



**ADDIS ABABA UNIVERSITY
COLLEGE OF HEALTH SCIENCES
SCHOOL OF PUBLIC HEALTH**

**Assessing Personal Dust Exposure and Chronic Respiratory Health Symptoms
among Street Sweepers in Addis Ababa, Ethiopia, 2017/18**

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Addis Ababa University
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Abbreviations and acronyms

AACSAA	Addis Ababa City Sanitation Administration Agency
ACGIH	American Conference of Governmental Industrial Hygienist
AM	Arithmetic Mean
AOR	Adjusted Odds Ratio
ATS	American Thoracic Society
CFC	Closed Filter Cassette
COR	Crude Odds Ratio
GM	Geometric Mean
GSD	Geometric Standard Deviation
ICD	International Classification of Disease
ILO	International Labor Organization
NCD	Non-communicable Disease
NIOSH	National Institute for Occupational Safety and Health
NORAD	the Norwegian Agency for Development Cooperation
NORHED	the Norwegian Programme for Capacity Development in Higher Education and Research for Development
OEL	Occupational Exposure Limit
OR	Odds Ratio
PI	Personal Investigator
PNOS	Particles Not Otherwise Specified
PPE	Personal Protective Equipment's
PPS	Population Proportion to Size
PVC	Polyvinyl Chloride
SD	Standard Deviation
SEG	Similar Exposure Groups
SKC	Scientific Kit Corporation
SOP	Standard Operating Procedure
TB	Tuberculosis
TLV	Threshold Limit Value
URTI	Upper Respiratory Tract Infections

Abstract

Background: Street sweeping dust is the determinant of the occurrence of respiratory symptoms among street sweepers who do not use the appropriate personal protective equipment. Therefore, the aim of this study was to assess personal street dust exposure, prevalence and associated factors of chronic respiratory health symptoms among street sweepers in Addis Ababa, Ethiopia.

Methods and materials: A cross-sectional study was conducted among a sample of 570 randomly selected street sweepers in Addis Ababa in 4 selected sub-cities using an American Thoracic Society respiratory symptoms questionnaire with a few modifications from March 17-May 13, 2018. 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. A total of 50 personal dust measurements among 25 randomly selected street sweepers were done from the selected sub-cities by fixing dust samplers around the breathing zone. Gravimetric analysis of filters was done before and after dust sampling using a standard micro-balance. 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: In this study, the prevalence of chronic respiratory health symptoms among street sweepers was 70.3% with prevalence of a cough (28.3%), phlegm (24.7%), wheezing (18.0%), breathlessness (44.9%), nose irritation (28.8%), and sneezing (37.1%). None of the participants used respiratory protective devices, while the wearing of nose/mouth mask was reported 11.5%. Chronic respiratory health symptoms among street sweepers were significantly associated with age (AOR=2.29, 95% CI; 1.21-4.34), working hours per day (AOR=1.91, 95% CI; 1.21-3.02) and wear of nose/mouth mask (AOR=0.42, 95% CI; 0.24-0.73). The GM (\pm GSD) dust exposure level (n=50) of the street sweepers was $10.14 (\pm 1.43) \text{ mg/m}^3$. This 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 street sweepers. The street sweepers were exposed to street dust level above the recommended occupational exposure level. Addis Ababa city sanitation administration agency should provide adequate and high-quality respirator devices and watering the street surface before sweeping is highly recommended. Further studies using strong study design in comprehensive streets of Addis Ababa are highly recommended.

1. INTRODUCTION

1.1 Background

Street sweeping is an occupation related to the cleaning of waste materials thrown at public roads and streets. It is considered harmful due to the close contact that exposes employees to a number of risk factors such as dust, bio-aerosol, volatile organic matter, spores, and microorganisms existing in the municipal waste, which make them liable to occupational diseases. Street sweeping dust is the determinant of the occurrence of respiratory health symptoms among street sweepers who do not use appropriate PPE. Exposure to dust particles irritated the respiratory tract which leads to varying degrees of respiratory health symptoms (1–3). The dust dispersed in the air during street sweeping is not only affecting the street sweepers but also to individuals who have exposure to that street (4).

Street sweepers have a great role in keeping the cleanliness of the municipalities. However, the nature of the job such that workers are exposed to dust that is generated during sweeping activity. Most of the time, people engaged in street sweeping are those with low socio-economic status, low educational status and live in poor housing condition (5).

Around 6% of the total waste generated in Addis Ababa municipality comes from the street and public areas. Street sweeping in Addis Ababa is carried out both mechanically and manually. However, the largest part of Addis Ababa streets (about 2,031 km) i.e., 134 km level one road which cleaned three times a day, 1010 km level two road which cleaned twice a day, and 887 km level three road which cleaned ones a day are cleaned manually using sweeping equipment's such as traditional brooms, shovels, handcarts etc. (6). To perform this activity around 5,000 street sweepers are employed by Addis Ababa City Sanitation Administration Agency (AACSA). These employees are grouped in a team of 3 – 6 individuals per team and clean 2.0 – 2.5 km for each team. Sweeping is commonly taking place in the early morning (4:30 - 8:00 am) and in the afternoon (2:00 - 5:00 pm). This activity has a great contribution to increasing the scattering of the dust level in the air. Moreover, there are supervisors who control the efficiency and outcome of the activity. They also facilitate the logistic issues and take workers attendance.

1.1 Statement of the Problem

Globally, NCDs are the leading causes of death. From the 56 million total deaths occurred in the world, 38 million (68%) were due to NCDs, chiefly cardiovascular diseases (46.2%), cancers (21.6%), chronic respiratory diseases (10.7%) and diabetes (4%). Approximately three-quarters of all NCD deaths occur in developing countries (7,8).

Chronic respiratory diseases cause a serious public health problem in all countries of the globe; specifically, over 500 million of these individuals live in developing countries and underprivileged inhabitants (9–11). Occupational respiratory illnesses account for up to 30% of all recorded work-related diseases. It also estimates for up to 50% occurrence among workers in high-risk sectors such as mining, construction, and dust generating works. ILO (2011) addresses annual work-related deaths; i.e., cancer (32%), circulatory diseases (23%), accidents and violence (18%), respiratory diseases (8%), and communicable diseases (7%) (12). Work-related respiratory symptoms are broadly abundant in low financial gain regions of Africa like Ethiopia. In Ethiopia, the total death of NCDs was estimated to account for 691,000 individuals (30%), with cardiovascular diseases (9%), cancers (6%), chronic respiratory diseases (3%), diabetes (1%) and other NCDs (11%) (13).

Street sweeping occupation is linked with exposure to chemicals and dust such as organic and inorganic dust, bio-aerosol, volatile organic matter and fumes which could arise during vehicular movement, sweeping with brooms, by wind and other human activities. It involves a health problem to street sweepers that don't take the essential actions to prevent inhalation of dust such as utilization of appropriate nose/mouth masks by exposing to street dust (14). A study conducted in one street of Addis Ababa (Bole Brass street) indicated significantly higher arithmetic mean of dust level in street sweepers ($12.87 \pm 4.91 \text{mg/m}^3$) as compared to the ACGIH TLV recommendation for total dust (10mg/m^3) (4). Exposure to high street dust can cause respiratory health diseases due to the inhalation of particulate matter such as vehicular emissions, dust originating from soil, plant fragments and other biological materials (15). Due to that, the prevalence of respiratory symptoms among those workers was high (54.3%) with a cough 43.3%, phlegm 24.8%, wheezing 19.3%, breathlessness 17.8% and chest coldness 14.9% (16).

Several studies have shown an association between exposures to the high concentration of dust with respiratory conditions in different working environments (17–21). However, concerning

street sweeping occupation a few studies conducted which deal only the morbidity profile (16,22) and one study has demonstrated street dust exposure level among street sweepers (4) in the study area. This indicates that no combined study has done to assess both street dust exposure concentration and chronic respiratory health problems among the street sweepers. So, in order to overcome this gap, this study aims to assess personal dust exposure and prevalence of chronic respiratory health symptoms among street sweepers in Addis Ababa, Ethiopia.

1.1 Significance of the Study

The findings from this study will benefit street sweepers 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 sanitation administration agency (AACSSAA) to develop appropriate workplace intervention measures to protect the health of street sweepers. Also government, non-government, industries, authorities, and policy makers may use the recommendation from this study in developing strategies and enforce legislation for further improvement.

Findings from this research can also contribute to the body of knowledge and formulate the basis for other research on street sweeping as occupational and other health effects to human and environment.

2. LITERATURE REVIEW

Work-related disorders are the main cause of health problems in worker population. One of the main problems comes across dusty occupation is respirable dust ($<10 \mu\text{m}$). Exposure to those dust is associated with an increase in morbidity and death from respiratory disease (23).

Individuals working in street sweeping are suffering from respiratory and non-respiratory symptoms that may lead to adverse health effects. Some of the respiratory symptoms are sneezing, cough, wheezing, chest pain, dyspnea, phlegm, and nose irritation, whereas non-respiratory symptoms are skin lesion, eye irritation, conjunctivitis (5).

2.1. Prevalence of Respiratory Health Symptoms in Work Places

In 2016, a study done among 60 sweepers and 60 controls in Jalandhar city (Punjab), India reported that high prevalence of symptoms of chronic bronchitis was observed for street sweepers (24).

The study done in India (2014) revealed that the prevalence of respiratory health symptoms were significantly higher among female street sweepers with symptoms of nose irritation (50%), sneezing (46.6%), rhinitis (40%), cough (36.6%), phlegm (26.65%), and wheezing (23%), $p < 0.05$. Dyspnea was higher among the street sweepers (13.3%) but not significant, $p > 0.05$ (5).

In Calabar- Nigeria, a comparative cross-sectional study conducted among 200 street sweepers and 200 controls who worked for less than two years revealed a significantly higher frequency of respiratory complaints among street sweepers than the control group, mainly cough (25.5 vs. 12.0%), chest pain (13.0 vs. 4.0%), catarrh and sneezing (6.0 vs. 0.5%), $p < 0.01$ (14).

A study on respiratory morbidity among street sweepers working at Hanumannagar Zone of Nagpur Municipal Corporation, Maharashtra revealed that the proportion of chronic respiratory morbidity (chronic bronchitis, bronchial asthma, and bronchiectasis) was significantly higher among street sweepers (8.1%) than the comparison group (2.1%), $p = 0.0157$ (2).

In India (2008), a cross-sectional study on morbidity pattern in street sweepers showed that the common morbid conditions were anemia (20.5%), respiratory system (15%), cardiovascular system (9.9%), hypertension (9.5%) and eyes (9.2%). But, according to ICD 10 System of

Disease Classification, URTI (7.3%), chronic bronchitis (5.9%), and bronchial asthma (1.8%) were the main morbid conditions affecting the respiratory system of the street sweepers (3).

A study carried out on Tanzania among 102 street sweepers indicated that the prevalence of respiratory health symptoms was significantly high with a cough (54.9%), phlegm (39.2%), wheezing (32.4%), nose irritating (36.3%), and sneezing (63.7%), $p < 0.05$. However, breathlessness (31.4%) showed no significant difference in the street sweepers, $p > 0.05$ (1).

A study carried out on 138 street sweepers and 127 university workers in Egypt, Beni- Suef district showed that street sweepers had significantly higher rates of respiratory complaints such as chronic productive cough (18.1 vs. 7.1%) and history of bronchial asthma (3.6 vs. 3.1%) compared to the comparison group respectively, $p = 0.02$ (25).

The study done in Egypt, Abbasia district found that street sweepers had significantly more prevalence of a chronic cough (17.5 vs. 5.8%), but a significantly lower prevalence of wheezing (1.0 vs. 23.1%), with $p < 0.05$ as compared to the control groups. Regarding chest tightness, no statistically significant differences were found between both groups, $p > 0.05$ (26).

A study performed in Dejen cement factory, Ethiopia, showed that the cumulative chronic respiratory symptoms were more prevalent among the workers (62.9%) with a cough (24.5%), wheezing (36.9%), phlegm (24.5%), chest pain (21.0%) and shortness of breath (38.6%) (27).

A community based cross-sectional study undertaken among 208 street sweepers and 203 petty traders in Addis Ababa showed the overall prevalence of chronic respiratory health symptoms was significantly higher among street sweepers 113(54.3%) compared to the unexposed group 51(25.12%) with cough (43.3%) vs. (15.3%), phlegm (24.8%) vs. (9.4%), wheezing (19.3%) vs. (5.4%), breathlessness (17.8%) vs. (6.4%) and chest coldness (14.9%) vs. (3.9%), $p < 0.05$ (16).

A study done in Addis Ababa street sweepers disclosed that the cumulative prevalence of respiratory symptoms were 279(68.9%), with cough 180(44.4%), breathlessness 137(33.8%), the sign of eye discomfort 193(47.7%), sneezing 181(55.3%), and nose irritation 134(33.1%) (22).

2.2. Dust Level among Street Sweepers

A study done in Ghaen (Iran) showed that the AM of personal respirable dust among the exposed group is 11.96 mg/m^3 (SD = 14.69) which is exceeded the recommended TLV based on the

ACGIH for nuisance respirable particles (5 mg/m^3). However, the value in the comparison group is 0.93 mg/m^3 that is below the ACGIH TLV of 5 mg/m^3 (17).

Likewise, the study conducted in Tehran, Iran, showed that the GM of total dust concentration for highly exposed workers is 16.55 mg/m^3 that is beyond for low exposed workers (0.9 mg/m^3) and recommended TLV of ACGIH (10 mg/m^3) (18).

Ehsan *et al.* (2015) conducted a study among 100 cement dust workers and 120 unexposed workers of cement industry in Mashhad, Iran. The exposed workers had a GM of 23.13 mg/m^3 inhalable dust exposure, which is exceeded the TLV of 10 mg/m^3 for inhalable particles (19).

A study among 200 street sweepers and 200 controls in Calabar- Nigeria revealed that respirable dust concentration among street sweepers was significantly higher ($0.194 \pm 0.002 \text{ mg/m}^3$), $p < 0.001$) in comparison with the non-exposed groups ($0.015 \pm 0.003 \text{ mg/m}^3$). All the measurements were not exceeded the TLV of ACGIH (10 mg/m^3) (14).

A study done on Dire Dawa cement factory found that the total dust concentration was high in the exposed workers [crusher (38.6 mg/m^3) and packing (18.5 mg/m^3)] as compared to the ACGIH TLV of 10 mg/m^3 and unexposed workers (0.4 mg/m^3) (20).

Personal measurements of total dust undertaken among 105 and 46 randomly selected workers in 2009 and 2010 that indicated the total GM dust exposure among the exposed groups (432 mg/m^3) exceeded the ACGIH TLV of 10 mg/m^3 for inhalable particles not otherwise specified (PNOS) (21).

A study conducted in one street of Addis Ababa (Bole Brass street) revealed that the arithmetic mean (SD) and the median (IQR) of personal overall dust concentration among 10 street sweepers was 12.87 mg/m^3 (4.91) and 10.71 mg/m^3 (7.43), respectively which was significantly higher than the recommended TLV based on the ACGIH for total dust (10 mg/m^3) (4).

2.3. Predictors of Respiratory Health Symptoms among Street Sweepers

2.3.1. Dust and Respiratory Health Symptoms

Street sweepers sweep waste materials thrown at public streets and they accomplish it in an open environment. Due to that, they are exposed to different types of health problems (1).

