ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCE

SCHOOL OF PUBLIC HEALTH

Assessment of Personal exposure levels to bagasse dust and its respiratory outcomes among workers at Wonji Shoa Sugar Estate, Oromia regional state, Ethiopia; Comparative Cross-Sectional study

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A Research Thesis Submitted to the Graduate Program of Addis Ababa University, College of Health Science, School of Public Health in Partial Fulfillment for the degree of Master of Public health in Environmental and Occupational Health specialty

June, 2024

Addis Ababa, Ethiopia

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By: Walelign Erkalo **Signature ________ Date _________**

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Acknowledgments

First and foremost, I offer my heartfelt thanks to the Almighty God for granting me the strength, patience, and perseverance to successfully complete this research work.

I would like to express my deepest and most sincere gratitude to my primary advisor, Dr. Samson Wakuma, whose unwavering support, insightful guidance, constructive feedback, and continuous encouragement were instrumental throughout every stage of this thesis. I am also profoundly grateful to my co-advisor, Dr. Teferi Abegaz, for his valuable input and mentorship.

My sincere appreciation goes to Professor Abera Kumie for his dedicated support, thoughtful advice, and inspiring leadership, which greatly enriched my academic journey and this research endeavor.

I would also like to acknowledge Addis Ababa University, College of Health Sciences, particularly the Environmental and Occupational Health Unit, for equipping me with the knowledge and skills essential to my academic development. I extend my gratitude to all the academic and administrative staff who contributed to my professional growth during this program.

Special thanks go to the data collectors and supervisors, whose commitment and resilience in the face of challenging field conditions made the successful completion of this study possible. I am equally thankful to the study participants and their supervisors from Wonji Shoa Sugar Factory and Kiya Water Bottling Factory—your cooperation and willingness to participate are deeply appreciated.

Finally, I am grateful to NORAD/NORHED for funding this study through the research project titled "Reduction of the Burden of Injuries and Occupational Exposures through Capacity Building in Low-Income Countries". Your support has been vital to the realization of this work.

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List of Acronyms and Abbreviation

ATS- American Thoracic Society

BMI - Body mass index

BOLSA- Biro of Labour and Social Affairs

CFC- Closed face cassette

CRS- Chronic Respiratory Symptoms

FEV1- Forced Expiratory Volume at One Second

FMHACA- Food, Medicine, Health Administration and Control Authority

FVC- Forced Vital Capacity

ILO- International Labour Organization

LMIC- Low- and Middle-Income Countries

LEV- Local Exhaustive Ventilation

MOLS- Ministry of Labor and Skills

NIOSH- National Institute of Occupational Safety and Health

OSH- Occupational Safety and Health

PFT- Pulmonary Function Test

PPE- Personal Protective Equipment

PVC- Polyvinylchloride

SKC- Side Kick Cassella

SPSS- Statistical Package for Social Sciences software

Abstract

Background:

Sugar estate workers are exposed to high levels of sugarcane fiber (bagasse) dust that can reach to respiratory bronchioles and alveolar wall, causing sensitization and lung damage. Despite high levels of bagasse dust exposure, which can lead to chronic respiratory symptoms and lung function impairment, little information is available regarding the levels to personal bagasse dust and its impact on respiratory health, including on lung function.

Objective:

This study intended to determine personal exposure levels to bagasse dust and the prevalence of chronic respiratory symptoms and lung function parameters among sugar estate workers.

Methods:

An institution-based comparative cross-sectional study was conducted among 190 sugar estate workers and 191 non-exposed from water bottling. Fifty personal dust sampling was performed with a 37 mm Millipore plastic cassette with a PVC filter attached to the worker's breathing zone. Chronic Respiratory symptoms were evaluated using a standardized questionnaire and the lung function was measured following established spirometry guidelines. Multivariable logistic regression analysis with 95% CI and $p < 0.05$ was used to identify the factors and the measured lung function indices were analyzed by Analysis of Covariance.

Results:

About 85.7% of the workers were exposed to levels exceeding the recommended permissible threshold value, with geometric mean exposure levels of bagasse dust 9.49 ± 4.01 mg/m³, for total organic dust (5 mg/m³). The prevalence of at least one CRS (62.1%) was 2.43 times higher among exposed workers compared to non-exposed (PR = 2.43; 95% CI: 1.80–3.38). Significant associations were observed between CRS and age ≥35 years, non-use of respiratory protective devices, and weekly hours of working more than 48 with AOR (95% CI) of 4.851(1.123-20.952), 5.39(1.611-18.025) and 10.15(3.159-32.582), respectively. Among the exposed groups the lung function indices; Forced Expiratory Volume in one second (FEV1) and Forced Volume Capacity (FVC) were significantly reduced (p-value<0.05). All parameters (FVC, FEV_1 , FEV_1 /FVC) showed a negative correlation with cumulative dust exposure.

Conclusion and recommendation:

The adjusted prevalence ratios of respiratory symptoms were higher in the exposed group than non-exposed primarily due to bagasse dust exposure above the permissible exposure value of 5 mg/m^3. Age over 35 years, non-use of respiratory protective devices, and weekly working hours of more than 48 were the main determinants of CRS. Lung function indices, FVC and FEV_1 were lower in the exposed group than the non-exposed. These findings highlight the urgent need for targeted dust control measures in the sugar agro-industry to protect workers exposed to high levels of bagasse dust.

