የተመሰረተ ነው፤ ስለሆነም በጥናቱ ላይ ለመሳተፍም ሆነ ባልተመቸዎት ግዜ ጥናቱ አቋርጦ ለመውጣት መብትዎ የተጠበቀ ነው፡፡ በተሳታፊዎች ላይ የሚገኝ የአቧራ መጠን ከጥናቱ አባላት ዉጭ ለሌላ ማንም ተላልፎ አይሰጥም፡፡ እርስዎ የሰጡን መረጃ ከግል ማንነትዎ ጋር ምንም ዓይነት ግኙኝነት የለውም፡፡ የሰጡንን መረጃ ምስጥራዊነቱ የተጠበቀ ነው፡፡

ለበለጠ መረጃ፡ ጥናቱ በተመለከተ ማንኛውም ጥያቄ ካለዎት ተገኘወርቅ ይታየው (የጥናቱ ተመራማሪ) በአዲስ አባበ ዩኒቨርሲቲ ጤና ሳይንስ ኮሌጅ የሕብረተሰብ ጤና ትምህርት ክፍል ስልክ ቁጥር +251-9-13-22-75-83 ወይም ዶ/ር አበራ ቁሜ ስልክ ቁጥር +251-9-11-88-29-12 ወይም አቶ ወርቁ ተፈራ ስልክ ቁጥር +251-9-13-62-05-14 (የጥናቱ አማካሪዎች) በአዲስ አባበ ዩኒቨርሲቲ ጤና ሳይንስ ኮሌጅ የሕብረተሰብ ጤና ትምህርት ክፍል ወይም የሕብረተሰብ ጤና ትምህርት ክፍል የስነ-ምግባር ግምገማ ተቋም ስልክቁጥር +251115157701 ደውለው ማነጋገር ይችላሉ፡፡

እባክዎ ጥናቱ በተመለከተ ማንኛውም ግልፅ ያልሆነ ጥያቄ ካለዎት? በጥናቱ ለመሳተፍ ፈቃደኛ ነዎት?

Annex VIII: የስምምነት መዋዋያ ቅጽ

ጥጥናቱን በሚካሄደው አካል ስለጥናት በቂ መረጃ ተሰጥቶኛል፡፡ የጥናቱ ዋና ዓላማ በአዲስ አባባ ከተማ አስተዳደር አቃቂ ቃሊቲ ክፍለ ከተማ ከሚገኙት መካከለኛ የእንጨት ስራ ፋብሪካዎች ሰራተኞች ላይ የሚታዩ ስር የሰደደ የመተንፈሻ አካላት ችግር ምልክቶች ዳሰሳ ማድረግ፣ ስር የሰደደ የመተንፈሻ አካላት ችግርና መንስኤዎቻቸውን ማረጋገጥና በሰውነት ዉስጥ ሊገባ የሚችል የእንጨት አቧራ/ብናኝ መጠን መለካት መሆኑን ተረድቻለሁ፡፡ ከዚህም በተጨማሪ ከኔ የሚወሰደው መረጃ በእኔ ላይ ምንም ዓይነት ጉዳት የማያስከትልና መረጃውን ለጥናት ዓላማ ብቻ እንደሚውል ተረድቻለሁ፡፡

ማንኛውም እኔን የተመለከተ መረጃ ሚስጥራዊነቱ የተጠበቀ ነው፡፡ እንደዚሁም በጥናቱ ለመሳተፍ ፍቃደኛ ካልሆንኩ በጥናቱም ለመሳተፍ እንደማልገደድ ነገር ግን በዚህ ጥናት መሳተፌ ለሳይንሳዊ ዕውቀት ጠቃሚ መረጃ የማበርከትና ወደፊትበዚህ ዙሪያ ለሚሰሩ ስራዎች መሰረት የሚሆኑ ግብዓት መስጠት እንደምችል ተረድቻለሁ፡፡ በመሆኑም በዚህ ጥናት ላይ ለመሳተፍ የተስማማሁ መሆኔን በፊርማዬ አረጋግጣለሁ፡፡