The occupation-related lung diseases in sweepers are most likely due to the deposition of harmful airborne dust particles that are inhaled during sweeping (28).

Street sweeping dust consists of organic and inorganic particles which may cause adverse health effects. Hence, street sweeping dust is the main predictor in the contribution of respiratory health symptoms including a cough, phlegm, wheezing, sneezing and nose irritating among street sweepers who do not wear appropriate PPE with a statistically significant association, $p < 0.05$ (1).

Also, the study carried out in India among street sweepers showed that occupational exposures to dust among sweepers and sweeping without precautionary measures can cause respiratory and non-respiratory health symptoms. There is a strong association between the level of exposure to street dust and diminishing lung function parameters (5).

A study done in Jalandhar city (Punjab) concluded that the lung disease in sweepers is due to the deposition of airborne dust particles in airways which leads to exacerbation of immune responses of the epithelium to antigens (24).

A study carried out in India reported that exposure to high level of street dust among sweepers has a direct irritating effect on the respiratory organs, causing to some degree of lung function diminishing (15).

A comparative study carried out in Cairo, Egypt reported that exposure to dust caused by street sweeping, traffic exhaust particles, fumes, and other biological materials may lead to respiratory complaints such as a cough (26).

2.3.2. Socio-Demographic Factors and Respiratory Health Symptoms

Socio-demographic is a total measure of an individual's or family's demography and social position in relation to others. It is based on measures such as age, sex, income, education, occupation, and housing condition in social organization. It is a contributing factor for health and is well known to play a great role in the development of several diseases such as respiratory diseases (29), with lower socio-demographic status being associated with higher rates of morbidity and mortality from several chronic diseases, comprising cardiovascular disease, chronic bronchitis and chronic obstructive pulmonary disease (30).

2.3.2.1. Age and Respiratory Health Symptoms

A study done in Hanumannagar Zone of Nagpur Municipal Corporation reported that majority of the participants laid in the age group of 30 - 50 years (3).

The study conducted in India revealed that the proportion of chronic respiratory morbidity among street sweepers increases with increase in age of participants, $p < 0.05$ (2).

Study on Tanzania street sweepers reported more phlegm 7(63.6%) at age of above 61 years and wheezing 10(50.0%) at the age group of 18 – 35 years with a statistically significant difference, $p < 0.05$. But, more respiratory symptoms including cough 23(65.7%) at the age group of 51 – 60 years, sneezing 15(75.0%) at 18 – 35 years, nose irritating 17(47.2%) at 36 – 50 years, and breathlessness 4(36.4%) at 61 years and above were reported, but not statistically significant, $p > 0.05$ (1).

The study undertaken in Addis Ababa showed that street sweepers aged above 47 years were more likely to develop chronic respiratory symptoms (AOR = 1.382, 95% CI; 1.176 - 10.861) compared to those in the age group of 18–32 years old, $p < 0.05$ (16).

In addition to this, street sweepers with an age group of 27-37 and 38-48 years old were more likely to develop respiratory symptoms than sweepers with age group < 27 years, i.e., (AOR = 2.65, 95% CI; 1.362 - 5.166) and (AOR = 2.051, 95% CI; 1.018 - 4.13), respectively (22).

However, the study done in India female street sweepers showed that age of study participants had no significant differences between the sweepers and the healthy participants, $p = 0.91$ (15).

2.3.2.2. Sex and Respiratory Health Symptoms

Sex of study participants has an effect on the occurrence of respiratory health symptoms. A study conducted in Addis Ababa indicated that female sweepers were more likely to develop respiratory health symptoms (AOR = 2.188, 95% CI; 1.143 - 4.189) than males (22).

On the other hand, a study done in India revealed that sex of study participants has no significant difference between the sweepers and the comparison groups (5).

2.3.2.3. Educational Status and Respiratory Health Symptoms

Education contributes a great role in social and economic development. It enhances capabilities and is intensely connected with various socio-economic variables such as lifestyle and income for both individuals and societies. Also, level of education influences the type of occupation and income which can determine the home living condition. Education is an important factor influencing an individual's attitudes and awareness related to health and hygiene (31).

Street sweepers who had not attended school were more reported cough 34(64.4%) and phlegm 25(51.0%) symptoms, compared to that were attended school and the difference was statistically significant, $p < 0.05$. Also, respiratory symptoms including wheezing 20(40.8%), nose irritating 20(40.8%), sneezing 36(73.5%) and breathlessness 19(38.8%) were reported high among workers who did not attend school compared with those who had attended school, but the difference was not statistically significant, $p > 0.05$ (1).

Besides, workers whose education level was primary and below were more likely to develop chronic respiratory symptoms than workers whose education level was diploma and above (AOR = 4.07, 95 % CI; 1.86 - 8.92) (27).

But, according to the study done in Addis Ababa street sweepers no significant association was observed between respiratory health symptoms and educational status (22).

2.3.3 Work Place Characteristics and Respiratory Health Symptoms

2.3.3.1 Duration of Employment and Respiratory Health Symptoms

Study done in India revealed that sweepers with duration of employment more than 10 years had significantly higher occurrence of respiratory symptoms like sneezing (76.92% vs. 23.52%), nose irritation (76.92% vs. 29.41%), cough (61.54% vs. 17.64%), phlegm (46.15% vs. 11.76%), and rhinitis (61.54% vs. 23.52%) as compared to the sweepers worked for less than 10 years, $p < 0.05$. On the other hand, respiratory symptoms such as wheezing (46.15% vs. 11.76%) and dyspnea (15.38% vs. 11.76%) were higher among street sweepers who had above 10 years work experience than those who worked less than 10 years with no statistically significant difference, $p > 0.05$ (5).

The study carried out in Maharashtra, Hanumannagar Zone revealed that the risk of having chronic respiratory morbidity among street sweepers increased significantly with increasing employment duration (OR = 1.75, 95% CI; 1.09 - 2.81), $p = 0.021$ (2).

The study conducted on Tanzania street sweepers showed that respiratory symptoms such as a cough (63.0%), phlegm (44.4%), wheezing (40.7%), nose irritating (42.6%), sneezing (66.7%) and breathlessness (37.0%) were high for those who worked more than 5 years compared with those who worked 1 –5 years, even though it was not statistically significant, $p > 0.05$ (1).

A study done in Addis Ababa reported street sweepers with above 5 years of employment service had 6.418 times more likely to develop chronic respiratory symptoms (AOR = 6.418, 95% CI; 1.604 - 25.686) compared to individuals who had 1- 5 years of working service, $p < 0.05$ (16).

2.3.3.2 Previous Dust Exposure and Respiratory Health Symptoms

Street sweepers with more than 5 years past dust exposure showed more respiratory health symptoms including wheezing (38.7%) and breathlessness (41.9%), even if it was not statistically significant, $p > 0.05$. But, cough (61.2%), phlegm (40.8%), nose irritating (38.7%) and sneezing (67.3%) were reported more for sweepers who had less than 5 years past dust exposure (1).

Additionally, street sweepers with the history of previous dust exposure had the risk of 2.696 times more likely to develop chronic respiratory symptoms (AOR = 2.696, 95% CI; 1.278-5.685) than those with no previous dust exposure history (16).

2.3.3.1. Working Hours/Day, Working Days/Week and Respiratory Health Symptoms

A study carried out in Addis Ababa street sweepers revealed that long duration of working hours per a day and working above 5 days per a week were contributing factors for the occurrence of respiratory health symptoms among street sweepers, but not statistically significant (22).

A study conducted in Tanzania street sweepers showed working for 5 – 8 hours per a day had statistically high respiratory symptoms such as nose irritating (39.5%) and sneezing (68.6%) compared to those who were working for ≥ 9 hours per a day, $p < 0.05$ (1).

A study done in Addis Ababa revealed that street sweepers who work above 5 hours per a day were more likely to develop chronic respiratory symptoms (AOR = 3.925, 95% CI; 2.060 - 7.477) than those who work \leq 5 hours per a day (16).

2.3.4. Availability and Utilization of Personal Protective Equipment's and Respiratory Health Symptoms

In 2012, a study conducted among Tanzania street sweepers revealed that the availability of PPE was moderate, but the wearing of PPE was low. For example, coverage and utilization of nose/mouth mask was 70.6% and 61.8% respectively, even if nose/mouth mask utilization and respiratory health symptoms were not significantly associated, $p > 0.05$ (1).

A study on Calabar- Nigeria revealed that the street sweepers rarely used any protective devices such as face masks and were exposed to a high dust level generated at the test sites may have contributed to increases in the prevalence of respiratory and non-respiratory symptoms (14).

A cross-sectional study conducted among street sweepers in Nagpur, Maharashtra, India showed that none of the study participants were reported using protective devices such as face masks, goggles, boots, or gloves while on duty (3).

Similarly, a study done at Beni-Suef, Egypt disclosed that none of the street sweepers were using protective devices such as face masks, goggles, gumboots or gloves during working (25).

Similarly, the study conducted at Cairo, Egypt revealed that none of the street sweepers were using protective devices such as face masks, goggles, gumboots or gloves during working (26).

A study on Addis Ababa street sweepers indicated that wearing of nose/mouth mask was 57.7%. Even though 57.7% of the sweepers were nose/mouth mask users, there was no statistical association between chronic respiratory symptoms and nose/mouth mask wearing, $p > 0.05$ (16).

Moreover, the study done in Addis Ababa street sweepers showed that only 12% of the street sweepers used a piece of cloths as a respirator while on duty. So, poor use of PPE was contributing factors for the occurrence of respiratory symptoms among street sweepers, but not statistically significant (AOR = 4.167, 95% CI; 0.522 - 33.247) (22).

2.3.5. Smoking and Respiratory Health Symptoms

Smoking is a well-known determinant factor causing chronic bronchitis that is the main health problem occurred among street sweepers. Sabde YD and Zodpey SP *et al.* showed that percentage of smokers among street sweepers (17.90%) was higher compared with the non-exposed group (10.46%) (3).

A study on cement production workers presented smoking contributed to increasing the prevalence of respiratory symptom and reduction of lung function indices (32).

A comparative study done in Cairo, Egypt indicated the proportion of smokers among the sweepers and the control groups were 35% and 45.2%, respectively (26).

Street sweepers at Beni-Suef, Egypt have a significantly higher prevalence of smoking (30.4% vs. 18.1%) compared to the university workers, $p = 0.001$ (25).

A study done in Iran revealed that the prevalence of smoking among the exposed workers was 18% with a pack - year range of 0 - 15 pack - year. However, smoking behaviors have no significant difference between the exposed and non-exposed groups (18).

A study done at Addis Ababa street sweepers reported smoking behavior was not associated with chronic respiratory symptoms, $p > 0.05$. Only 2.9 % of the workers were cigarette smokers (16).

2.3.6 Previous Respiratory illness and Respiratory Health Symptoms

Street sweepers who had past history of respiratory illness reported more respiratory health symptoms compared with those who had no past history of respiratory illness (57.1% vs. 42.9%) respectively, with no statistically significant difference, $p > 0.05$ (1).

A study carried out in Addis Ababa reported that street sweepers had past history of respiratory illnesses such as asthma 60(23%), bronchitis 55(22%), emphysema 42(16%), heart attack 75(29%) and TB 26(10%). Even though a number of past respiratory illnesses were reported, earlier respiratory diseases such as emphysema (AOR = 2.53, 95% CI; 1.072 - 5.97) and TB (AOR = 2.24, 95% CI; 1.584 - 3.065) were the contributing factors for respiratory symptoms among street sweepers (22).

Another study done among Addis Ababa street sweepers stated that past history of respiratory illnesses was not associated with chronic respiratory symptoms, $p > 0.05$. Past history of chronic respiratory illnesses was reported by 32(15.4 %) street sweepers (16).

2.3.7. Energy source used at home and Respiratory Health Symptoms

About 104 (25.7 %) of the study participants used clean energy sources, of which 33(8.2 %) and 71(17.6 %) used electricity and fuel gases (kerosene) at home, respectively (22).

A community based cross-sectional study done in Addis Ababa showed that under-five children from households that used biomass (fuelwood, dung cakes, residues and/or charcoal) for cooking were 2.96 times more likely to develop acute respiratory infections in relative to under-five children from households that used clean fuels (electric and LPG or liquefied petroleum gas) (AOR= 2.96, 95% CI; 1.38-3.87). Regarding households usage of fuel; 145(34.4%) charcoal, 89 (21.1%) woodfuel, 18 (4.3%) urban residues and leaves, 76(18.0%) kerosene, 10 (2.4%) LPG or liquefied petroleum gas, and 82 (19.4%) electricity (33).

Likewise, out of 59 sampled households in Addis Ababa reported that 39(66%) used biomass fuels or traditional fuels (including fuel wood, charcoal, dung, cakes), 9(15%) used kerosene and the remaining 11(19%) used clean fuels (including electricity and LPG or liquefied petroleum gas) as the main source of energy (34).

Conceptual Framework

By considering the above reviews chronic respiratory health symptoms and dust exposure among street sweepers were summarized on the conceptual framework presented below (figure 1). This conceptual framework was developed by assuming respiratory health symptoms of street sweepers will also be related to those factors as reviewed from the literature. As indicated in the conceptual framework chronic respiratory health symptoms of street sweepers can be associated with socio-demographic, behavioral factors, workplace characteristics, and street dust.