Key Words: Bagasse dust, Chronic respiratory symptoms (CRS), Lung Function Parameters (FVC, FEV1, FEV1/FVC)

1. Introduction

1.1. Background

Sugarcane is an agro-energy crop produced mainly in Low- and Middle-Income Countries (LMIC). Generally, about 4% of global sugarcane production has been contributed by Sub-Saharan African countries with South Africa taking the lead followed by Sudan (1). In the past few years, Ethiopia's sugar manufacturing industry has been growing continuously; it is now a key industrial sector. Wonji Shoa Sugar factory is the pioneer among the major 8 sugar factories in Ethiopia working to its full potential, with a cultivation field of more than 16,000 hectares of sugarcane plantation. Over 6,500 workers are currently benefited from the job opportunities created by Wonji Shoa Sugar Factory as a permanent, contract, seasonal employees. (2) (52). Despite their significant contributions to food supply and employment, sugar factories are associated with a high prevalence of occupational morbidity and mortality worldwide (3).

Through the whole process starting from the pre-harvest burning till the final refinery and packaging workers are exposed to high levels of organic bagasse dust exceeding the NIOSH organic dust exposure limit of 5 mg/m^3. Even though the pre-harvest sugarcane burning practice facilitates the manual cutting of the stalk by the workers using machetes, this practice will considerably expose the workers to different types of gaseous substances and dust particle basically sugarcane bagasse ash. Bagasse dust consists of fine particles with varying aerodynamic diameters that can irritate the upper respiratory tract and penetrate deeply into the alveolar ducts and sacs. Inhalation of this organic sugarcane fiber bagasse dust by workers and nearby communities can adversely affect human health, leading to persistent respiratory symptoms and gradual impairment of lung function indices (4) (5). Frequent exposure to bagasse dust during sugar processing and refining can lead to bagassosis, a respiratory disease similar to extrinsic allergic alveolitis. It progresses through acute and chronic stages, typically starting with shortness of breath and followed by coughing (6). Studies highlight significant respiratory health risks among sugar industry workers. In India, 92% were exposed to bagasse dust, with 32% reporting respiratory symptoms (7, 8). Brazilian workers exhibited reduced pulmonary function indices, while in Africa, 75% experienced CRS, and 54% showed pulmonary impairments (9, 10). The risk of developing this condition is closely linked to socioeconomic, behavioral, and job-related factors (11, 12).

1.2. Statement of the problem

The first documented case of bagasse dust exposure was reported among bagasse handlers working in a sugar factory supplying materials to a particle board factory in Egypt (10). Specific standards for assessing organic dust exposure, such as bagasse, are not well-defined and are generally considered under the NIOSH general dust exposure limit of 5 mg/m³ (13). Unfortunately, the occupational exposure limit for such organic dust may not sufficiently safeguard sugar estate workers from negative health outcomes due to the exposure of sugarcane bagasse dust contaminated with microorganisms. Workers in the sugar factory are exposed to bagasse dust every day at their workplace. Bagasse dust exposure has been linked to various health problems among workers, including respiratory irritation, allergic reactions, cancers of the nasal cavity and lungs, as well as eye and skin conditions (6) (11).

The study findings done in different countries on the effect of bagasse dust exposure on lung function parameters have been controversial (7, 14-16) . For instance, studies from Indian sugar factories revealed that there was a decrease in all lung function parameters among different sections of the sugar factor workers with a significant decrease noticed in bagasse baling workers (7, 15). Contrary to the above study done in Costa Rica found that bagasse dust exposure did not seem to affect the ventilatory lung function parameters forced expiratory volume in 1 s (FEV1), forced vital capacity (FVC) and FEV1/FVC (6).

Despite the expected higher exposure levels, there has been very limited information regarding bagasse exposure among workers in sugar industries as well as on health outcomes, particularly in pulmonary function impairment in the Ethiopian sugar agro-processing sector. The limited information regarding the exposure status was mainly based solely on aerial total dust (PM) measurements which were not gathered from worker proxies' breathing zones. The magnitude of personal bagasse dust exposure level in sugar factories is rarely addressed in occupational exposure assessments in the Ethiopian context. The respiratory sequels reported were based on self-report and assessed merely by using CRS questionnaires with not having the ventilatory lung function parameters status of the workers (11, 12). Therefore, this study aims to determine personal exposure levels to bagasse dust and its impact on CRS and pulmonary function indices among Wonji Shoa sugar estate workers.

1.3. Rationale and significance of the study

Rationale

Sugar factories are growing in Ethiopia contributing a significant role in economic development and creating job opportunities for many citizens. Bagasse dust exposure poses a significant burden on the respiratory health of sugar factory workers, with both immediate and long-term consequences that can ultimately undermine workforce well-being and reduce the sector's productivity. Likewise, almost all sugar mill factories in Ethiopia lacks thorough and periodic occupational exposure assessment to bagasse and other inorganic dusts. This study assessed the levels of personal sugarcane bagasse dust exposure and its respiratory health outcomes in sugar factory, Ethiopia.