የተሳታፊው ፊርማ_____ቀን_____

የመረጃ ሰብሳቢው ስምና ፊርማ_____ቀን_____

Annex IX: Amharic Version Questionnaire

አዲስ አባባ ዩኒቨርሲቲ፣ ጤና ሳይንስ ኮሌጅ፣ የሕብረተሰብ ጤና ትምህርት ክፍል ለጥናቱ ተሳታፊዎች የመረጃ መስጫ

በ 2011 ዓ/ም በአዲስ አበባ ከተማ አስተዳደር አቃቂ ቃሊቲ ክፍለ ከተማ ስር በሚገኙ መካከለኛ የእንጨት ስራ ፋብሪካዎች ውስጥ በሚገኙ ሰራተኞች ላይ የሚታየውን ስር የሰደደ የመተንፈሻ አካል በሽታዎችንና የአቧራ/ብናኝ መጠን ለመወሰን የተዘጋጀ መጠይቅ፡፡

ቃለ-መጠይቅ የተደረገበት ቀን_____

የመጠየቁ ኮድ_____

እባክዎ መልስዎ ከትክክለኛው ኣማራጭ ላይ ሙሉ በሙሉ በሰማያዊ እስክርቢቶ በማክበብ ይመልሱ፡፡ መልስዎ በቁጥርከሆነ እባክዎ ትክክለኛ ቁጥር በተሰጠው ክፍት ቦታ ያስቀምጡ, ለምሳሌ ዕድሜ በዓመት፡፡

ተ/ቁ	ጥያቄ	ምላሾች	ይለፉ
ክፍል አንድ፡ ማህበራዊና ዴሞግራፊያዊ መስፈርት			
100	ፆታ	1. ወንድ 2. ሴት	
101	ዕድሜ	_____ ዓመት	
102	የጋብቻ ሁኔታ	1. ያላገባ/ች 2. ያገባ/ች 3. ተለያይተው የሚኖሩ 4. የፈታ/ች 5. የሞተችበት/ባት	
103	የትምህርት ደረጃ	1. ያልተማረ/ች 2. የመጀመሪያ ደረጃ 3. ሁለተኛ ደረጃ 4. ምስክር ወረቀትና ከዛ በላይ	
104	የወር ገቢ	_____ ብር	
ክፍል ሁለት፡ ያለፈ የስራ ታሪክ			
200	ይህንን የእንጨት ስራ መቼ ጀመሩ?	____/_____ ዓ/ም	
201	አሁን በሚሰሩበት በዚህ ፋብሪካ ስንት ጊዜ ሰሩ?	_____ ዓመት	
202	አሁን በሚሰሩበት ፋብሪካ በቀን ምን ያክል ሰዓትይሰራሉ?	_____(በሰዓት)	
203	አሁን በሚሰሩበት ፋብሪካ በሳምንት ስንት ቀን ይሳራሉ?	_____(በቀን)	
204	በእንጨት ስራ ፋብሪካ ውስጥ ለምን ያህል ጊዜ ሰሩ?	_____(በዓመት/ወር ይግለፁ)	