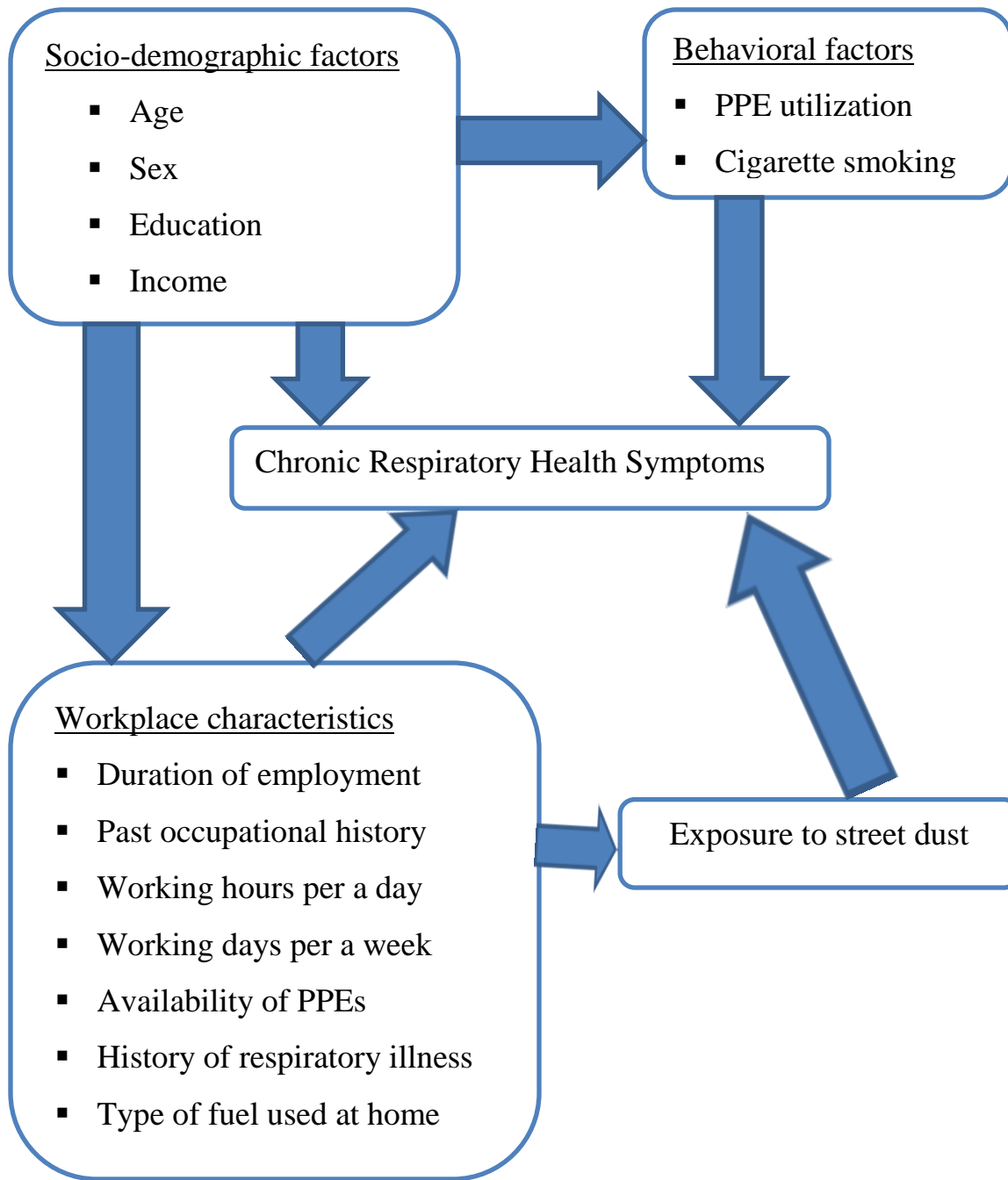


Figure 1: Conceptual framework for street dust exposure and chronic respiratory health symptoms among street sweepers in Addis Ababa, Ethiopia, 2018.

3. OBJECTIVES

3.1. General Objective

The general objective of this study was to assess personal dust exposure, prevalence and associated factors of chronic respiratory health symptoms among street sweepers in Addis Ababa, Ethiopia, 2017/18.

3.2. Specific Objectives

1. To assess the prevalence of chronic respiratory health symptoms among street sweepers
2. To determine factors associated with chronic respiratory health symptoms among street sweepers
3. To estimate the level of street dust exposure among street sweepers

4. METHODS AND MATERIALS

4.1. Study Area and Period

The study was carried out in Addis Ababa in 4 selected sub-cities (Lideta, Bole, Addis ketema, and Yeka) from March 17, 2018 – May 13, 2018. Addis Ababa is the capital city of Ethiopia that geographically lays $9^{\circ}1'48''\text{N}$ latitude and $38^{\circ}44'24''\text{E}$ line of longitude. It covers an area of 540 square kilometers (54,000 hectares) with a total population of 3,147,000 (35). The city has ten sub cities and 116 districts. Addis Ababa is under a rapid expansion and center for commerce, banking, national offices, and small-scale business like a street seller, shop sales, craft men, demolition and construction of a big building are located, which indicates high movement of individuals from different components of the World, rural and peripheral areas for socio-economic issues. Due to high movement of people and vehicle traffic, each associated with much generation of wastes and more vehicle traffic which creates fumes, aerosol, bio-aerosol and dust that may result in an increment of the occurrence of respiratory health symptoms among street sweepers who do not use appropriate PPE (1).

There are about 5,000 street sweeper workforces who are employed by Addis Ababa city sanitation Administration Agency.

4.2. Study Design

A cross-sectional quantitative study was conducted among AACCSAA street sweepers.

4.3. Source Population

All street sweepers who are engaged in Addis Ababa city sanitation administration agency were the source population.

4.4. Study Population

All street sweepers who are employed in the four selected sub-cities; Lideta, Addis Ketema, Bole, and Yeka sub-city were the study population.

4.5. Study Subjects

Street sweepers included in the actual study were the study subjects.

4.6. Eligibility Criteria

4.6.1. Inclusion Criteria

Permanent street sweepers with one year and above work experience in street sweeping and currently employed in street sweeping.

4.6.2. Exclusion Criteria

- Participants who are severely ill at the time of data collection as they may not be able to respond appropriately
- Supervisors, by considering their duty are only controlling and will not be exposed to the dust in the working area.

4.7. Sample Size Determination

4.7.1. Sample Size Determination For Specific Objective One

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

- ✓ P: 54.3%, prevalence of chronic respiratory symptoms among street sweepers (16)
- ✓ d: Margin of error or level of precision or maximum error to commit = 5 %
- ✓ $Z_{\alpha/2}$: Critical value at 95% confidence level = 1.96.
- ✓ α : Level of significance (5%)
- ✓ n: Required sample size

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

$$n = (1.96)^2 * 0.543 * (1-0.543) / (0.05)^2 = 381$$

Since the total population was below 10,000 ($N < 10,000$), adjustment was needed by using the correction formula as follows;

$$n_{\text{final}} = n / (1 + n/N)$$

$$n = 381 / (1 + 381/5,000) = 354$$

By considering 10% for non-response rate, the final sample was **389**.

4.7.2. Sample Size Determination For Specific Objective Two

The sample size to determine factors associated with respiratory health symptoms among street sweepers was calculated using double population proportion equation (Epi-info version 7.2) with the following assumptions:

- ✓ P_1 : 60%, prevalence of respiratory symptoms among street sweepers who had a working hour of less than or equal to five (working hour ≤ 5) per a day (non-exposed group), and
- ✓ P_2 : 72.04%, prevalence of respiratory health symptoms among street sweepers who had a working hour of above five (working hour > 5) per a day (exposed group) (16)
- ✓ n = Required sample size for the two groups ($n_1 + n_2$)
- ✓ n_1 = Sample size of street sweepers who had working hour ≤ 5 (non-exposed group)

- ✓ n_2 = Sample size of street sweepers who had working hour > 5 (exposed group)
- ✓ $r = 1$, proportion of exposed to non-exposed i.e., $n_2: n_1$ ($n_2 = r n_1$)
- ✓ $Z_{\alpha/2}$ = Critical value at 95% confidence level = 1.96.
- ✓ Z_{β} = Standard normal distribution value corresponding 80% power to detect the assumed difference = 0.84

$n_1 = 259$, since $n_1 = n_2$, the total sample size (n) = $2n_1 = 518$.

By adding 10% for non-response, the final sample size was 570. The sample size for objective two gave maximum sample size that was 570. Therefore, the sample size of this study was **570**.

4.7.3. Sample Size Determination For Specific Objective Three

The sample size for the dust exposure assessment was determined based on Rappaport *et al* 2008 considering that at least 5-10 randomly selected individuals in a similar exposure group (SEG) with repeated measurements are adequate to estimate the group exposure level for dust sampling based on personal exposure measurements (36). SEG is a group of workers working the same type of tasks in a similar work area for the same length of time using the same material. With the above assumptions, 5 workgroups with 5 study participants each were selected. This makes to perform a total of 50 dust measurements on 25 randomly selected street sweepers. This sample size was assumed to be adequate to estimate the dust exposure given limited resources (36).

4.8. Sampling Procedure

The sub-cities found in Addis Ababa were stratified into 2 groups (high and low street sweeping waste generation). Using simple random sampling (lottery method) 2 sub-cities were selected from each group. Then the sample of study participants from each selected sub-city was allocated proportionally. By using sub-city registration sheet as a framework, a sample of 570 study subjects was selected by lottery method. To perform this method, pieces of paper were written a number and the rest not written anything closed properly, mixed well; the principal investigator picked a piece of paper one by one, opened and got the assigned number they had participated in the study (Figure 2).

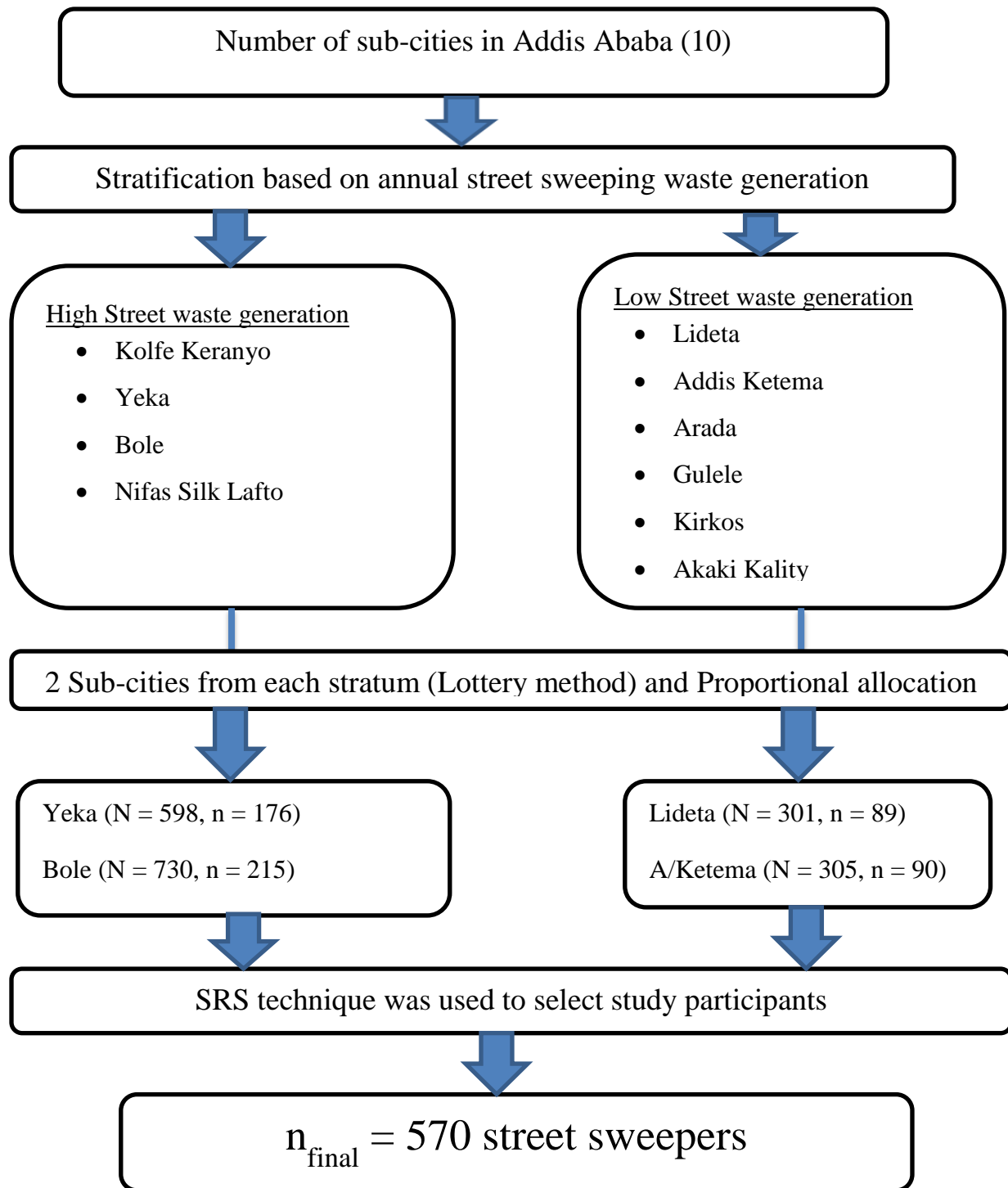
For the personal street dust monitoring, an exposure study was conducted in five widely-served streets. Those sampled streets were selected purposely. The reasons for street selection were: accessibility of an adequate number of street sweepers, regular provision of street sweeping (twice and above per a day), an occurrence of a relatively high amount of street dust, and

nearness of the streets to data collectors. Sampling was conducted during the morning shift from 5:00 - 8:00 am. A total of 50 samples were performed on 25 individuals with repeated measurements from the selected streets. This was adequate for representativeness of the study participants due to resource constriction (Table 1).

Table 1: Selected streets for dust exposure measurement in Addis Ababa, Ethiopia, 2018

S/No	Sub-city	Woreda	Street name		Total distance covered (km)	Remark
			Initial	Final		
1	Bole	3	Atlas international hotel	Embassy of Rwanda	2.0	One side
		13	Emperial hotel	Bole bridge	2.5	One side
		14	Roba bakery	Noc (around Emperial hotel)	1.5	One side
2	Lideta	9	National Meteorology	Areqie factory	2.4	Two side
3	Yeka	6	Adwa hotel 2	Meles Zenawi foundation	2.0	Two side

The sampling procedure for the respiratory symptoms questionnaire interview was described as follows;



Key: N = stands for the total number of street sweepers in the sub-city, n = stands for the sample of street sweepers from each sub-city, n_{final} = stands for the total sample size

Figure 2: Schematic representation of sampling procedure among street sweepers in Addis Ababa, Ethiopia, 2018.

4.9. Data Collection and Measurement

4.9.1. Data Collection Tools

Primary data source were carried out to accomplish this study by using three kinds of data collection tools i.e., questionnaire/interview, observational checklist and dust measurement.

4.9.1.1. Assessment of Respiratory Health Symptoms/ Questionnaire or Interview

As their reading skills were unknown, an interviewer-administered questionnaire based on the American thoracic society (ATS) questionnaire on respiratory symptoms with a few modifications was used in this study (37). 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, previous occupational history, smoking habits, past history of respiratory illnesses, and respiratory symptoms like a cough, phlegm, wheezing, shortness of breath, sneezing, and nose irritation. Face to face interview was performed in Amharic by the trained data collectors and the principal investigator.

4.9.1.2. Observational Checklist

At the time of data collection, a site visit at the work area was conducted that help to observe whether the study participants utilizes the appropriate personal protective devices or not.

4.9.1.3. Dust Level Measurement

To estimate the extent to which workers had been exposed to street dust, personal dust monitoring was conducted for randomly selected workers at different work groups. As we observe from a preliminary walk-through visit, four operations were performed in street sweeping (i.e., sweeping the street surface, collecting the litters in one site, loading the wastes into the dustbin and handcarts, and transporting and disposing of the dust into a nearby waste storage designated for that purpose). The sweepers perform their duty by rotation and they have similar dust exposure level.

Personal total dust was sampled using pre-weighed Polyvinyl Chloride (PVC) filter membranes with a pore size of 5 μ m placed on a Millipore plastic closed face 37-mm diameter filter cassette (CFC) connected to an SKC sidekick pump through which air was pumped by a rechargeable battery-powered motor at a constant flow rate of 2.0 l/min (Figure 10). The samplers were adjusted on the right shoulder straps as close to the breathing zone as possible (within 30 cm diameter of the breathing area) in order to keep the consistency of the results. Since the length of working time per a day was short, 150 minutes was the optimum sampling time. Sampling was

carried out at approximately the same time (morning from 5:00 - 8:00 am) every day over an entire working time (without pause) or until the task was finished. This sampling time (5:00 - 8:00 am) was chosen because of accessibility of a large number of street sweepers and high dust levels were observed in the morning. The selection of this sampling duration is consistent with NIOSH manual on occupational exposure strategy. The NIOSH manual makes consideration of using either full-shift or partial time with the assumption that the exposure levels are similar (36). The time of the sampling period was recorded using a digital minute timer.