Significance of the study

This study's results will enhance the existing understanding of how bagasse dust exposure affects workers' respiratory health. Moreover, the insights gained can inform policy development and assist health planners and stakeholders in implementing effective measures to reduce and manage dust exposure in occupational settings. Furthermore, the data generated from this study can be used for future study as a baseline.

2. Literature review

2.1. Sugarcane Agro-processing

Sugarcane (Saccharum officinarum) is one of the most widely cultivated cash crops in tropical and subtropical regions across the globe. Brazil and India together contribute approximately 57% of global sugarcane production, with Pakistan, China, Thailand (17) and Sub- Saharan Africa countries accounting the rest (1). The processing of sugarcane is expanding rapidly to support the production of sugar, bioethanol, electricity, and other valuable products. (18). In Ethiopia, the sugar industry has experienced rapid growth since the establishment of the first factory in the early 1950s, evolving into a key component of the national economy. At present, there are eight operational sugar factories across the country, including Wonji Shoa, Metehara, Fincha, Arjo Dediessa, Omo Kuraz II and III, Kessem, and Tana Beles, with ongoing expansion efforts.

The Wonji Sugar Factory, located in the Oromiya region near Adama City, 110 kilometers from Addis Ababa, is Ethiopia's oldest sugar factory, established in 1954 by the Dutch firm. It was the pioneer of the sugar industry, followed by the Shoa in 1962. To modernize and replace these aging facilities, an expansion project began in 2013/2014, focusing on both cane cultivation and factory upgrades. The modernized Wonji Shoa Sugar Factory is currently designed to crush 6,250 tons of sugarcane per day, yielding approximately 174,946 tons of sugar each year. With planned expansions, its capacity is expected to reach 12,500 TCD, boosting annual sugar output to around 220,700 tons (2).

Sugar manufacturing involves several occupations with distinct processing units mandatory for the sugar production (7). Sugar production from sugarcane passes through several integrated processes starting from planting till processing, during which, sugar estate workers exposed to different types of OSH hazards. Pre-harvest burning and manually cutting of sugarcane pose a tremendous risk on workers' health particularly of respiratory, renal, cardiovascular, musculoskeletal and dermatological problems. During the processing and refinery which is highly energy intensive phase the sugar estate workers are mainly exposed to heat, noise, chemicals mainly of carcinogenic, bagassosis and other chronic infections (19). That significantly harm the productivity of workers with related morbidities and mortalities and economy of the factories by spending millions of dollars for such incidents compensation (20).