ተ/ቁ	ጥያቄ	ምላሾች	ይለፉ
205	ከዚህ በፊት ከእንጨት ስራ ውጪ ሌላ አቧራማ የሆነ ስራ ሰርተው ያውቃሉ?	1. አዎ 2. አይደለም	መልስዎ አይደለም ከሆነ ወደ ጥያቄ 207 ይለፉ
206	ለጥያቄ ቁጥር 205 መልስዎ አዎ ከሆነ፣ ለምን ያህል ጊዜ ከዚህ በታች በተጠቀሱት ቦታ ሰርተዋል(በዓመት) (ከአንድ በላይ መልስ ይቻላል)	1. ብረታ ብረት _____ 2. ድንጋይ መፍጫ _____ 3. ማዕድን ማውጣት _____ 4. ወፍጮ ቤት _____ 5. መንገድ ጥርጊያ_____ 6. ሌላ ካለ ይጥቀሱ_____	
207	በእንጨት ስራ ፋብሪካ ሎሎች የስራ ክፍል ውስጥ ከዚህ በፊት ሰርተው ያውቃሉ?	1. አዎ 2. አይደለም	መልስዎ አይደለም ከሆነ ወደ ጥያቄ 209 ይለፉ
208	ለጥያቄ ቁጥር 207 መልስዎ አዎ ከሆነ፣ በየትኛው የስራ ክፍል ሰርተዋል? ለምን ያህል ጊዜ? (ከአንድ በላይ መልስ ይቻላል)	1. መሰንጠቅ _____ 2. ማለስለስ _____ 3. መፋቅ/መቦርቦር _____ 4. ማጽዳት _____ 5. ሌላ ካለ ይጥቀሱ_____	
209	ምግብ በራስዎት ያበስላሉ?	1. አዎ 2. አይደለም	
210	ለጥያቄ ቁጥር 209 መልስዎ አይደለም ከሆነ፣ በሌላ ሰዎች ምግብ በቤትዎ ይበሰላል?	1. አዎ 2. አይደለም	
211	ለጥያቄ ቁጥር 209 ወይም 210 መልስዎ አዎ ከሆነ፣ ምግብ በአብዛኛው የት ይበስላል?	1. እቤትዉስጥ 2. እደጅ ክፍት ቦታ ላይ 3. ኩሽና ወስጥ	
212	ለጥያቄ ቁጥር 209 ወይም 210 መልስዎ አዎ ከሆነ፣ በአብዛኛው ምግብ ለማብሰል ምን ዓይነት የሀይል ምንጭ ይጠቀማሉ? (ከአንድ በላይ መልስ ይቻላል)	1. ከሰል 2. እንጨት 3. ጋዝ 4. ኤሌክትሪክ	
ክፍል ሶስት፡ የቀድሞ የመተንፈሻ አካላት ህመም ታሪክን በተመለከተ			
300	በቀድሞ ሂወትዎ በሃኪም የተነገርዎት የቆየ የሳንባ ችግር ታመው ያውቃሉ?	1. አዎ 2. አይደለም	መልስዎ አይደለም ከሆነ ወደ ጥያቄ 400 ይለፉ
301	ለጥያቄ ቁጥር 300 መልስዎ አዎ ከሆነ፣ የትኛው ዓይነት የጤና ችግር ከዚህ በፊት ገጥመዎት ነበረ (ከአንድ በላይ መልስ ይቻላል)	1. የቆየ የጉሮሮ ቁስለት 2. መተንፈስ የሚያውክ የሳንባ በሽታ 3. አስም 4. የሳንባ ካንሰር 5. የሳንባ ነቀርሳ/ቲቢ 6. የሳንባ ምች 7. ሌላ አይነት ይጠቀስ_____ _____	