During sampling measurement observation checklist and data sheet were used to note pertinent data.

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

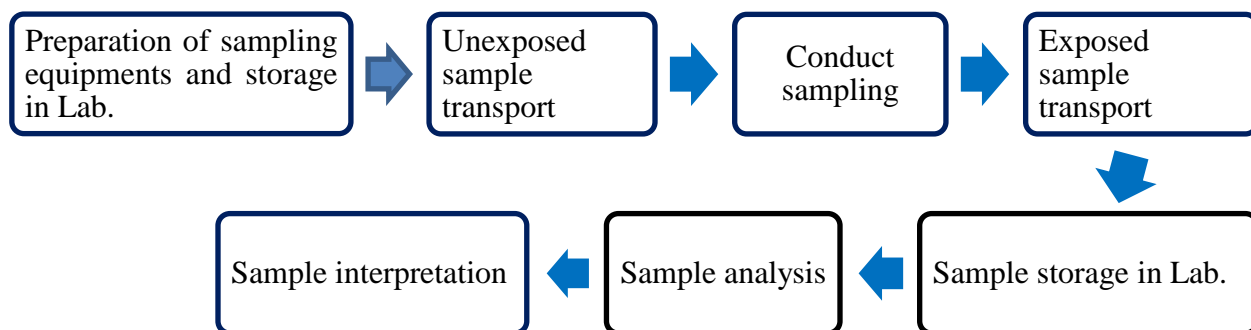


Figure 3: Sequence of dust sampling among street sweepers in Addis Ababa, Ethiopia, 2018.

4.9.2. Data Collection Personnel

Four data collectors and two supervisors were involved in the questionnaire interview.

Personal street dust measurement was performed by the trained data collector and the principal investigator. During personal street dust sampling, the principal investigator and the data collector was clearly explained the procedures for dust measurement to study participants in a group, mount the sampling tools on the study participants, detach the sampling pumps from the study participants, and record exposure activities of the study participants.

4.10. Data Quality Assurance

Standardized questionnaire modified from ATS was used to assure data quality. Prior to data collection, two days training was given to the data collectors and supervisors on the purpose of

the study, data collection techniques and data quality management by the investigator in order to fill the questionnaire appropriately and to reduce bias. Additionally, the questionnaire was translated from English to Amharic and back-translated to English using standard procedure to check its validity. Each data collector has checked the questionnaires frequently for completeness and consistency. At the end of the day, the supervisors checked all the filled questionnaires. The principal investigator was cautiously observed and followed the overall activities of the study.

For personal dust sampling, the air flow rates in the sampling pumps were 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 will be dropped). The position of the sampling head and the flow rate was checked every 30 minutes by the data collector. Data collectors frequently observed the study participants all over the study period. Each series of sampling were controlled and corrected daily towards one field blank samples that were used to correct any weight changes occurred by atmospheric conditions and the handling of the samples during transportation and sampling in workplaces. Prior to fieldwork, one-day training was given to the investigator by the senior expert. At the end of sampling, the filter cassettes were 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 post-weighing. Standard operative procedures (SOP) were followed in each step to make sure the quality of weighing using the microbalance. Prior to weighing, the microbalance has waited until it becomes zero. Standard balance such as 1000 mg was used periodically to check the reliability and validity of the microbalance.

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.

4.11. Variables

4.11.1. Dependent Variables

- Chronic respiratory health symptoms
- Street dust concentration

4.11.2. Independent Variables

- ✓ Socio-demographic factors: age, sex, educational status, income
- ✓ Behavioral factors: cigarette smoking, utilization of PPEs

- ✓ Workplace characteristics: duration of employment, length of working hours/day, length of working days/week, past history of dust exposure, availability of PPE, previous history of respiratory illness, type of fuel used at home

4.11.3. Operational Definitions

Chronic Breathlessness: is a condition occurring when hurrying on the level ground or walking up a slight hill for at least three months in the last 12 months (37).

Chronic Cough: Experience of a cough as much as 4– 6 times per a 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 the last 12 months (37).

Chronic 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 the last 12 months (37).

Chronic Respiratory Health Symptoms: The development of one or more of the symptom/s of a cough, phlegm, wheezing, shortness of breath, sneezing, or nose irritation which last/s at least three months in the last 12 months (37).

Chronic Wheezing: a condition causing a whistling sound of the chest on inspiration/expiration when having cold/occasionally apart from colds or most days/night for at least three months in the last 12 months (37).

Fuel type: the primary source of energy used at home for cooking and was classified into two categories: biomass or traditional fuels (wood, coal, gas), and clean fuel (electric) (33).

High street waste generation: sub-cities with a street waste generation of greater than or equal to the average of the street sweeping waste generated by Addis Ababa city ($\geq 2,520$ tons per a year). Example: Bole (3,312 tons) (6).

Low street waste generation: sub-cities with a street waste generation of below the mean of the street sweeping waste generated by Addis Ababa city ($< 2,520$ tons per a year. Example: Addis Ketema (2,370 tons) (6).

Non-smokers: workers who smoke less than 20 packs of cigarettes in a lifetime or less than 1 cigarette a day for one year (37).

Nose/mouth mask: a device worn over the mouth or nose or over both to prevent the respiratory tract from dangerous dust and other materials (16).

Past dust exposure: is any previous work experience in dusty environment

Past respiratory illness: respiratory disease likes TB, chronic bronchitis, lung cancer etc. that were developed earlier and identified by doctors.

Personal street dust exposure: is the evaluation of street dust by loading the sampling equipment on an individual worker to determine the dust level exposure.

PPE utilizer: is the use of at least nose/mouth mask or respirator at the time of data collection

Respirator: a material worn over the whole face to prevent the respiratory tract from dangerous dust and other materials (16)

Smokers: workers who smoked at the time of data collection or had stopped smoking less than one month ago.

Street dust: is the dust created from the street while sweeping

Street dust concentration: is the level of total dust which is determined by using personal dust monitoring and expressed in mg/m^3 .

Street sweeper: a person who is permanently employed in sweeping the public street, and has at least one year and above work experience in street sweeping.

4.12. Data Management

At the time of data collection, the principal investigator checked the questionnaire for completeness and consistencies. The coded data were cleaned and entered into epidemiological information package (Epi Info version 7.2) and exported to statistical package for social sciences (SPSS) version 21 for data analysis. But, prior to starting data analysis cross-checking of the questionnaire with the soft copy was performed to ensure consistency.

During personal dust sampling, a site visit was done every 30 minutes to check the flow rate of the sampling pump (2.0 lit/min), and the appropriate location of the sampler head on the study participants. Both exposed and unexposed samples were handled carefully in a labeled canned tin during transporting. Dust sampling equipment was handled carefully in a bag, transported and stored in a dust free lab (Environmental and Occupational Health laboratory at the College of Health Sciences, Addis Ababa University) until they weighed. Exposure data was entered into MS-Excel spreadsheet and exported into SPSS version 21 for data analysis.

4.13. Data Analysis

Descriptive statistics were used to describe the study participants 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, bi-variable logistic regression analysis was done to

determine the COR with 95% CI that was used to check the association between dependent and independent variables individually. The multivariable logistic regression analysis was run using enter method to assess the relative effect of the independent factors on chronic respiratory health symptoms. Multivariable logistic regression analyses were used to determine the presence of an association between independent variables and the outcome variables by controlling the possible effect of confounders. Only nine variables with a p-value < 0.20 at the bi-variable logistic regression analysis were kept in the final model. Based on AOR with 95% CI, variables with p < 0.05 were considered as significant independent factors.

The exposed filter membrane was weighed quantitatively by gravimetric analysis using a standard Mettler Toledo XPE105 microbalance scale with a detection limit of 0.01 mg and maximum of 120 gm at Environmental and Occupational Health (EOH) laboratory of College of Health Sciences, Addis Ababa University. Before weighing of sample filters, both the unexposed and exposed filters were equilibrated for at least 24 hours in a conditioning environment (relative humidity between 37-55%, and temperature between 20.1-21.7°C). Weighing of the sampling filter before and after sampling was done by the trained laboratory technician.

The result of the dust concentration was described by using descriptive statistics such as measure of central tendency (AM and GM) and a measure of dispersion (SD and GSD). Using One-way ANOVA variation within groups and between groups (days, places and tasks) was assessed. The significant groups (sampling days and sampled streets) were checked specifically in which group significantly differed by using post hoc (Bonferroni) test.

The concentration of dust was calculated using the following equation;

$$\text{Concentration (mg/m}^3\text{)} = \frac{\text{Post weight of filter} - \text{Pre- weight of filter (mg)} - \text{Blank weight (mg)}}{\text{Flow rate (lit per min)} * \text{Sampling duration (min)} * 1/1000 \text{ m}^3\text{/lit}}$$

Where;

- Weight of the dust (mg) = (weight of the filter after sampling - weight of the filter before sampling) (mg) - weight of the field blank (mg)
- Volume of air sampled (m³) = flow rate of the pump (lit/minutes) multiplied by the time of the sampling (minutes) multiplied by 1/1000 m³/lit.
- Concentration of dust (mg/m³) = Weight of the dust (mg) divided by the Volume of air sampled (m³).

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) (38).

4.14. Ethical Issues

Ethical clearance was taken from the School of Public Health ethical review committee and gave permission letter. An official letter was written to Addis Ababa city sanitation Administration Agency (AACCSAA). Permission letter was obtained from AACCSAA requesting facilitation to conduct a research study and this official letter was approved and distributed to the 4 sub-cities sanitation administration office for information and co-operation. The aim and method of the study and importance of their participation were clearly explained to each individual. The study participants who fulfill the inclusion criteria for the study and agreed to participate was given Amharic written consent and signed before data collection started. Verbal consent was obtained for photo taking to show the dust sampling demonstration. Issues of rights, privacy, and confidentiality were ensured during data collection period. Confidentiality was kept by making anonymous and assuring information will not be accessible to anyone except the research personnel. Privacy was maintained by arranging a silent and comfortable place to the interviewer and study subject. Participants have the right to participate or not and to withdraw at any time when they feel discomfort. The study participant was not got a direct benefit like money but they become a beneficiary in the future from the study.

4.15. Dissemination of the Results

The result of this study will be presented to Addis Ababa University, school of public health and the copies will be given to Addis Ababa city sanitation Administration Agency (AACCSAA). The findings will also be disseminated via publication.

5. RESULTS

A total of 570 street sweepers from the selected 4 sub-cities (47 districts) were selected to participate in the study, of which 566 were involved with a response rate of 99.3%. Four individuals were found unwilling to participate and excluded from the study.

5.1. Socio-demographic characteristics of respondents

Out of 566 respondents, 470(83.0%) were females and 190(33.6%) were found between the age group of 28-37 years. Two hundred ninety-seven (52.5%) of the study participants were married. Regarding educational level, 209(36.9%) of the respondents attended grade 9-10. The mean (\pm SD) monthly income (ETB) of respondents was 1782.04(\pm 270.11) (Table 2).

Table 2: Socio-demographic characteristics of the street sweepers in Addis Ababa, Ethiopia, 2018 (N = 566)

Variables		Frequency	Percentage (%)
Sex	Male	96	17.0
	Female	470	83.0
Age (in year)	< 27	186	32.9
	28-37	190	33.6
	38-47	122	21.5
	> 48	68	12.0
Marital status	Single	175	30.9
	Married	297	52.5
	Divorced	52	9.2
	Widowed/Widower	42	7.4
Educational status	1-4	18	3.2
	5-8	148	26.1
	9-10	209	36.9
	11-12	86	15.2
	Above 12	105	18.6
Monthly income (ETB) Mean (\pm SD)		1782.04(\pm 270.11)	

5.2. Workplace characteristics and behavioral factors of respondents

Of the 566 respondents, 169(29.9%) of the respondents had greater than five years (> 5) work experience in street sweeping, and 156 (27.6%) of the study participants worked above five hours (> 5) per a day. Majority (95.9%) of the respondents worked above five days (> 5) per a week. One hundred forty-two (25.1%) street sweepers had past occupational history in dusty areas before they were employed in street sweeping, and 73(12.9%) respondents had past history of respiratory illnesses. Only 65(11.5%) street sweepers used standard nose/mouth mask and 10(1.8%) study participants had history of cigarette smoking behavior (Table 3).

Table 3: Workplace characteristics and behavioral factors of the street sweepers in Addis Ababa, Ethiopia, 2018 (N = 566)

Variables	Frequency	Percentage (%)
Work experience (in year)	>5	29.9
	1-5	70.1
Working hours per a day	>5	27.6
	≤5	72.4
Working days per a week	>5	95.9
	≤5	4.1
Past occupational history in dusty areas	Yes	25.1
	No	74.9
Previous history of respiratory illnesses	Yes	12.9
	No	87.1
Use of PPE (nose/mouth mask)	Yes	11.5
	No	88.5
Cigarette smoking behavior (current and ever smokers)	Yes	1.8
	No	98.2

5.3 Prevalence of chronic respiratory health symptoms among street sweepers

The overall prevalence of chronic respiratory health symptoms among street sweepers was 398(70.3%) [CI: 66.4 - 74.2] with prevalence of cough 160(28.3%), phlegm 140(24.7%), wheezing 102(18.0%), breathlessness 254(44.9%), nose irritation 163(28.8%), and sneezing 210(37.1%) (Table 4).

Table 4: Prevalence of chronic respiratory health symptoms among street sweepers in Addis Ababa, Ethiopia, 2018 (N = 566)

Chronic respiratory health symptoms		Frequency	Percentage (%)
Cough	Yes	160	28.3
	No	406	71.7
Phlegm	Yes	140	24.7
	No	426	75.3
Wheezing	Yes	102	18.0
	No	464	82.0
Breathlessness	Yes	254	44.9
	No	312	55.1
Nose irritation	Yes	163	28.8
	No	403	71.2
Sneezing	Yes	210	37.1
	No	356	62.9
Chronic respiratory health symptoms	Yes	398	70.3
	No	168	29.7

5.4. Previous history of respiratory illnesses among street sweepers

This study reported that 73(12.9%) street sweepers had a previous history of respiratory diseases before they have started street sweeping. Study participants who had: asthma 22(30.1%), chronic bronchitis 23(31.5%), emphysema 17(23.3%), and TB 11(15.1%) were reported (Figure 4).