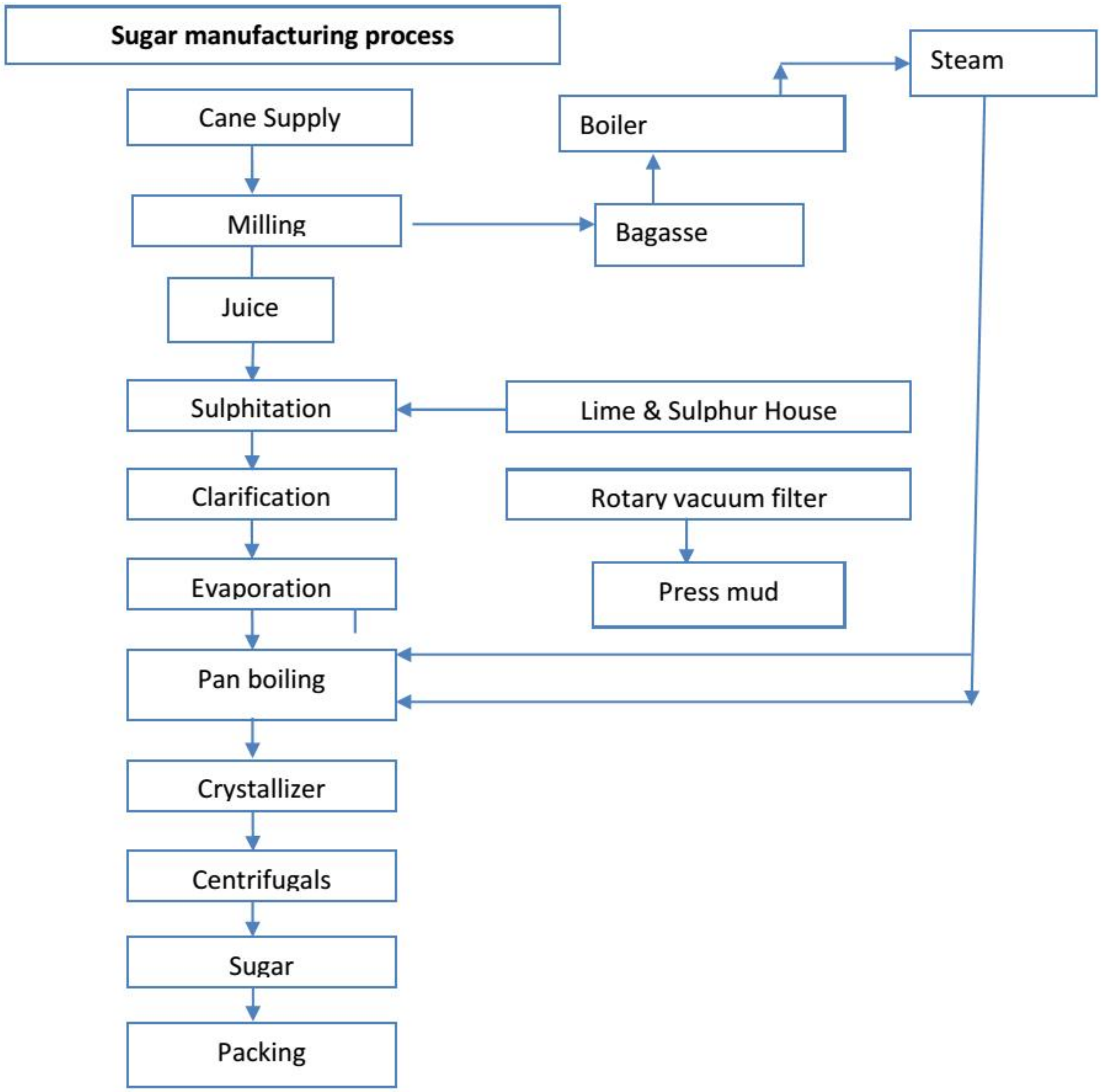

Figure 1. Flowchart Sugar Manufacturing Process

Bagasse, a by-product of sugarcane processing, is the fibrous residue left after the extraction of juice from sugarcane stalks. Its composition varies depending on the sugarcane variety, harvesting methods, and processing techniques. It is composed of cellulose fibers (40-50%), hemicellulose (20-25%), lignin (18-25%), and ash (1-4%), with moisture content ranging from 40-60%. Its high cellulose and lignin content make it valuable for bio-energy, paper production, and bio-composites, and its chemical composition allows for conversion into bio-fuels. Bagasse dust is an organic dust containing high concentrations of bio-aerosols, such as bacteria, actinomycetes, and fungi of plant origin. The aerodynamic diameter varies a lot from 0.5 to 3 microns, which are called as respirable dust to approximately 40 microns and above categorized under total dust, to which sugar factory workers are exposed by virtue of their occupation results in Bagassosis respiratory illness specific to sugarcane bagasse dust (7, 21).

Bagassosis belongs to interstitial lung diseases or hypersensitivity pneumonitis with granulomatous interstitial disorder resulting from reaction to allergens predisposed in occupational settings. It was first described by Ramanzzini in 1713 with the symptoms of cough and shortness of breath in workers exposed to dusts of cereal grains (22). It resembles an extrinsic allergic alveolitis. Chronic respiratory conditions linked to bagasse dust can reduce workers' productivity and impose financial burdens on their families due to treatment expenses. (7).

The clinical picture is mainly profound shortness of breath, cough, malaise, weight loss, and sometimes fever during the acute episode. Crepitation is a constant feature and chest radiographs usually show fine micronodular shadowing (13). There is a reduction in lung volumes, ventilatory capacity, and gas exchange in the alveolar level (23). Even if the acute disease is self-limiting and spontaneous symptomatic recovery occurs within six weeks after withdrawal from exposure to mouldy bagasse dust, prolonged and frequent exposure may end up with lung cancer (13, 24).

2.2. Bagasse Dust exposure and its determinants

Studies from major sugar-producing countries, including Brazil, India, Nicaragua, Thailand, China, and Costa Rica, have shown that sugar factory workers are exposed to significant levels of bagasse dust. Inhalable bagasse dust levels, such as 9.29 mg/m^3 reported in Thailand, often exceed recommended limits, leading to substantial respiratory health issues. That might end up with the risk of developing asthma, bronchitis, lung cancer and sugar factory specific respiratory problem; bagassosis (5, 6, 17, 25, 26). Likewise, the same results have been documented in Sub Saharan African countries (1, 14). In the Ethiopian context, studies have shown that over 75% of sugar factory workers operate in environments with bagasse dust concentrations exceeding the NIOSH-recommended permissible limit of 5 mg/m^3 for organic dust, presenting significant health risks to workers and potential operational challenges for the industry. Even if the measured level of bagasse dust exposure is only based on a static (areal) measurements strategy collected from fixed locations on the work stations. The variability of bagasse exposure experienced by individuals within factories is often inadequately captured in exposure assessments conducted in the country. The personal bagasse dust exposure method addresses these limitations by minimizing individual-level misclassification and enhancing precision through finer spatial measurements of dust exposure. This approach integrates data on dust exposure to pinpoint where and when bagasse dust exposure occurs, along with information on work patterns, behaviors, workplace conditions, and job-specific factors to identify who is exposed to bagasse and the mechanisms of exposure. Exposure for the bagasse dust is highly related with the socio-economic, behavioral and working condition or job-related factors (11, 12).

Socio-economic factors and dust exposure

Sugar estate workers are often from low-income backgrounds and are hired temporarily for seasonal work on short-term contracts with possible extension. This means employers don't have to provide benefits like pensions, healthcare, or employment insurance (1). Workers face health risks due to the physical strain of cane cutting and the poor living conditions, including overcrowded, low-quality housing. Payment based on production encourages workers to increase their workload, aiming for higher wages and better chances of being rehired in future seasons and possible permanent employment (4). Many workers spend their entire lives on the estate, living near the factory and exposed to bagasse dust for long periods. (11, 12).