ተ/ቁ	ጥያቄ	ምላሾች	ይለፉ
ክፍል አራት፡ ሲጋራ ማጤስ ባህሪ			
400	ሲጋራ አጢሰው ያውቃሉ? (የለም ማለት እስካሁን ድረስ ከ 20 ፓኮ በታች ማጨስ ወይም በቀን ከአንድ ሲጋራ በታች ለአንድ አመት ማጨስ)	1. አዎ 2. አይደለም	መልስዎ አይደለም ከሆነ ወደ ጥያቄ 404
401	ለጥያቄ ቁጥር 400 መልስዎ አዎ ከሆነ፣ አሁን ሲጋራ ያጤሳሉ (ባለፈው አንድ ወር ዉስጥ)?	1. አዎ 2. አይደለም	መልስዎ አይደለም ከሆነ ወደ ጥያቄ 404 ይለፉ
402	ለጥያቄ ቁጥር 401 መልስዎ አዎ ከሆነ፣ በቀን በአማካይ ምን ያህል ሲጋራ ያጤሳሌ?	_____ ሲጋራ በቀን	
403	ለምን ያህል ዓመት ሲጋራ አጤሱ(በዓመት)	_____ ዓመት	
404	በቤትዎ ውስጥ ሲጋራ የሚያጤስ ሌላ ሰው አለ?	1. አዎ 2. አይደለም	
ክፍል አምስት፡ ስር የሰደደ የመተንፈሻ አካላት ችግሮች			
ሀ. ሳል			
ሳል፡ በአንድ አመት ዉስጥ ለሶስት ወር ያህል፣ በቀን ከ4-6 ጊዜ፣ በሳምንት 4 ቀንና ከዛ በላይ ወይም አብዛኛውን ግዜ ጧት ከእንቅልፍዎ ሲነሱ ወይም በተቀሩት የቀን ወይም የሌሊት ሰዓት ሳል ካለዎት		
500	አብዛኛውን ግዜ በጠዋት ያስልዎታል?	1. አዎ 2. አይደለም	መልስዎ አይደለም ከሆነ (ጥያቄ ቁጥር 500 እና 501) ወደ ጥያቄ 505 ይለፉ
501	አብዛኛው ጊዜ ቀን ወይም ሌሊት ያስለዎታል?	1. አዎ 2. አይደለም	
502	አብዛኛው ጊዜ በሳምንት 4 ቀን ወይም ከዛ በላይ ያስለዎታል?	1. አዎ 2. አይደለም	
503	አብዛኛው ጊዜ ለተከታታይ 3 ወርና ከዛ በላይ በአንድ አመት አስሎዎት ያውቃል?	1. አዎ 2. አይደለም	
504	ይህ ሳል ለምን ያክል ጊዜ/ዓመት ነበረብዎት?	_____ዓመት	
ለ. አክታ			
አክታ፡ በአንድ አመት ዉስጥ ለሶስት ወር ያህል በቀን ሁለቴ፣ በሳምንት 4 ቀንና ከዛ በላይ ወይም አብዛኛውን ግዜ ጧት ከእንቅልፍዎ ሲነሱ ወይም አብዛኛውን ግዜ በቀን ወይም በሌሊት አክታ የመውጣት ችግር ካለዎት		
505	አብዛኛውን ግዜ ከደረትዎ አክታ ይወጣል?	1. አዎ 2. አይደለም	መልስዎ አይደለም ከሆነ ወደ ጥያቄ 507 ይለፉ
506	አብዛኛውን ግዜ እንደዚህ አይነት አክታ በቀን 2 ግዜ ወይም በሳምንት 4 ወይም ከዛ በላይ ይወጣል?	1. አዎ 2. አይደለም	
507	አብዛኛውን ግዜ ጧት ከእንቅልፍዎ ሲነሱ ከደረትዎ አክታ ይወጣል?	1. አዎ 2. አይደለም	

ተ/ቁ	ጥያቄ	ምላሾች	ይለፉ
508	አብዛኛውን ግዜ በቀን ወይም በሌሊት አክታ አለዎት?	1. አዎ 2. አይደለም	
509	ከላይ ላሉት ጥያቄዎች (505፣ 506፣ 507 ወይም 508) መልስዎ አዎ ከሆነ፤ የሚከተሉት ሁለት ጥያቄዎች ይመልሱ፡፡ ለሁሉም አይደለም ከሆነ ወደ ጥ.ቁ. 511 ይሂዱ፡፡ በ አንድ ዓመት ዉስጥ እንደዚህ ዓይነት አክታ በአብዛኛው ቀናት ለተከታታይ 3 ወርና ከዛ በላይ ነበረብዎት?	1. አዎ 2. አይደለም	
510	እንደዚህ አይነት አክታ የመውጣት ችግር ከጀመረዎት ስንት ዓመት ሆነዎት?	_____ ዓመት	
	ሐ. የማንኮራፉት ድምፅ በተመለከተ		
የማቃተት ድምፅ፡ በአንድ አመት ዉስጥ ለሶስት ወር ያህል ወደ ዉስጥ ወይም ወደ ዉጭ ሲተነፍሱ ወይም ሲቀዘቅዝዎት ወይም አልፎ አልፎ ከቅዝቃዜ ሲወጡ ወይም አብዛኛው ቀን ወይም ሌሊት ደረትዎ ላይ የማንኮራፈት ወይም የማፏጨት ድምፅ ካለዎት			
511	ከደረት የማንኮራፉት ወይም የማፏጨት ድምፅ ይሰማል?	1. አዎ 2. አይደለም	መልስዎ አይደለም ከሆነ ወደ ጥያቄ 514 ይለፉ
512	አብዛኛውን ግዜ በቀን ወይም በሌሊት ከደረት የማንኮራፉት ወይም የማፏጨት ድምፅ አልዎት?	1. አዎ 2. አይደለም	
513	የማንኮራፉት/የማፏጨት ድምፅ ማሰማት ከጀመሩ ምን ያክል ዓመት ሆነዎት?	_____ ዓመት	
	መ. ትንፋሽ ማጠር		
የትንፋሽ ማጠር፡ በአንድ አመት ዉስጥ ለሶስት ወር ያህል በፍጥነት ሲራመዱ ወይም ኮረብታ ሲወጡ የትንፋሽ መቆራረጥ ችግር ካለዎት			
514	ደረጃ ወደ ላይ ወይም ዳገት/አቀበት ሲወጡ ትንፋሽ ያጥሮታል?	1. አዎ 2. አይደለም	መልስዎ አይደለም ከሆነ ወደ ጥያቄ 517 ይለፉ
515	ለጥያቄ ቁጥር 514 መልስዎ አዎ ከሆነ፤ ከዕድሜ አቻ ከሆኑ ጓደኞችዎ ጋር ሲሄዱ ትንፋሽ የማጠር ስሜት ይሰማዎታል ?	1. አዎ 2. አይደለም	
516	ትንፋሽ ማጠር ከጀረዎት ምን ያክል ዓመት ሆነዎት?	_____ዓመት	
	ሠ. የደረት ህመም		
517	ባለፉት ሦስት አመታት በደረት ህመም ምክንያት ስራ ቀርተዉ ወይም ታመው ተኝተዉ ያዉቃሉ?	1. አዎ 2. አይደለም	መልስዎ አይደለም ከሆነ ወደ ጥያቄ 600 ይለፉ
518	በአብዛኛዉ ለቅዝቀዜ በሚጋለጡበት ጊዜ የደረት ህመም ይሰማዎታል?	1. አዎ 2. አይደለም	
519	የደረት ህመሙ አክታ ኑሮት ያዉቃል?	1. አዎ 2. አይደለም	