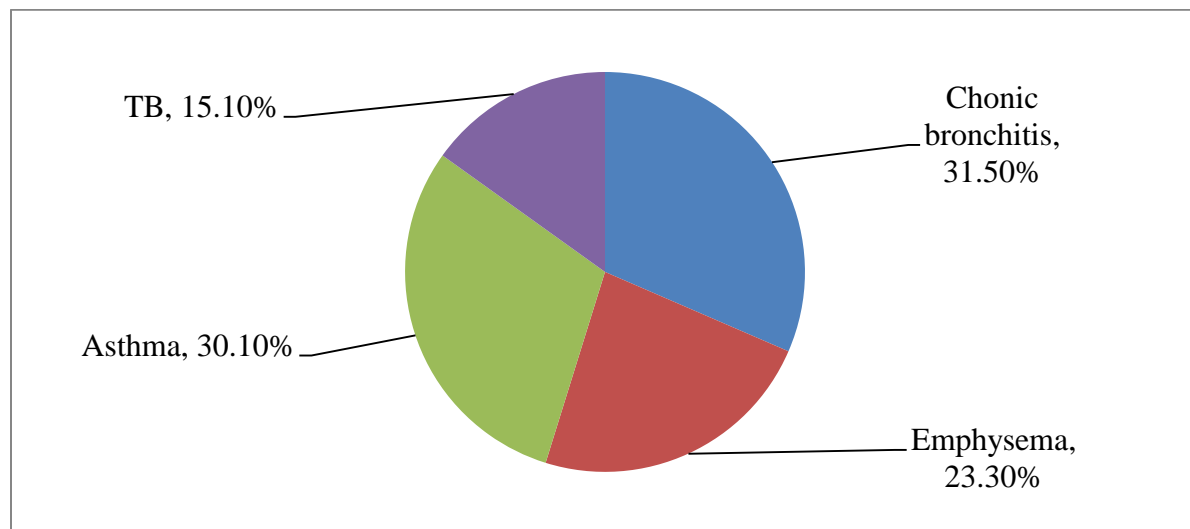


Figure 4: Previous history of respiratory disease among street sweepers in Addis Ababa, Ethiopia, 2018 (N = 73)

5.5. Type of fuel used for cooking among street sweepers

Regarding the type of fuel used for cooking as a primary source; biomass or traditional fuels (including wood, coal, and gas) 373(66%), and clean fuel or electric 193(34%) (Figure 5).

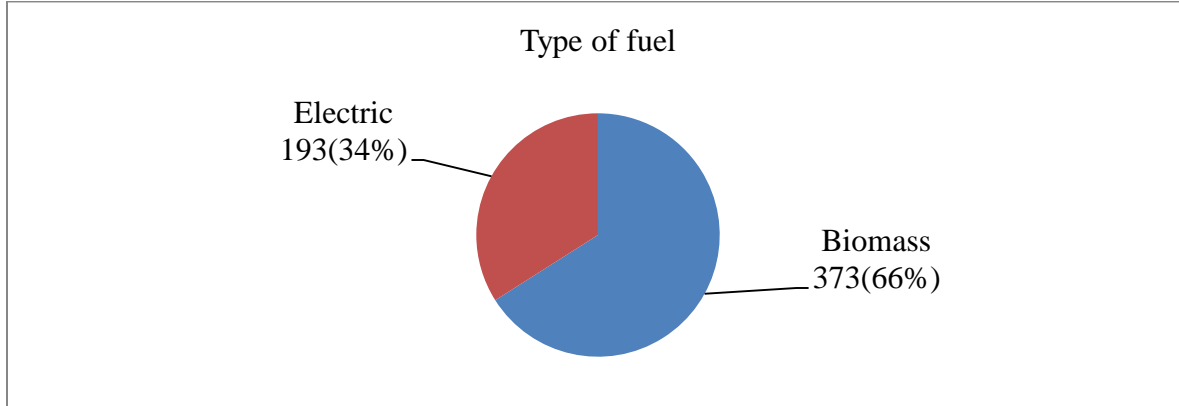


Figure 5: Type of fuel used for cooking among street sweepers in Addis Ababa, Ethiopia, 2018 (N= 566)

5.6. Availability and wearing of PPE among street sweepers

Out of 566 respondents, none of them reported using of respirator whereas availability vs. utilization of other PPEs such as nose/mouth masks 132(23.3%) vs. 65(11.5%), hand gloves 540(95.4%) vs. 538(95.1%), eye goggles (self) 20(3.5%) vs. 20(3.5%), boots 441(77.9%) vs. 291(51.4%), apron 560(98.9%) vs. 558(98.6%), and helmet 3(0.5%) vs. 1(0.2%) (Figure 6).

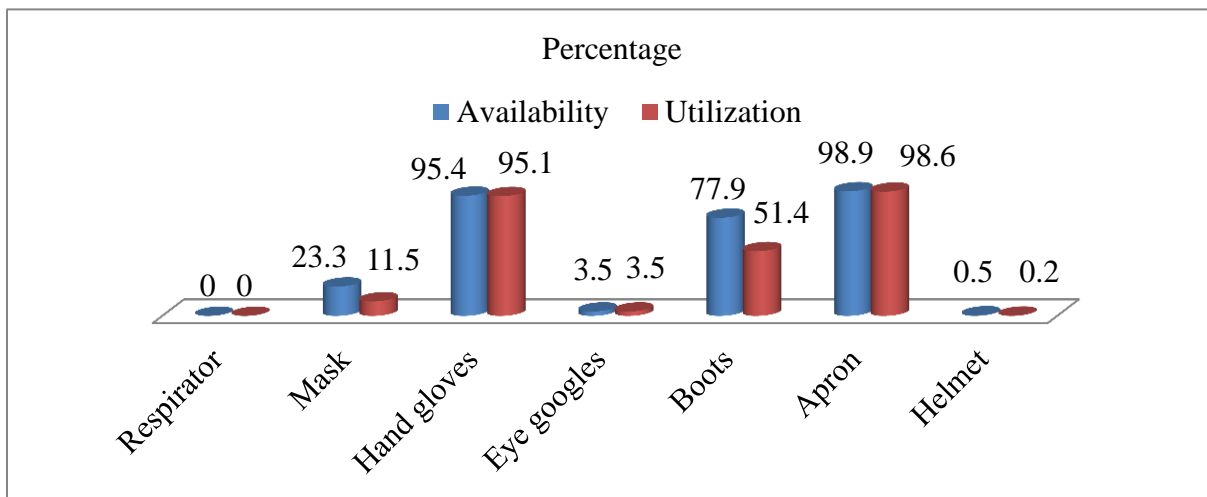


Figure 6: Availability and utilization of PPE among street sweepers in Addis Ababa, Ethiopia, 2018 (N = 566)

5.7. Factors associated with chronic respiratory health symptoms among street sweepers

5.7.1. Bivariate analysis

Age of participants, marital status, educational status, work experience, working hours per a day, past history of respiratory diseases, use of nose/mouth masks, and type of fuel used for cooking were significantly associated with chronic respiratory health symptoms in bivariate analysis ($p < 0.05$) (Table 5).

Table 5: Bivariate analysis of associated factors and chronic respiratory health symptoms among street sweepers in Addis Ababa, Ethiopia, 2018 (N = 566)

Variable		Chronic respiratory health symptoms		COR (95% CI)	P-value
		Yes N (%)	No N (%)		
Sex	Male	66(16.6)	30(17.9)	1.00	0.712
	Female	332(83.4)	138(82.1)	1.09(0.68-1.76)	
Age (in year)	< 27	110(27.7)	76(45.2)	1.00	
	28-37	133(33.4)	57(33.9)	1.61(1.05-2.47)	0.028*
	38-47	98(24.6)	24(14.3)	2.82(1.66-4.81)	<0.001*
	> 48	57(14.3)	11(6.6)	3.58(1.76-7.27)	<0.001*
Marital status	Single	108(27.1)	67(39.9)	1.00	
	Married	215(54.0)	82(48.8)	1.63(1.09-2.42)	0.016*
	Divorced	41(10.3)	11(6.5)	2.31(1.11-4.81)	0.025*
	Widowed/er	34(8.5)	8(4.8)	2.64(1.15-6.04)	0.022*
Educational status	1-4	17(4.3)	1(0.6)	10.46(1.34-81.66)	0.025*
	5-8	111(27.9)	37(22.0)	1.85(1.07-3.17)	0.027*
	9-10	150(37.7)	59(35.1)	1.57(0.95-2.57)	0.077*
	11-12	55(13.8)	31(18.5)	1.09(0.61-1.97)	0.771
	Above 12	65(16.3)	40(23.8)	1.00	
Monthly income, (mean \pm SD)		1769 \pm 245	1814 \pm 320	1.01(1.00-1.01)	0.071*
Work experience (in year)	> 5	134(33.7)	35(20.8)	1.93(1.26-2.96)	0.003*
	1-5	264(66.3)	133(79.2)	1.00	
Working hours per day	> 5	122(30.7)	34(20.2)	1.74(1.13-2.69)	0.012*
	\leq 5	276(69.3)	134(79.8)	1.00	
Working days per week	> 5	384(96.5)	159(94.6)	1.55(0.66-3.66)	0.315
	\leq 5	14(3.5)	9(5.4)	1.00	
Past occupational history	Yes	103(25.9)	39(23.2)	1.16(0.76-1.76)	0.504
	No	295(74.1)	129(76.8)	1.00	

History of respiratory diseases	Yes	59(14.8)	14(8.3)	1.91(1.04-3.53)	0.038*
	No	339(85.2)	154(91.7)	1.00	
Nose/mouth masks	Yes	35(8.8)	30(17.9)	0.44(0.26-0.75)	0.002*
	No	363(91.2)	138(82.1)	1.00	
Smoking behavior	Yes	8(2.0)	2(1.2)	1.70(0.36-8.10)	0.504
	No	390(98.0)	166(98.8)	1.00	
Type of fuel	Biomass	277(69.6)	96(57.1)	1.72(1.18-2.49)	0.004*
	Electric	121(30.4)	72(42.9)	1.00	

Note: 1.00= reference,

CI- confidence interval, COR- crude odds ratio, SD- standard deviation, * Variables which were included in the multivariable analysis, Biomass (coal, wood, and gas), $p < 0.05$

5.7.2. Multivariable analysis

After controlling the possible confounders three variables (age, length of working hours per a day, and use of nose/mouth mask) became statistically significant in the final model ($p < 0.05$).

Age of participants was significantly associated with chronic respiratory health symptoms among street sweepers. Sweepers in the age group of 38-47 years old were 2.29 times more likely to develop chronic respiratory health symptoms compared to individuals with the age group of < 27 years old (AOR = 2.29, 95% CI; 1.21 - 4.34), $p = 0.011$.

Length of working hours per a day was significantly associated with chronic respiratory health symptoms among street sweepers. Street sweepers who work above five (> 5) hours per a day were more likely to develop chronic respiratory health symptoms than those who had worked less than or equal to five (≤ 5) hours per a day (AOR = 1.91, 95% CI; 1.21 - 3.02), $p = 0.005$.

Wearing of nose/mouth mask was significantly associated with chronic respiratory health symptoms. Street sweepers who used nose/mouth mask had 58% less likely to develop chronic respiratory health symptoms than workers who did not use (AOR = 0.42, 95 % CI; 0.24 - 0.73), $p = 0.002$ (Table 6).

Table 6: Multivariable analysis of associated factors and chronic respiratory health symptoms among street sweepers in Addis Ababa, Ethiopia, 2018 (N = 566)

Variable		Chronic respiratory health symptoms		COR (95% CI)	AOR (95% CI)	P-value
		Yes N (%)	No N (%)			
Age (in year)	< 27	110(27.7)	76(45.2)	1.00	1.00	
	28-37	133(33.4)	57(33.9)	1.61(1.05-2.47)	1.31(0.81-2.11)	0.270
	38-47	98(24.6)	24(14.3)	2.82(1.66-4.81)	2.29(1.21-4.34)	0.011*
	> 48	57(14.3)	11(6.6)	3.58(1.76-7.27)	2.26(0.88-5.81)	0.090
Marital status	Single	108(27.1)	67(39.9)	1.00	1.00	
	Married	215(54.0)	82(48.8)	1.63(1.09-2.42)	1.25(0.80-1.97)	0.331
	Divorced	41(10.3)	11(6.5)	2.31(1.11-4.81)	1.67(0.74-3.76)	0.220
	Widowed	34(8.5)	8(4.8)	2.64(1.15-6.04)	1.48(0.56-3.91)	0.433
Education al status	1-4	17(4.3)	1(0.6)	10.46(1.34-81.66)	3.90(0.47-32.43)	0.208
	5-8	111(27.9)	37(22.0)	1.85(1.07-3.17)	0.98(0.52-1.85)	0.995
	9-10	150(37.7)	59(35.1)	1.57(0.95-2.57)	1.29(0.76-2.20)	0.345
	11-12	55(13.8)	31(18.5)	1.09(0.61-1.97)	0.78(0.41-1.47)	0.432
	Above 12	65(16.3)	40(23.8)	1.00	1.00	
Income (mean ± SD)		1769 ± 245	1814 ± 320	1.01(1.00-1.01)	1.00(0.99-1.00)	0.828
Work Exp. (years)	> 5	134(33.7)	35(20.8)	1.93(1.26-2.96)	1.21(0.73-2.00)	0.463
	1-5	264(66.3)	133(79.2)	1.00	1.00	
Working hours/day	> 5	122(30.7)	34(20.2)	1.74(1.13-2.69)	1.91(1.21-3.02)	0.005*
	≤ 5	276(69.3)	134(79.8)	1.00	1.00	
History of Res. ds	Yes	59(14.8)	14(8.3)	1.91(1.04-3.53)	1.78(0.94-3.38)	0.079
	No	339(85.2)	154(91.7)	1.00	1.00	
Nose/mout h masks	Yes	35(8.8)	30(17.9)	0.44(0.26-0.75)	0.42(0.24-0.73)	0.002*
	No	363(91.2)	138(82.1)	1.00	1.00	
Fuel type	Biomass	277(69.6)	96(57.1)	1.72(1.18-2.49)	1.41(0.94-2.11)	0.094
	Electric	121(30.4)	72(42.9)	1.00	1.00	

Note: 1.00= reference

AOR- adjusted odds ratio, CI- confidence interval, COR- crude odds ratio, ETB- Ethiopian birr, SD- standard deviation, Biomass (coal, wood, and gas), * variables which were statistically significant in the final model (p < 0.05), Resp.-respiratory, Exp-experience

5.8. Level of dust exposure among street sweepers

A total of 25 street sweepers were included in the study. The majority (84%) of the study participants were females.

5.8.1. Observations related to street dust exposure

From our field observation, four operations were performed in street sweeping i.e., sweeping the street surface, collecting the litters in one site, loading the wastes into the dustbin and handcarts, and transporting and disposing of the dust into a nearby waste storage designated for that purpose (Figure 8). The sweepers perform their duty by rotation and they have similar dust exposure level. We also observed that the position of the sampling cassettes did not affect the exposure result as the street sweepers uses both hands (right or left) as needed to accomplish their operation (personal observation).

5.8.2. Personal street dust exposure

The arithmetic mean (\pm SD) and geometric mean (\pm GSD) of the overall personal street dust concentration was $10.82(\pm 4.19)$ mg/m³ and $10.14(\pm 1.43)$, respectively with a range varying from 4.44 - 23.87 mg/m³. Out of the total samples, 26(52%) of the samples were above 10 mg/m³ which was the ACGIH recommendation (Table 9).

Street sweepers who clean the street surfaces were exposed to relatively high dust exposure [GM (\pm GSD) of $11.71(1.46)$] mg/m³. On the other hand, street sweepers who engaged in loading the collected dust into the dustbin or handcarts were less exposed to street dust [GM (\pm GSD) of $8.33(1.31)$] mg/m³. However, the task description of the workers was decided based on their internal agreement, i.e., the first come the first served (Table 10).

Regarding dust exposure concentration there was a variation at least between two sampling days (df= 9, F = 3.417, p = 0.003). The post hoc test (Bonferroni) indicated that there was a significant difference in mean exposure levels between day 30/04/2018 with day 05/05/2018 & 12/05/2018.