Behavioral factors, Bagasse dust exposure and Respiratory Health

Worker dissatisfaction arises from inadequate and improper personal protective equipment (PPE) and limited safe work practices in the workplace. Furthermore, not using respiratory protection masks and neglecting respiratory safety measures increase their exposure to bagasse dust, leading to potential respiratory complications. (11, 12).

Working condition or Job-related factors, Bagasse dust exposure and Respiratory Health

The high level of bagasse dust exposure is mainly due to the absence of essential technologies, such as total enclosure of dusty work sections and proper ventilation mechanism, to control particulate emissions in areas where workers are exposed for extended periods, impacting their respiratory health. Additionally, the lack of administrative non-exposed such as job rotation, limiting time spent in dust-prone areas, and implementing wetting practices further exacerbates the issue. Poor maintenance and inspection of power turbine machines, along with inadequate labor inspection and delayed corrective actions, also contribute significantly. Moreover, an unsafe working environment combined with weekly workload exceeding 48 hours further increases workers' exposure to bagasse dust. (11, 12).

2.3. Bagasse dust exposure and CRS

Numerous studies have demonstrated that exposure to bagasse dust increases the risk of developing chronic respiratory conditions such as COPD, chronic bronchitis, exacerbated asthma, and bagassosis, particularly among sugar estate workers, despite some inconsistencies in the findings (26-30). From study conducted in Costa Rica the percentage of workers reporting wheezing (20.5%) and SOB (20.5%) during the pre-harvesting and harvesting seasons was higher among the workers exposed to bagasse dust (6). Whereas in African countries like Sudan and South Africa, studies showed that three forth of sugar factory workers experience persistent type of respiratory symptoms that may be directly linked with bagasse dust exposure while 54% of them ended up with respiratory sequels like pulmonary impairment (12, 14). From a longitudinal study conducted in Wonji Shoa and Metehara Sugar factor, 60.6% of the participants had experienced at least one chronic respiratory symptom during the active sugarcane crushing period (12). Accordingly, the individual complaints of CRS, such as wheezing, cough, breathlessness and work-related shortness of breath, were shown to be more common during the active sugar-crushing period compared with the non-operational seasons (6, 11, 12, 15, 16). The prevalence of the complaints of the CRS were mainly due to the absence of proper training on the use of respiratory protection devices. Even if training is given for the workers, individuals' behavior on complying for respiratory safety tips like wearing respiratory protection masks were poor that will significantly associated with the development of CRS. Some other studies relate the CRS with the age of the workers (>48years) and working hours of more than 48hours per week (11, 12, 25, 31).

2.4. Bagasse dust exposure and Lung Function Impairment

The pulmonary function tests assess respiratory efficiency. Studies done on the effect of bagasse dust up on lung function parameters were contrasting each other. Several studies have found that there will be a significant changes in FVC, FEV1, FEV1/FVC%, and PEFR in bagasse exposed workers (8, 27, 32). Evidences from studies conducted in India the overall Prevalence of pulmonary impairment was 32% with obstructive type of pulmonary impairment showed the maximum number of exposed in sugar factory workers (7, 15). The same findings have been reported in Brazil with lowered pulmonary indices (16). In contrast, some studies pointed out that exposure to bagasse dust did not seem to affect the ventilatory lung function parameters (6, 21). Duration of occupational exposure to organic dust (bagasse) due to their long work experience in this sector was the major factor to increase the likelihood of pulmonary impairment in sugar factory workers (7, 15).

Therefore, this study will address those inconsistences, controversies and knowledge gaps raised by the literatures reviewed particularly to fill knowledge and research gaps in Ethiopia related to the personal exposure level of bagasse dust and its impact on lung function parameters.

2.5. Summary of literature review

The sugar processing industry encompasses several complementary stages, from sugarcane plantation, cultivation and harvesting to refining and packaging of final product sugar. During these whole processes, workers face various chemical and physical health hazards, particularly exposure to organic dust (bagasse), which poses significant risks to respiratory health. This high level of exposure is primarily due to the absence of dust control technologies like local exhaust ventilation (LEV), inadequate availability of personal protective equipment (PPE), and its poor utilization by workers. Furthermore, the lack of administrative non-exposed such as job rotations, labor inspections, safety audits, and routine machine maintenance contributes to increased exposure and associated respiratory complaints. The severity of respiratory issues is closely linked to the concentration of bagasse dust and the duration of exposure. Prolonged employment, excessive dust levels, and uncomfortable working conditions further exacerbate respiratory symptoms, reducing workers' productivity.

Periodic monitoring and intervention are crucial to address this economically and socially impactful problem, safeguarding workers' health and improving overall productivity.