ተ/ቁ	ጥያቄ	ምላሾች	ይለፉ
ክፍል 6፡ የብናኝ መከላከያ ትጥቅ አጠቃቀም			
600	በስራ ላይ በሚሆኑበት ወቅት የብናኝ መከላከያ ይጠቀማሉ?	1. አዎ 2. አይደለም	መልስዎ አይደለም ከሆነ ወደ ጥያቄ 602 ይለፉ
601	ለጥያቄ ቁጥር 600 መልስዎ አይደለም ከሆነ፣ ከሚከተሉት ዉስጥ የትኛዉን መከላከያ ይጠቀማሉ? (ከአንድ በላይ መልስ ይችላል)	1. የአፍ/አፍንጫ መሸፈኛ 2. ጭምብል (የፊትመሸፈኛ) 3. የአየር ማጣሪያ መሳሪያ 4. ሌላ ካለ ይጥቀሱ_____ ___	
602	ለጥያቄ ቁጥር 600 መልስዎ አይደለም ከሆነ፤ የብናኝ መከላከያ ልብስ የማይለብሱበት ምክንያቱ ምንድን ነዉ?	1. ጭራሽ ስለሌለ 2. ለስራ ስለማይመች 3. ለመልበስ ስለማይመች 4. በማስሪያ ቤት ስለማይቀረብ 5. ጎጅ ብናኝ ስለሌለ 6. ሌላ ካለ ይጥቀሱ_____	
ክፍል 7፡ የስራ ላይ ጤናና ደህንነት ስልጠና፣ ክትትልና ድጋፍ			
700	የስራ ደህንነትና ጤና ስልጠና ወስደው ያውቃሉ?	1. አዎ 2. አይደለም	
701	በስራ ደህንነት ጤና ጉዳዮች ላይ ክትትልና ድጋፍ ተደርጎሎት ያውቃል?	1. አዎ 2. አይደለም	

Annex X: Wood dust concentration

Table 10: Personal total dust exposure among woodworkers in medium scale woodwork factories in Akaki Kality sub city, Addis Ababa, 2019 (n=40)