Comparing dust exposure concentration with task operation there was a significant difference at least between two tasks (df = 3, F = 3.018, p = 0.039). But, the post hoc test (Bonferroni) showed that there was no significant difference in mean exposure levels between task groups.

With regard to dust exposure concentration there was a variation at least between two sampling streets (df = 4, F = 6.978, p < 0.001). The post hoc test (Bonferroni) showed that there was a significant difference in mean exposure levels between Roba Bakery street with Emperial, Atlas, Adwa hotel and Metereology streets.

6. DISCUSSION

The finding of this study revealed that the overall prevalence of chronic respiratory health symptoms among street sweepers was high (70.3%) which is comparable with previous studies conducted in different countries (1–3, 14–16,22, 25,26), however relatively higher than previous studies conducted in Addis Ababa, 54.3% (16) and 68.9% (22). This difference could be variation in the definition of the outcome variable, i.e. Tsegaye B, (2016) used only the development of one or more of the symptoms of a cough, phlegm, wheezing, shortness of breath, and chest tightness while this study used the development of one or more of the symptoms of cough, phlegm, wheezing, shortness of breath, sneezing, and nose irritation to say presence or absence of chronic respiratory health symptoms. Taking relatively large sample size in this study could also be a reason for this higher prevalence of chronic respiratory health symptoms as Tamene M, (2017) appreciates small sample size as a limitation on his study.

This study showed that only 65(11.5%) of the street sweepers utilizes standard nose/mouth mask which is consistent to the previous studies conducted in Tanzania and Addis Ababa (1,16,22). The low utilization of standard nose/mouth mask might be due to lack of standard nose/mouth mask supply by the agency as a result of low emphasize given to the workplace safety and or not clearly understand the importance of nose/mouth mask for the street sweepers. In addition to that, low awareness of street sweepers on the importance of nose/mouth mask might have a contribution to under-utilization of it. However, this is inconsistent with previous studies carried out in India and Egypt which reported none of the street sweepers wear standard nose/mouth mask (3,25,26).

This study revealed that street sweepers belonged to age group of 38 - 47 years old were 2.29 times more likely to develop chronic respiratory health symptoms than workers aged below 27 years old (AOR = 2.29, 95 % CI; 1.21 - 4.34), $p = 0.011$. The result of this study was inline to the previous study conducted in Addis Ababa which reported more chronic respiratory health symptoms among participants aged between 27 - 37 and 38 - 48 years old (22). This might be due to the variation in the appropriate utilization of nose/mouth mask, i.e., the young people may wear it properly while the old people may have a misconception on the nose/mouth mask utilization. Another reason could be individual immunity as the age of individual increases immunity decreases. Hence they had more chronic respiratory symptoms.

In this study, street sweepers who had greater than five (> 5) working hours per a day in street sweeping had 1.91 times the risk of developing chronic respiratory health symptoms than those who worked for less than or equal to (≤ 5) hours per a day (AOR = 1.91, 95 % CI; 1.21 - 3.02), $p = 0.005$. This finding was analogous with a study conducted in Addis Ababa (16,22) and Tanzania (1). This could be due to the fact that exposures to street dust for a long time (hours) enhanced dust accumulation in the respiratory system, i.e., in the alveoli. So, this accumulation of dust may irritate the alveoli and could develop the respiratory health symptoms.

This study also reported that nose/mouth mask utilization was significantly associated with the development of chronic respiratory health symptoms. Street sweepers who used nose/mouth mask had 58% less likely to develop chronic respiratory health symptoms (AOR = 0.42, 95 % CI; 0.24 - 0.73), $p = 0.002$. The finding of this study was unlike to the result of the previous studies done in different countries, i.e., Beni-Suef, Egypt (25), Calabar, Nigeria (14), Tanzania (1), and Addis Ababa (16,22). This might be due to using of the standard nose/mouth mask may reduce the entrance of dust into the respiratory system rather than using a piece of clothes worn to cover the nose/mouth or both.

The geometric mean (\pm GSD) of the overall personal street dust concentration for the selected five streets was $10.14 (\pm 1.43) \text{ mg/m}^3$ with a range varying between 4.44 and 23.87 mg/m^3 . From this finding, we observed that the overall personal total dust concentration was lower than that of the previous study conducted in one street of Addis Ababa (Bole Brass street) (4). This discrepancy might be due to the seasonal variation, i.e., the data collection time in this study was some what cold season hence the dust might not be dispersed as the dry season. However, the result of this study (GM) was exceeded the ACGIH TLV recommendation (10 mg/m^3) (38). This high level of dust exposure might result from the traditional method of street sweeping which involved manual operation using traditional hand brooms on a dry surface that generated and suspended the dust around the breathing area of the working groups.

This study revealed that there was a statistical difference in dust exposure concentration between the ten measurement days. This variation might be due to the difference in weather conditions of the days which the samples were conducted. It also showed that the street stretched from Roba bakery to Noc (around Emperial hotel) had significantly higher dust exposure concentration comparing to the other sampled streets. This is probably due to conditions such as high vehicle flow and relatively old road surfaces which creates high street waste.

6.1. STRENGTH AND LIMITATION OF THE STUDY

6.1.1. Strength

Relatively large sample size with strong power was used in the interview. Also, performing personal street dust exposure monitoring was the strength of this study.

6.1.2. Limitation

Respondents recall bias was possibly introduced during interviewing the study participants which 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. Street dust contains a wide range of particle sizes including coarse particles with aerodynamic diameters $> 50 \mu\text{m}$. Since the sampling head used in the present study was 37mm millipore plastic sampling head (CFC) it is known to significantly underestimate these coarse particles (30 – 100 μm). Sample losses may occur as a result of adhering to the interior part of the cassette walls was also considered as a limitation.

Only a few streets of Addis Ababa and few street sweepers out of about 5000 sweepers were sampled for personal dust exposure assessment. Hence, this makes difficult to look at the association of chronic respiratory health symptoms with the street dust concentration.

7. CONCLUSION AND RECOMMENDATIONS

7.1. Conclusion

According to the present study, the overall prevalence of chronic respiratory health symptoms among street sweepers was high. Age of participants, length of working hours per a day, and use of standard nose/mouth mask were significantly associated with chronic respiratory health symptoms. Out of the total measurement samples (n = 50), 52% of the street sweepers were exposed to street dust concentration that was exceeded the occupational exposure limit recommended by the ACGIH TLV guideline (10 mg/m³).

7.2. Recommendations

The following precautions are recommended to reduce the dust exposure during sweeping. The use of respiratory protective devices like standard nose/mouth mask is the most widely used preventive measure which reduces airborne dust entry into respiratory systems while on duty. So, Addis Ababa city sanitation administration agency (AACSSAA) should be provided consistently adequate and high-quality respiratory protective devices and encourages street sweepers to utilize while on their duty. Applying effective dust-control measures such as watering the street surface prior to sweeping will considerably reduce the dust. Further studies should conduct using strong study design technique in broad streets of Addis Ababa to see the association between the street dust exposure and respiratory symptoms. This might be needed as the street of Addis Ababa may vary by many situations like the flow of vehicles, the standard of the street, sweeping frequency.

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ANNEXES

ANNEX I: QUESTIONNAIRES (ENGLISH VERSION)

ADDIS ABABA UNIVERSITY, COLLEGE OF HEALTH SCIENCES, SCHOOL OF PUBLIC HEALTH

PARTICIPANT INFORMATION SHEET

I. Participant Information Sheet For The Interview

Greetings:

How are you? I am _____. I came from Addis Ababa University, College of Health Science, School of Public Health to conduct research. The aim of the study is to assess personal street dust exposure and chronic respiratory health symptoms among street sweepers in Addis Ababa, Ethiopia. Therefore, this study will have a great role in the control and prevention of chronic respiratory symptoms among street sweepers. Further, I believe that this study will help governments and stakeholders to focus on this area to solve the problems faced by these workers. During the study period, a standard questionnaire from ATS with few modifications and observational checklist will be used. 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. This interview will take about 20 minutes.

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. This study will not have any harm to the study participants except spending time for the interview. 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 interview, please be free to withdraw or discontinue at any time you want. Any personal information given by you will be kept anonymously.

Whom to contact: If you have any question about the research you may contact *Kenfe Tsehay* (PI) Addis Ababa University, College of Health Sciences, School of Public Health (Tel +251-9-10-57-03-45) or *Dr. Abera Kumie* (Tel +251-9-11-88-29-12) or *Mr. Yifokir Tefera* (Tel +251-9-13-75-40-82) (supervisors) Addis Ababa University, College of Health Sciences, School of Public Health or *School of Public Health ethical review committee* (Tel +251-115157701).

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

II. Participant Information Sheet For The Dust Monitoring

Greetings:

How are you? I am _____. I came from Addis Ababa University, College of Health Science, School of Public Health to conduct research. The aim of the study is to assess personal street dust exposure and chronic respiratory health symptoms among street sweepers in Addis Ababa, Ethiopia. Therefore, this study will have a great role in the control and prevention of chronic respiratory symptoms among street sweepers. Further, I believe that this study will help governments and stakeholders to focus on this area to solve the problems faced by these 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 street dust which is probably to be inhaled by you. A small sampling head will be attached to your breathing zone that is used to trap the street 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 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.

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

10-57-03-45) or Dr. Abera Kumie (Tel +251-9-11-88-29-12) or Mr. Yifokir Tefera (Tel +251-9-13-75-40-82) (supervisors) Addis Ababa University, College of Health Sciences, School of Public Health or *School of Public Health ethical review committee* (Tel +251-115157701).

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

INFORMED CONSENT FORM

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

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

1. If yes, continue to the following questions

2. If no, provide compliment, and skip to the next participant

Participant signature: _____ Date: _____

Name of data collector _____ Signature: _____ Date: _____

IDENTIFICATION

Name of principal investigator: Kenfe Tsehaye, Phone number: +251-9-10-57-03-45

Questionnaire code: _____ Sub-city: _____ Street level _____

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

Table 7: Questionnaire (English Version)

PART I. SOCIO-DEMOGRAPHIC CHARACTERISTICS			
S/N	Question	Response	Skip
1	Sex:	1. Male 2. Female	
2	Age:	_____ years	
3	Marital status:	1. Single 2. Married 3. Divorced 4. Widowed/Widower	

4	Educational level:	1. Illiterate 2. 1 - 4 3. 5 – 8 4. 9 -10 5. 11 - 12 6. Above 12	
5	What is your income per a month?	_____ Ethiopian birr	
6	When did you start this job?	____/____ E.C (Year)	
7	How long do you working in this job?	_____ Year	
8	What is your working time?	____ to ____ hours	
9	How many working hours per a day?	_____ hours	
10	How many working days per a week?	_____ days	
<i>PART II. PAST OCCUPATIONAL HISTORY</i>			
11	Have you ever worked for any other dusty job?	1. Yes 2. No	Q. No. 13
12	If “Yes” for Q. No 12: 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. Flour mill _____ 5. Other (specify) ____	
13	Do you prepare food by yourself?	1. Yes 2. No	
14	If “No” for Q. No 13: Does food prepared in your home even by other people?	1. Yes 2. No	
15	If “Yes” for Q. No 13 or 14: 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	
<i>PART III. PAST HISTORY OF RESPIRATORY ILLNESSES</i>			
16	Was either of your past life ever told by a doctor that you had a chronic lung condition as listed below?	1. Yes 2. No	Q. No. 18
17	If “Yes” for Q. No 17:	1. Chronic bronchitis	

	What type of health problem did you experience earlier? (more than one answer possible)	2. Emphysema 3. Asthma 4. Lung cancer 5. Tuberculosis (TB) 6. Other (specify) ____	
PART IV. CIGARETTE SMOKING BEHAVIOUR			
18	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	Q. No. 22
19	Do you now smoke cigarettes (as of 1 month ago)?	1. Yes 2. No	Q. No. 21
20	How many cigarettes do you smoke per day now?	_____ cigarettes/day.	
21	For how long did you smoke cigarette?	_____ years	
22	Is there any person who smoke cigarette in your home?	1. Yes 2. No	
PART V. RESPIRATORY SYMPTOMS			
A. COUGH			
23	Do you usually have a cough?	1. Yes 2. No	Q. No. 25
24	Do you usually cough as much as 4 to 6 times a day, 4 or more days out of the week?	1. Yes 2. No	
25	Do you usually cough at all on getting up in the morning?	1. Yes 2. No	
26	Do you usually cough at all during the rest of the day or at night?	1. Yes 2. No	
27	If "Yes" to any of the above (23, 24, 25, or 26), Answer the following 2 questions: If No to all skip to Q.No. 29. Do you usually cough like this on most days for 3 consecutive months or more during the last 12 months?	1. Yes 2. No	
28	For how many years have you had this 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 3 months in the last 12 months)	_____ years	
B. PHLEGM			
29	Do you usually bring up phlegm from your chest?	1. Yes 2. No	Q. No. 31
30	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	
31	Do you usually bring up phlegm at all on getting up in the morning?	1. Yes 2. No	
32	Do you usually bring up phlegm at all during the rest of the day or at night?	1. Yes 2. No	
33	If “Yes” to any of the above (29, 30, 31, or 32), Answer the following 2 questions: If No to all skip to Q.No. 35. Do you bring up phlegm like this on most days for 3 consecutive months or more during the last 12 months?	1. Yes 2. No	
34	For how many years have you had trouble with 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 3 months in the last 12 months)	_____ years	
C. WHEEZING, NOSE IRRITATING, AND SNEEZING			
35	Does your chest ever sound wheezy or whistling when you have a cold?	1. Yes 2. No	
36	Does your chest ever sound wheezy or whistling occasionally apart from colds?	1. Yes 2. No	
37	Does your chest ever sound wheezy or whistling most days or nights?	1. Yes 2. No	

38	If “Yes” to any of the above (35, 36, or 37), Answer the following question: If No to all skip to Q.No. 39. For how many years has this been present? <i>(Wheezing: a condition causing a whistling sound of the chest on inspiration/expiration when having cold or occasionally apart from colds or most days/night for at least 3 months in the last 12 months)</i>	_____ years	
39	Are you troubled by nose irritation?	1. Yes 2. No	Q. No. 41
40	If “Yes” for Q. No 39: For how many years has this been present?	_____ years	
41	Are you troubled by sneezing once you start street sweeping?	1. Yes 2. No	Q. No. 43
42	If “Yes” for Q. No 41: For how many years has this been present?	_____ years	
D. BREATHLESSNESS			
43	Have you troubled by shortness of breath when hurrying the level or walking up a slight hill?	1. Yes 2. No	Q. No. 49
44	Do you have to walk slower than people of your age on the level because of breathlessness?	1. Yes 2. No	
45	Do you ever have to stop for breath when walking at your own pace on the level?	1. Yes 2. No	
46	Do you ever have to stop for breath after walking about 100 yards or 96 m (after a few minutes) on the level?	1. Yes 2. No	
47	Are you too breathless to leave the house or breathless on dressing or undressing?	1. Yes 2. No	
48	If “Yes” to any of the above (43, 44, 45, 46, or 47), Answer the following question: If No to all skip to Q.No. 49.	_____ years	

	For how many years has this been present? <i>(Breathlessness: a condition occurring when hurrying on the level ground or walking up a slight hill for at least 3 months in last 12 months)</i>		
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Adopted from: American Thoracic Society and National Heart & Lung Institute Division of Lung Disease Respiratory Questionnaire (ATS-DLD) (37).