2.6. Conceptual Framework

This conceptual framework illustrates the interconnections between associated factors and outcome variables in the study, identifying key variables for investigation. Developed through an extensive review of studies on bagasse dust exposure, CRS, and pulmonary function among sugar estate workers, it guides the research process. CRS and pulmonary function (dependent variables) are directly influenced by employment duration, working hours, and bagasse dust exposure (independent variables). Additionally, they are linked to socio-demographic factors (age, sex, education, income), anthropometric measures (weight, height, BMI), and behavioral factors (PPE use, training, cooking fuel type, and smoking habits).

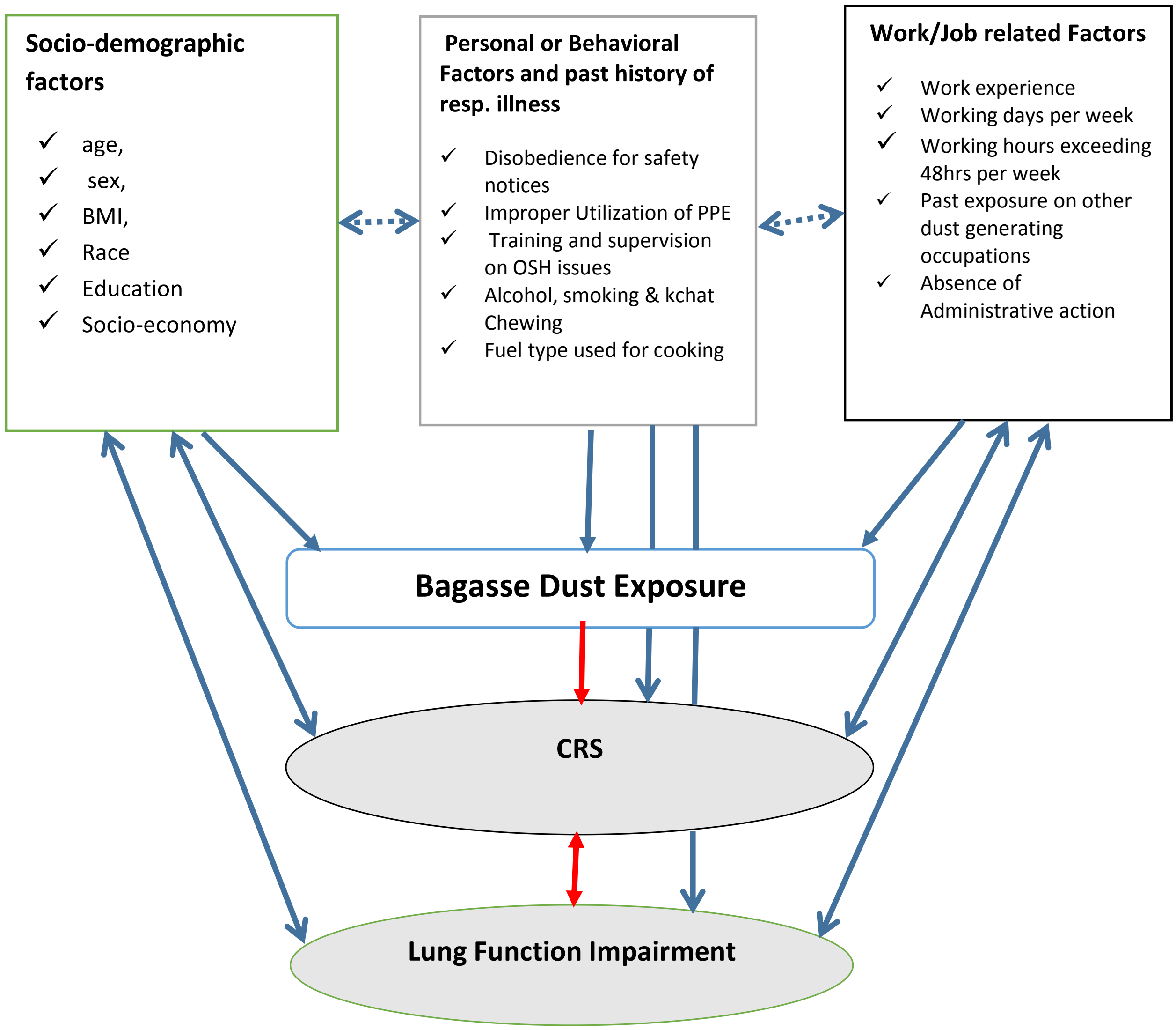

Figure 2. Conceptual framework of the study (12).

3. OBJECTIVES

3.1. General Objective:

The general objective of the study was to determine personal exposure levels to bagasse dust and its impact on CRS and pulmonary function indices among Wonji Shoa sugar estate workers, from January to March, 2025, Ethiopia.

3.2. Specific objectives:

- To determine the magnitude of personal bagasse dust exposure among Wonji Shoa sugar estate workers.
- To assess the prevalence and determinants of CRS among Wonji Shoa sugar estate workers
- To determine the Lung Function parameters among Wonji Shoa sugar estate and Kiya Water bottling factory workers.