Sampling code	Sampling Time (min)	Average flow rate (lit/min)	Volume of air (m3)	Net weight of dust (mg)	Dust concentration (mg/m3)
WDSW01	117	2.0	0.234	3.21	13.72
WDSW02	166	2.0	0.332	4.20	12.65
WDSW03	118	2.0	0.236	3.43	14.53
WDSW04	161	2.0	0.322	3.82	11.86
WDSW05	142	2.0	0.284	4.82	16.97
WDSW06	161	2.0	0.322	5.78	17.95
WDSW07	125	2.0	0.250	2.62	10.48
WDSW08	137	2.0	0.274	2.19	7.99
WDSW09	146	2.0	0.292	3.23	11.06
WDSW10	153	2.0	0.306	1.73	5.65
WDSW11	98	2.0	0.196	1.17	5.97
WDSW12	158	2.0	0.316	1.36	4.30
WDSW13	156	2.0	0.312	3.96	12.69
WDSW14	159	2.0	0.318	5.51	17.33
WDSW15	137	2.0	0.274	7.19	26.24
WDSW16	152	2.0	0.304	6.52	21.45
WDSW17	148	2.0	0.296	7.22	24.39
WDSW18	146	2.0	0.292	2.59	8.87
WDSW19	157	2.0	0.314	1.75	5.57
WDSW20	162	2.0	0.324	1.69	5.22
WDSA21	128	2.0	0.256	1.21	4.73
WDSA22	158	2.0	0.316	1.55	4.91
WDSA23	109	2.0	0.218	5.16	23.67
WDSA24	142	2.0	0.284	1.37	4.82
WDSA25	98	2.0	0.196	3.05	15.56
WDSA26	150	2.0	0.300	4.32	14.40
WDSA27	167	2.0	0.334	4.20	12.57
WDSA28	156	2.0	0.312	2.32	7.44
WDSA29	158	2.0	0.316	2.92	9.24
WDSA30	154	2.0	0.308	3.06	9.94
WDSA31	153	2.0	0.306	1.37	4.28
WDSA32	141	2.0	0.282	3.46	12.27
WDSA33	151	2.0	0.302	6.01	19.90
WDSA34	148	2.0	0.296	1.98	6.69

Sampling code	Sampling Time (min)	Average flow rate (lit/min)	Volume of air (m3)	Net weight of dust (mg)	Dust concentration (mg/m3)
WDSA35	164	2.0	0.328	7.04	21.46
WDSA36	157	2.0	0.314	4.10	13.06
WDSA37	160	2.0	0.320	3.22	10.06
WDSA38	162	2.0	0.324	2.46	7.59
WDSA39	141	2.0	0.282	1.97	6.99
WDSA40	91	2.0	0.182	1.04	5.71
Max	167	2.0	0.334	7.22	26.24
Min	91	2.0	0.182	1.04	4.28
Range	76		0.152	6.18	21.94
AM	144.68	2.00	0.289	3.40	11.75
SD	19.73		0.039	1.80	6.13
GM	143.16		0.286	2.94	10.27
GSD	1.17		1.165	1.74	1.71

AM- arithmetic mean, G.M- geometric mean, GSD- geometric standard deviation, Max- maximum value, Minimum value, SD- standard deviation

Note: Sampling date- 13th May -16th May, 2019 and 20th May -23rd May, 2019.

Table 11: Total wood dust exposure level by task (department) among woodworkers in medium scale woodwork factories in Akaki Kality sub city, Addis Ababa, 2019 (n=40)

Task	AM±SD(mg/m^3)	GM±GSD(mg/m^3)
Sawing	12.06±6.72	10.40±1.76
Sanding	11.45±5.64	10.14±1.68

Annex XI: Personal Dust Sampling Demonstration

Figure 11: Dust sampling demonstration of woodworkers in medium scale woodwork factories in Akaki Kality sub city, Addis Ababa, 2019

Figure 12: Working condition in various sections of medium scale woodwork factories in Akaki Kality Sub City, Addis Ababa, 2019

Figure 13: Dust sampling equipments used among woodworkers in Akaki Kality Sub City Addis Ababa 2019.

Declaration

I, the undersigned declared that this my original work, has not been presented for degree in this or other university and that all sources of materials used for this thesis has been fully acknowledged.

Name: Tegegnework Yitayew

Signature _____ Date_____

Place: Addis Ababa University

Date of submission_____

This thesis has been submitted for examination with my approval as university advisor,

Name: Abera Kumie (MD, MSc, Ph.D.)

Signature _____