ANNEX II: OBSERVATIONAL CHECKLIST (ENGLISH VERSION)

S/N	Question	Response	Explanations
49	Availability of PPEs (more than one answer possible)	1. Respirator	
		2. Nose/mouth masks	
		3. Hand gloves	
		4. Eye protection /goggles	
		5. Footwear (boots)	
		6. Clothing/apron/overall	
		7. Helmet	
50	Utilization of PPEs during working (more than one answer possible)	1. Respirator	
		2. Nose/mouth masks	
		3. Hand gloves	
		4. Eye protection /goggles	
		5. Footwear (boots)	
		6. Clothing/apron/overall	
		7. Helmet	

ANNEX III: QUESTIONNAIRES (AMHARIC VERSION)

አዲስ አበባ ዩኒቨርሲቲ፣ ጤና ሳይንስ ኮሌጅ፣ የሕብረተሰብ ጤና ትምህርት ክፍል

ለጥናቱ ተሳታፊዎች የመረጃ መስጫ ቅፅ

I. ለቃለ መጠይቅ የሚሰጥ የመረጃ መስጫ ቅፅ

ጤና ይስጥልኝ!

እንደምን አሉ፣ እኔ _____ እባላለሁ። ከአ/አባባ ዩኒቨርሲቲ፣ ጤና ሳይንስ ኮሌጅ የሕ/ሰብ ጤና ትምህርት ክፍል መረጃ ለመሰብሰብ ነው የመጣሁት። የዚህ ጥናት ዋና ዓላማ በአ/አባባ ከተማ አስተዳደር ከሚገኙት የመንገድ ፅዳት ሰራተኞች በሰውነት ወስጥ ሊገባ የሚችል የመንገድ አባራ መለካትና የቆየ የመተንፈሻ አካላት ችግር ምልክቶች ዳሰሳ ማድረግ ነው። በዚህ መሰረት ይህ ጥናት በመንገድ ፅዳት ሰራተኞች የሚታዩ 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 እንድያሰቀምጡ ይረዳል ብዬ አስባለው። ጥናቱ በሚካሄድበት ወቅት ለጥናቱ የተዘጋጀ ደረጃው የጠበቀ መጠይቅና ትዕዛዝበት እጠቀማለሁ። ጥናቱ ከሕ/ሰብ ጤና ት/ት ክፍል የስነ-ምግባር ግምገማ ተቋም የስነ-ምግባር ፈቃድ የተሰጠው ነው። እርስዎ በጥናቱ ስለተመረጡ ስለጥናቱ አስፈላጊውን መረጃ እንዲሰጡኝ በትህትና እጠይቃለሁ። መጠይቁ 20 ደቂቃ ያህል ጊዜ ይፈጃል።

ጥናቱ ለተሳታፊዎች በቀጥታ የሚሰጥ ነገር የለውም። ነገር ግን ከጥናቱ የሚገኝ መረጃ መሰረት በማድረግ የመስተካከል እርምጃ እንዲወሰድ ይረዳል። ጥናቱ ለቃለ መጠይቅ ከሚፈጀው ጊዜ ውጭ በተሳታፊዎች የሚያስከትለው አንዳች ጉዳት የለም። በጥናቱ ላይ መሳተፍ በሙሉ ፈቃደኝነት የተመሰረተ ነው፤ ስለሆነም በጥናቱ ላይ ለመሳተፍም ሆነ ባልተመቸዎት ጊዜ ጥናቱ አቋርጦ ለመውጣት መብትዎ የተጠበቀ ነው። እርስዎ የሰጡን መረጃ ከግል ማንነትዎ ጋር ምንም ዓይነት ግንኙነት የለውም። የሰጡንን መረጃ ምስጢራዊነቱ ፍፁም የተጠበቀ ነው።

ለበለጠ መረጃ: ጥናቱ በተመለከተ ማንኛውም ጥያቄ ካለዎት *ክንፈ ፀሃዩ* (የጥናቱ ተመራማሪ) በአዲስ አበባ ዩኒቨርሲቲ ጤና ሳይንስ ኮሌጅ የሕብረተሰብ ጤና ትምህርት ክፍል ስልክ ቁጥር +251-9-10-57-03-45 ወይም ዶ/ር አበራ ቁሜ ስልክ ቁጥር +251-9-11-88-29-12 ወይም አቶ ይፎክር ተፈራ ስልክ ቁጥር +251-9-13-75-40-82 (የጥናቱ

አማካሪዎች) በአዲስ አበባ ዩኒቨርሲቲ ጤና ሳይንስ ኮሌጅ የሕብረተሰብ ጤና ትምህርት ክፍል ወይም የሕብረተሰብ ጤና ትምህርት ክፍል የስነ-ምግባር ግምገማ ተቋም ስልክ ቁጥር +251-115157701 ደውለው ማነጋገር ይችላሉ።

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

II. ለአባራ መለካት የሚሰጥ የመረጃ መስጫ ቅፅ ጤና ይስጥልኝ!

እንደምን አሉ, እኔ _____ እባላለሁ። ከአዲስ አበባ ዩኒቨርሲቲ፣ ጤና ሳይንስ ኮሌጅ የሕብረተሰብ ጤና ትምህርት ክፍል መረጃ ለመሰብሰብ ነው የመጣሁት። የዚህ ጥናት ዋና ዓላማ በአዲስ አበባ ከተማ አስተዳደር ከሚገኙት የመንገድ ፅዳት ሰራተኞች በሰውነት ዉስጥ ሊገባ የሚችል የመንገድ አባራ መለካትና የቆየ የመተንፈሻ አካላት ችግር ምልክቶች ዳሰሳ ማድረግ ነው። በዚህ መሰረት ይህ ጥናት የመንገድ ፅዳት ሰራተኞች የሚታዩ 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 እንድያሰቀምጡ ይረዳል ብየ አስባለው። ጥናቱ በሚካሄድበት ወቅት የመንገድ አባራ መለኪያ መሳርያ እጠቀማለሁ። ጥናቱ ከሕብረተሰብ ጤና ትምህርት ክፍል የስነ-ምግባር ፈቃድ የተሰጠው ነው። እርስዎ በጥናቱ ስለተመረጡ ስለጥናቱ አስፈላጊውን መረጃ እንዲሰጡኝ በትህተና እጠይቃለሁ።

የመንገድ አባራ መለካት አካሄድ: የመንገድ አባራ መለኪያ መሳሪያ በሰውነትዎ ላይ እንድያደርጉ በትህትና ይጠየቃሉ። መሳርያው በመተንፈሻ አካላት ዙርያ የሚደረግ አባራ መለኪያ የያዘ ሆኖ ወገብ ላይ የሚደረግ ፓምፕ አለው። ፓምፑ በአባራ መለኪያ በኩል መተንፈሻ አካላት አካባቢ ላይ ያለውን አየር ለመሳብ የሚያገለግል ነው። የአባራ መለኪያው መሳርያ ከትንሽ ድምፅ በስተቀር በጤና ይሁን በስራ ላይ የሚያመጣው ተፅዕኖ የለም። የመንገድ አባራ 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 እርምጃ እንዲወሰድ ይረዳል። ከዚህ በተጨማሪ በዳሰሳ

ግዜ የተገኘውን የብናኙ ደረጃ እናሳውቅዎታሎን። ጥናቱ አዲሱ ለመለካት ከሚፈጀው ግዜ ውጭ በተሳታፊዎች የሚያስከትለው አንዳች ጉዳት የለም። በጥናቱ ላይ መሳተፍ በሙሉ ፈቃደኝነት የተመሰረተ ነው፤ ስለሆነም በጥናቱ ላይ ለመሳተፍም ሆነ ባልተመችዎት ግዜ ጥናቱ አቋርጦ ለመውጣት መብትዎ የተጠበቀ ነው። በተሳታፊዎች ላይ የሚገኝ የአዲሱ መጠን ከጥናቱ አባላት ውጭ ለሌላ ማንም ተላልፎ አይሰጥም። እርስዎ የሰጡን መረጃ ከግል ማንነትዎ ጋር ምንም ዓይነት ግንኙነት የለውም። የሰጡንን መረጃ ምስጢራዊነቱ የተጠበቀ ነው።

ለበለጠ መረጃ: ጥናቱ በተመለከተ ማንኛውም ጥያቄ ካለዎት *ክንፈ ፀሃዩ* (የጥናቱ ተመራማሪ) በአዲስ አበባ ዩኒቨርሲቲ ጤና ሳይንስ ኮሌጅ የሕብረተሰብ ጤና ትምህርት ክፍል ስልክ ቁጥር +251-9-10-57-03-45 ወይም ዶ/ር አበራ ቁሜ ስልክ ቁጥር +251-9-11-88-29-12 ወይም አቶ ይጮክር ተፈራ ስልክ ቁጥር +251-9-13-75-40-82 (የጥናቱ አማካሪዎች) በአዲስ አበባ ዩኒቨርሲቲ ጤና ሳይንስ ኮሌጅ የሕብረተሰብ ጤና ትምህርት ክፍል ደውለው ማነጋገር ይችላሉ።

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

የስምምነት ማረጋገጫ ቅፅ

ከላይ የተጠቀሱትን ግምት ወስጥ በማስገባት በጥናቱ ላይ እንዲሳተፉ በአክብሮት እጠይቃለሁ።

እኔ ከዚህ በታች ፊርማዬ የተቀመጠው ስለ ጥናቱ ዓላማ በሚገባኝ ቋንቋ መግለጫና ማብራርያ ስለተሰጠኝ በጥናቱ ለመሳተፍ የተስማማሁት መሆኔ በፊርማዬ አረጋግጣለሁ። በማንኛውም ግዜ ጥናቱ አቋርጬ መውጣት እንደሚችልም ለዚህም ድርጊት ምንም ዓይነት ጫና እንደማይደርስብኝም ተርድቻለሁ።

ከላይ ባገኙት የመረጃ ግንዛቤ መነሻ በማድረግ በጥናቱ ላይ ለመሳተፍ ይስማማሉ?

- 1. አዎ ከተስማሙ ከዚህ በታች ያሉት ጥያቄዎች መልስ
- 2. ካልተስማሙ ግን አመስግነህ ወደ ሚቀጥለው ተሳታፊ ሂድ

የተሳታፊ ፊርማ: _____ ቀን: _____

የመረጃ ሰብሳቢው ስም: _____ ፊርማ: _____ ቀን: _____

ማንነት መለያ

የተመራማሪ ስም: *ክንፈ ፀሃዩ*, ስልክ ቁጥር: +251-9-10-57-03-45

የመጠይቅ ኮድ: _____ ክፍለ-ከተማ: _____ የመንገዱ ደረጃ _____
 እባክዎ መልስዎ ከትክክለኛው አማራጭ ላይ ሙሉ በሙሉ በማክበብ ይመልሱ:: መልስዎ በቁጥር ከሆነ እባክዎ ትክክለኛ ቁጥር በተሰጠው ክፍት ቦታ ያስቀምጡ፣ ለምሳሌ ዕድሜ በዓመት::

Table 8: Questionnaire (Amharic Version)

<i>ክፍል አንድ: ማህበራዊና ዲሞክራሲያዊ መስፈርት</i>			
ተ/ቁ	መጠይቅ	መልስ	ማሳሰቢያ
1	ፆታ:	1. ወንድ 2. ሴት	
2	ዕድሜ:	_____ ዓመት	
3	የትዳር ሁኔታ:	1. ያላገባ/ች 2. ያገባ/ች 3. የፈታ/ች 4. የሞተች/ች/ባት	
4	የትምህርት ደረጃ:	1. ያልተማረ/ች 2. 1 — 4 3. 5 — 8 4. 9 — 10 5. 11 — 12 6. ከ 12 በላይ	
5	የወር ገቢዎት ምን ያህል ነው?	_____ ብር	
6	ይሄ የመንገድ ፅዳት ስራ መቼ ነው የጀመሩት?	____/____ ዓ/ም	
7	በዚ የመንገድ ፅዳት ስራ ላይ ምን ያህል ጊዜ ሰሩ?	_____ ዓመት	
8	የስራ ሰዓትዎ ከ ስንት እስከ ስንት ሰዓት ነው?	ከ _____ እስከ _____	
9	በአማካይ በቀን ለምን ያህል ሰዓት ይሰራሉ?	_____ ሰዓት (እ.አ.አ)	
10	በአማካይ በሳምንት ለምን ያህል ቀን ይሰራሉ?	_____ ቀን	
<i>ክፍል ሁለት: ከስራው ጋር የተያያዘ የቀድሞ ታሪክ</i>			
11	ከዚህ በፊት ከመንገድ ፅዳት ወጪ አባራማ በሆነ ቦታ ላይ ሰርተዋል?	1. አዎ 2. አይደለም	ጥ.ቁ. 13
12	ለጥያቄ ቁጥር 11 መልስዎ አዎ ከሆነ, ለምን ያህል ጊዜ ከዚህ በታች በተጠቀሱት ቦታ ሰርተዋል (በዓመት) (ከአንድ በላይ መልስ ይቻላል)	1. ብረታ ብረት _____ 2. ድንጋይ መፍጫ _____ 3. ህንፃ ግንባታ _____ 4. ወፍጮ ቤት _____ 5. ሌላ ካለ ይጥቀሱ _____	

13	እራስዎ ምግብ ያበስላሉ ወይ?	1. አዎ 2. አይደለም	
14	ለጥያቄ ቁጥር 13 መልስዎ አይደለም ከሆነ, ከመኖሪያ ቤትዎ ዉስጥ ምግብ በሌላ ሰው ቢሆንም ይበስላል ወይ?	1. አዎ 2. አይደለም	
15	ለጥያቄ ቁጥር 13 ወይም 14 መልስዎ አዎ ከሆነ, በአብዛኛው ምግብ ለማብሰል ምን ዓይነት ሀይል ይጠቀማሉ? (ከአንድ በላይ መልስ ይቻላል)	1. ከሰል 2. እንጨት 3. ጋዝ 4. ኤሌክትሪክ	
<i>ክፍል ሦስት: የቀድሞ ታሪክ የመተንፈሻ አካላት ህመም በተመለከተ</i>			
16	በቀድሞ ሂደትዎ በሃኪም የተነገሩት የቆየ የሳንባ ችግር ታምሞ ያውቃሉ?	1. አዎ 2. አይደለም	ጥ.ቁ. 18
17	ለጥያቄ ቁጥር 16 መልስዎ አዎ ከሆነ, የትኛው ዓይነት የጤና ችግር ከዚህ በፊት ገጥመዎት ነበረ (ከአንድ በላይ መልስ ይቻላል)	1. የቆየ የጉርሮ ቁስለት (የቆየ ብሮንካይትስ) 2. መተንፈስ የሚያውክ የሳንባ በሽታ 3. አስም 4. የሳንባ ካንሰር 5. የሳንባ ነቀርሳ/ቲቢ 6. ሌላ አይነት ይጠቀስ _____	
<i>ክፍል አራት: ሲጋራ ማጨስ ባህሪ</i>			
18	ሲጋራ አጭሰው ያውቃሉ? (የለም ማለት እስካሁን ድረስ ከ 20 ጋራ በታች ማጨስ ወይም በቀን ከአንድ ሲጋራ በታች ለአንድ አመት ማጨስ)	1. አዎ 2. አይደለም	ጥ.ቁ. 22
19	ለጥያቄ ቁጥር 18 መልስዎ አዎ ከሆነ, አሁን ሲጋራ ያጨሳሉ (ባለፈው አንድ ወር ዉስጥ)?	1. አዎ 2. አይደለም	ጥ.ቁ. 21
20	አሁን በአማካይ በቀን ምን ያህል ሲጋራ ያጨሳሉ?	_____ ሲጋራ በቀን	
21	ምን ያህል አመታት ሲጋራ አጨሱ (በአመት)?	_____ አመት	
22	በቤትዎ ዉስጥ ሲጋራ የሚያጨስ ሰው አለ ወይ?	1. አዎ 2. አይደለም	
<i>ክፍል አምስት: የመተንፈሻ አካላት ችግር</i>			
<i>1. ሳል</i>			
23	አብዛኛውን ጊዜ ሳል አለዎት?	1. አዎ 2. አይደለም	ጥ.ቁ. 25