4. Methods

4.1. Study area

The study was conducted in Wonji Shoa Sugar factory where the modern sugar industry was pioneered in Ethiopia in the early 1950s with an initial production of 140 tons of sugar a day. Followed by the Shoa Sugar Factory in 1962 with 170 tons of sugar production capacity a day. Later on, the two factories were administered as one factory (Wonji Shoa) with the current production capacity of 110,231 tons of sugar per annum. Beyond sugar production, the factory contributes around 20 megawatts of electric power to the national grid, satisfying its own demand of 11 megawatts. The factory is situated in Oromiya region near Adama City at 110 Kilo Meters from Addis Ababa centered at GPS coordinates of 8° 24' 25" north and 39° 16' 25" east, having a crushing capacity of 6250 tons of sugarcane per day with over 10678 workers currently employed permanently and contractually as daily laborer and seasonal workers (12).

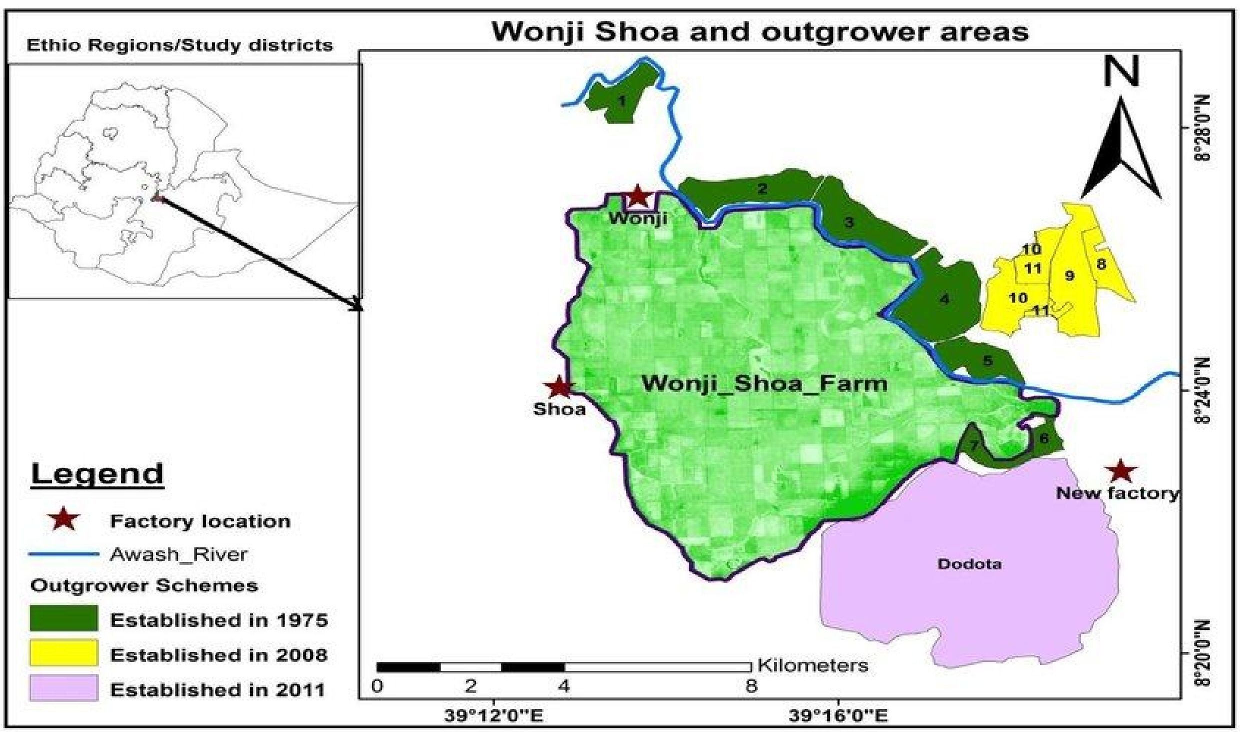

Figure 3. Map of Wonji-Shoa sugar factories, factory-operated plantation, and plots of out growers.

(Source: (33)).

4.2. Study design and period

An institution-based comparative cross-sectional study was conducted on Wonji Shoa Sugar factory and Kiya Water bottling factory workers from January to March, 2025. In this study, a water bottling factory was selected as a control group, based on the assumption that dust generation in this setting is minimal or negligible.

4.3. Source and study population

The source population was the working population in Wonji Shoa sugar factory and Kiya Water bottling factory and our study population was those study participants selected from selected work stations.

Inclusion criteria

The inclusion criteria for the study participants were workers aged above 18 years and with more than one year of work experience in the sugar and water bottling factories.

Exclusion criteria

On the other hand, workers with self-reported cardiopulmonary disorders, such as heart disease and past severe respiratory illnesses, as well as those who had undergone recent surgery involving the chest, abdomen, head, or eyes, were excluded from the study. It's to prevent exacerbation of their existing conditions, as spirometry involves forced breathing maneuvers that can increase intra-thoracic pressure and strain the cardiovascular or surgical sites.