24	አብዛኛውን ጊዜ ከ 4 እስከ 6 ጊዜ በቀን ፣ 4 ወይም ከዛ በላይ በሳምንት ሳል ያስለዎታል?	1. አዎ 2. አይደለም	
25	አብዛኛውን ጊዜ ጧት ከእንቅልፍ ሲነሱ ያስለዎታል?	1. አዎ 2. አይደለም	
26	በተቀሩት የቀን ወይም የሌሊት ሰዓት ያስለዎታል?	1. አዎ 2. አይደለም	
27	ላንዳቸው ጥ.ቁ. (23, 24, 25 ወይም 26) መልስዎ አዎ ከሆነ, የሚከተሉት ሁለት ጥያቄዎች ይመልሱ፡፡ ለሁሉም አይደለም ከሆነ ወደ ጥ.ቁ. 29 ይሂዱ፡፡ ባለፈው 12 ወር ውስጥ እንደዚህ ዓይነት ሳል በአብዛኛው ቀናት ለተከታታይ 3 ወርና ከዛ በላይ አስለዎት ያቃል?	1. አዎ 2. አይደለም	
28	ሳሉ ለምን ያህል ጊዜ ቆይቷል? (ሳል፡ በአንድ አመት ውስጥ ለሶስት ወር ያህል በቀን ከ4-6 ጊዜ፣ በሳምንት 4 ቀንና ከዛ በላይ ወይም አብዛኛውን ጊዜ ጧት ከእንቅልፍ ሲነሱ ወይም በተቀሩት የቀን ወይም የሌሊት ሰዓት ሳል ካለዎት)	_____ ዓመት	
II. አክታ			
29	አብዛኛውን ጊዜ ከደረትዎ አክታ ይወጣል?	1. አዎ 2. አይደለም	ጥ.ቁ. 31
30	አብዛኛውን ጊዜ እንደዚህ አይነት አክታ በቀን 2 ጊዜ ወይም በሳምንት 4 ወይም ከዛ በላይ ይወጣል?	1. አዎ 2. አይደለም	
31	አብዛኛውን ጊዜ ጧት ከእንቅልፍ ሲነሱ ከደረትዎ አክታ ይወጣል?	1. አዎ 2. አይደለም	
32	አብዛኛውን ጊዜ በቀን ወይም በሌሊት አክታ አለዎት?	1. አዎ 2. አይደለም	
33	ላንዳቸው ጥ.ቁ. (29, 30, 31 ወይም 32) መልስዎ አዎ ከሆነ, የሚከተሉት ሁለት ጥያቄዎች ይመልሱ፡፡ ለሁሉም አይደለም ከሆነ ወደ ጥ.ቁ. 35 ይሂዱ፡፡ ባለፈው 12 ወር ውስጥ እንደዚህ ዓይነት አክታ በአብዛኛው ቀናት ለተከታታይ 3 ወርና ከዛ በላይ ነበረብዎት?	1. አዎ 2. አይደለም	
34	እንደዚህ አይነት አክታ የመውጣት ችግር ከጀመረዎት ስንት ዓመት ሆነዎት? (አክታ፡ በአንድ አመት ውስጥ ለሶስት ወር ያህል በቀን ሁለቱ፣ በሳምንት 4 ቀንና ከዛ በላይ ወይም	_____ ዓመት	

	አብዛኛውን ጊዜ ጧት ከእንቅልፍ ሲነሱ ወይም አብዛኛውን ጊዜ በቀን ወይም በሌሊት አክታ የመውጣት ችግር ካለዎት)		
III. የማቃተት ወይም የማንከራፈት ድምፅ፣ የአፍንጫ መቆጣትና ማስነጠስ			
35	ሲቀዘቅዝዎት ደረትዎ የማንከራፈት ወይም የማፋጨት ድምፅ ያሰማል?	1. አዎ 2. አይደለም	
36	አልፎ አልፎ ከቅዝቃዜ ሲወጡ ደረትዎ የማንከራፈት ወይም የማፋጨት ድምፅ ያሰማል?	1. አዎ 2. አይደለም	
37	አብዛኛው ቀን ወይም ሌሊት ደረትዎ የማንከራፈት ወይም የማፋጨት ድምፅ ያሰማል?	1. አዎ 2. አይደለም	
38	ላንዳቸው ጥ.ቁ. (35, 36 ወይም 37) መልስዎ አዎ ከሆነ, የሚቀጥለው ጥያቄ ይመልሱ። ለሁሉም አይደለም ከሆነ ወደ ጥ.ቁ. 39 ይሂዱ። ይህን የማንከራፈት ድምፅ ማስማት ከጀመረዎት ምን ያህል ጊዜ ሆነዎት? (የማቃተት ድምፅ፣ ባለፈው 12 ወር ውስጥ ለሶስት ወር ያህል ወደ ውስጥ ወይም ወደ ውጭ ስያስተነፍሱ ወይም ሲቀዘቅዝዎት ወይም አልፎ አልፎ ከቅዝቃዜ ሲወጡ ወይም አብዛኛው ቀን ወይም ሌሊት ደረትዎ የማንከራፈት ወይም የማፋጨት ድምፅ ደረትዎ ላይ የማንከራፈት ወይም የማፋጨት ድምፅ ካለዎት)	_____ ዓመት	
39	የአፍንጫ መቆጣት ችግር አለዎት?	1. አዎ 2. አይደለም	ጥ.ቁ. 41
40	ለ ጥ.ቁ. 39 መልስዎ አዎ ከሆነ, ይህን የአፍንጫ መቆጣት ከጀመረዎት ምን ያህል ጊዜ ሆነዎት?	_____ ዓመት	
41	ይህን ስራ ከጀመሩ የማስነጠስ ችግር ይታያዎታል?	1. አዎ 2. አይደለም	ጥ.ቁ. 43
42	ለ ጥ.ቁ. 41 መልስዎ አዎ ከሆነ, ይህን አይነት ማስነጠስ ከጀመረዎት ምን ያህል ጊዜ ሆነዎት?	_____ ዓመት	
IV. የትንፋሽ ማጠር ወይም መቆራረጥ			
43	በፍጥነት ሲራመዱ ወይም ኮረብታ ሲወጡ የትንፋሽ ማጠር ችግር አጋጥመዎት ያውቃል?	1. አዎ 2. አይደለም	ጥ.ቁ. 49
44	ከትንፋሽ ማጠር ምክንያት ከእኩዮችዎ ባነሰ ፍጥነት የመራመድ ችግር አጋጥመዎት ያውቃል?	1. አዎ 2. አይደለም	

45	በራስዎ ፍጥነት ሜዳ ላይ ሲራመዱ የትንፋስ መቋረጥ ችግር አጋጥመዎት ያውቃል?	1. አዎ 2. አይደለም	
46	ለ100 ያርድ ወይም 96 ሜ ያህል ሜዳ ላይ ከተራመዱ በኋላ የትንፋስ መቋረጥ ችግር አጋጥመዎት ያውቃል?	1. አዎ 2. አይደለም	
47	ከቤት ሲወጡ ፣ ልብስ ሲለብሱ ወይም ስያወልቁ ከፍተኛ የትንፋስ መቋረጥ ችግር አጋጥመዎት ያውቃል?	1. አዎ 2. አይደለም	
48	ላንዳቸው ጥ.ቁ. (43, 44, 45, 46 ወይም 47) መልስዎ አዎ ከሆነ, የሚቀጥለው ጥያቄ ይመልሱ፡፡ ለሁሉም አይደለም ከሆነ ወደ ጥ.ቁ. 49 ይሂዱ፡፡ እንደዚህ አይነት የትንፋስ መቋረጥ ችግር ከጀመረዎት ስንት ዓመት ሆነዎት? (የትንፋስ ማጠር፡ ባለፈው 12 ወር ውስጥ ለሶስት ወር ያህል በፍጥነት ሲራመዱ ወይም ኮረብታ ሲወጡ የትንፋስ መቆራረጥ ችግር ካለዎት)	_____ ዓመት	

ANNEX IV: OBSERVATIONAL CHECKLIST (AMHARIC VERSION)

ተ/ቁ	መጠይቅ	መልስ	ማብራርያ
49	የግል ስራ ትጥቅ ስለመኖሩ (ከአንድ በላይ መልስ ይቻላል)	1. ጭምብል ወይም ሰው ሰራሽ የመተንፈሻ መሳርያ	
		2. የአፍ ወይም የአፍንጫ መሸፈኛ	
		3. የእጅ ጓንት	
		4. የአይን መከላከያ/መነፅር	
		5. ቦት/ሴፍቲ ጫማ	
		6. የስራ ሙሉ ልብስ /ሽርጥ	
		7. የብረት ባርኔጣ	
50	የግል ስራ ትጥቅ አጠቃቀም (ከአንድ በላይ መልስ ይቻላል)	1. ጭምብል ወይም ሰው ሰራሽ የመተንፈሻ መሳርያ	
		2. የአፍ ወይም የአፍንጫ መሸፈኛ	
		3. የእጅ ጓንት	
		4. የአይን መከላከያ/መነፅር	
		5. ቦት ጫማ	
		6. የስራ ሙሉ ልብስ /ሽርጥ	
		7. የብረት ባርኔጣ	

ANNEX V: STREET DUST CONCENTRATION

Table 9: Personal total dust exposure (mg/m³) among street sweepers in Addis Ababa, Ethiopia, 2018 (n = 50)

Sample code	Sampling duration (minutes)	Average flow rates (liter/minutes)	Volume of air (m ³)	Net weight of dust (mg)	Dust concentration (mg/m ³)
KRT 1	138	2.00	0.276	2.40	8.70
KRT 2	139	2.00	0.278	4.81	17.30
KRT 3	144	2.00	0.288	5.96	20.69
KRT 4	147	2.00	0.294	6.77	23.03
KRT 5	146	2.00	0.292	4.64	15.89
KRT 6	124	2.00	0.248	5.92	23.87
KRT 7	134	2.00	0.268	4.40	16.42
KRT 8	140	2.00	0.280	2.78	9.93
KRT 9	126	2.00	0.252	1.78	7.06
KRT 10	131	2.00	0.262	4.02	15.34
KRT 11	117	2.00	0.234	2.08	8.89
KRT 12	105	2.00	0.210	1.76	8.38
KRT 13	121	2.00	0.242	2.40	9.92
KRT 14	96	2.00	0.192	3.09	16.09
KRT 15	104	2.00	0.208	2.36	11.35
KRT 16	152	2.00	0.304	2.05	6.74
KRT 17	146	2.00	0.292	2.07	7.09
KRT 18	144	2.00	0.288	2.89	10.03
KRT 19	155	2.00	0.310	2.05	6.61
KRT 20	155	2.00	0.310	2.20	7.10
KRT 21	130	2.00	0.260	2.81	10.81
KRT 22	131	2.00	0.262	3.16	12.06
KRT 23	131	2.00	0.262	2.95	11.26
KRT 24	134	2.00	0.268	2.13	7.95
KRT 25	139	2.00	0.278	1.60	5.76
KRT 26	149	2.00	0.298	2.60	8.72
KRT 27	149	2.00	0.298	3.91	13.12
KRT 28	154	2.00	0.308	3.42	11.10
KRT 29	149	2.00	0.298	2.91	9.77
KRT 30	149	2.00	0.298	1.53	5.13
KRT 31	113	2.00	0.226	1.87	8.27
KRT 32	112	2.00	0.224	2.21	9.87
KRT 33	113	2.00	0.226	2.27	10.04

KRT 34	113	2.00	0.226	2.21	9.78
KRT 35	114	2.00	0.228	2.20	9.65
KRT 36	163	2.00	0.326	3.79	11.63
KRT 37	158	2.00	0.316	3.74	11.84
KRT 38	153	2.00	0.306	3.03	9.90
KRT 39	149	2.00	0.298	2.14	7.18
KRT 40	155	2.00	0.310	3.16	10.19
KRT 41	134	2.00	0.268	3.05	11.38
KRT 42	130	2.00	0.260	2.40	9.23
KRT 43	131	2.00	0.262	2.86	10.92
KRT 44	133	2.00	0.266	3.56	13.38
KRT 45	134	2.00	0.268	2.33	8.69
KRT 46	153	2.00	0.306	4.26	13.92
KRT 47	152	2.00	0.304	2.50	8.22
KRT 48	121	2.00	0.242	1.41	5.83
KRT 49	125	2.00	0.250	1.11	4.44
KRT 50	144	2.00	0.288	3.03	10.52
Max	163		0.236	6.77	23.87
Min	96		0.192	1.11	4.44
Range	67		0.134	5.66	19.43
A.M	135.58	2.00	0.271	2.93	10.82
SD	16.10		0.032	1.19	4.19
G.M	134.59		0.269	2.73	10.14
GSD	1.13		1.132	1.46	1.43

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

Note: The sampling dates- Day 1,2,3,4,5,6,7,8,9,10: 30/04/2018, 02/05/2018, 04-08/05/2018, 10-12/05/2018, respectively.

Table 10: Total dust exposure levels by task among sweepers in Addis Ababa, Ethiopia, 2018

S/N	Task operation	AM (\pm SD) (mg/m^3)	GM (\pm GSD) (mg/m^3)
1	Sweeping	12.57(5.09)	11.71(1.46)
2	Collection	11.24(3.70)	10.59(1.48)
3	Loading into dustbin	8.59(2.11)	8.33(1.31)
4	Transporting and disposing of waste	9.13(2.64)	8.86(1.28)
5	Total	10.82(4.19)	10.14(1.43)

AM- arithmetic mean, G.M- geometric mean, GSD- geometric standard deviation, SD- standard deviation

ANNEX VI: PERSONAL DUST SAMPLING DEMONSTRATION



Figure 7: Street sweeping operation: Sweeping; Collecting wastes and dust in one place; Loading dust in a dust bin and cart; Transporting and disposing of wastes and dust, Addis Ababa, Ethiopia, 2018



Figure 8: Typical sampling demonstration and picture of nose/mouth mask, respectively among street sweepers of Addis Ababa, Ethiopia, 2018



Figure 9: Dust sampling equipments used among street sweepers in Addis Ababa, Ethiopia, 2018, i.e., Hand pump, 37 mm Millipore plastic cassette (CFC), PVC filter, and Rota meter respectively.

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: Kenfe Tsehaye

Signature _____

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 _____