4.4. Sample size determination

4.4.1. Sample size calculation for specific objective one (the magnitude/level of bagasse dust)

The sample size for personal bagasse dust exposure monitoring was determined following the guidelines proposed by Rappaport and Kupper for occupational exposure assessment. These guidelines suggest that "selecting 5 to 10 workers at random, with 10 to 20 exposure measurements per Similar Exposure Group (SEG), is sufficient to characterize exposure levels with SEG refers to a set of workers who perform similar tasks, in comparable environments, and for equivalent duration." (34). In the sugar factory, five SEGs were identified as potentially exposed to sugarcane bagasse dust: sugarcane milling, bagasse handling, boiler operation, evaporator section, and packaging in the pan house. Five workers were selected from each SEGs randomly (n=25) in a voluntarily base. Accordingly, two repeated measurements on consecutive days from each SEGs were performed, which gave us a total of 50 dust samples.

4.4.2. Sample size calculation for the second specific objective (prevalence and determinants of CRS)

By the assumption that flour mill and bagasse dust are categorized under organic dusts with similar characteristics. A comparative cross-sectional study conducted in Hawassa, Ethiopia, "to assess the CRS, pulmonary function and associated factors among flour mill factory workers" (35) showed that "the proportion of chest tightness among flour mill and soft drink factory workers was 23 (11.9) and 6 (2.9) respectively" which gave us the largest sample size among other respiratory complaints when computed by the double population proportion formula as follows.

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

Where n= sample size

$Z_{\alpha/2}$=1.96 at 95% confidence level

Z_{β} = Desired power of 85 % =1.0364

P_1=proportion of chest tightness among flour mill workers = 0.23 (11.9)

P_2=proportion of chest tightness among soft drink factory workers = 0.06 (2.9)

P_1-P_2=The expected difference in proportions between the two groups =0.17

Finally yields a total sample size of 346, where n1 = n2 = 173.

4.4.3. Sample size calculation for specific objective three (Pulmonary function indices)

By the assumption that coffee and bagasse dust are categorized under organic dusts with similar characteristics. A cross sectional study conducted in Ethiopia "to assess the reduction in Lung Function among Workers in Primary Coffee Processing Factories" (36) showed that the mean value and standard deviation of FVC in all age group were 4.03 (0.69) and 4.41 (0.63) for coffee processing and water bottling factory workers respectively give rise to the largest sample size (N=198) from the lung function indices. From the above study our sample size was computed using the the mean difference equation as follows,

$$n_1 = n_2 = \frac{\left(Z_{\alpha/2}+Z_\beta\right)\times(\delta_1^2+\delta_2^2)}{d^2},$$

Where n = n1 = n2 = sample size in each group

$Z_{\alpha/2}$=1.96 at 95% confidence level

$Z\beta$ = Desired power of 80 % =0.84

δ_1 = standard deviation among study group = 0.69

δ_2=standard deviation among control group = 0.63

d=mean difference (mean1 =4.03 and mean2 = 4.41) = 0.38

Due to the limited number of spirometric mouthpieces present in our hand, the lung function parameters were conducted among a total of 95 participants, both from the sugar estate and the water bottling factory in a 1:1 ratio.

Table 1. Summary of Sample determination of the study

S/no	Parameter	Rappaport recommendation	Number of department	Number of workers	Total number of workers	Total number of dust measurement
1	Number of personal bagasse dust measurements	5-10 from SEG	5	5 workers for each SEGs	25	50
2	Variables	Proportion		Calculated SS	Non response rate of (10%)	Total number of SS (both groups)

	Chest Tightness	11.9	2.9	346	35	381	
3	Variables	Mean (±SD)		SS Calculated	Nonresponse rate (10%	Total number of SS in each group	
		Group 1	Group 2			Group 1	Group 2
	FVC	4.41 (0.63)	4.03 (0.69)	178	196	98	98

The sample size computed for assessing the prevalence of (CRS) was the largest among all specific objectives, totaling 346. After accounting for a 10% non-response rate, the final sample size for the study was determined to be 381. For the LFT due to the limited number of spirometric mouthpieces present in our hand, the parameters were conducted among a total of 95 male participants, both from the sugar estate and the water bottling factory in a 1:1 ratio.

4.5. Sampling procedures

A total sample size of 381 was proportionally allocated between Wonji Shoa Sugar Factory and Kiya Water Bottling Factory. Within each factory, the sample was further distributed across different work sections using stratified random sampling. Study participants were then randomly selected from each departmental sampling frame using simple random sampling.

For the personal bagasse dust sampling, participants were selected from the five SEGs, with five workers randomly chosen from each department on a voluntary basis. The Similar Exposure Groups (SEGs) selected from the sugar factory included key work sections that are directly involved in the production process. These included the sugarcane milling section, where sugarcane delivered from the harvesting area is crushed both outdoors (Branko section) and indoors using five milling machines to extract sucrose juice. The juice then undergoes clarification and sulphitation in the evaporation section before proceeding to the pan house, where crystallization and centrifugation take place to produce raw sugar crystals. The final product is then processed in the packaging section for weighing and distribution. Meanwhile, the by-product of sugarcane milling, known as bagasse, is initially stored outdoors and then fed into the boiler section for steam and power generation. In addition, a portion of the bagasse is baled and stored for use during the next production season's start-up. These sections were selected based on their relevance to the production process and the likelihood of exposure to sugarcane bagasse dust, which aligns with the objectives of the study. From thesee sections a total of 50 samples were performed on 25 individuals twice from the selected departments, which is adequate and representative due to resource constraints and Rappaport recommendation.

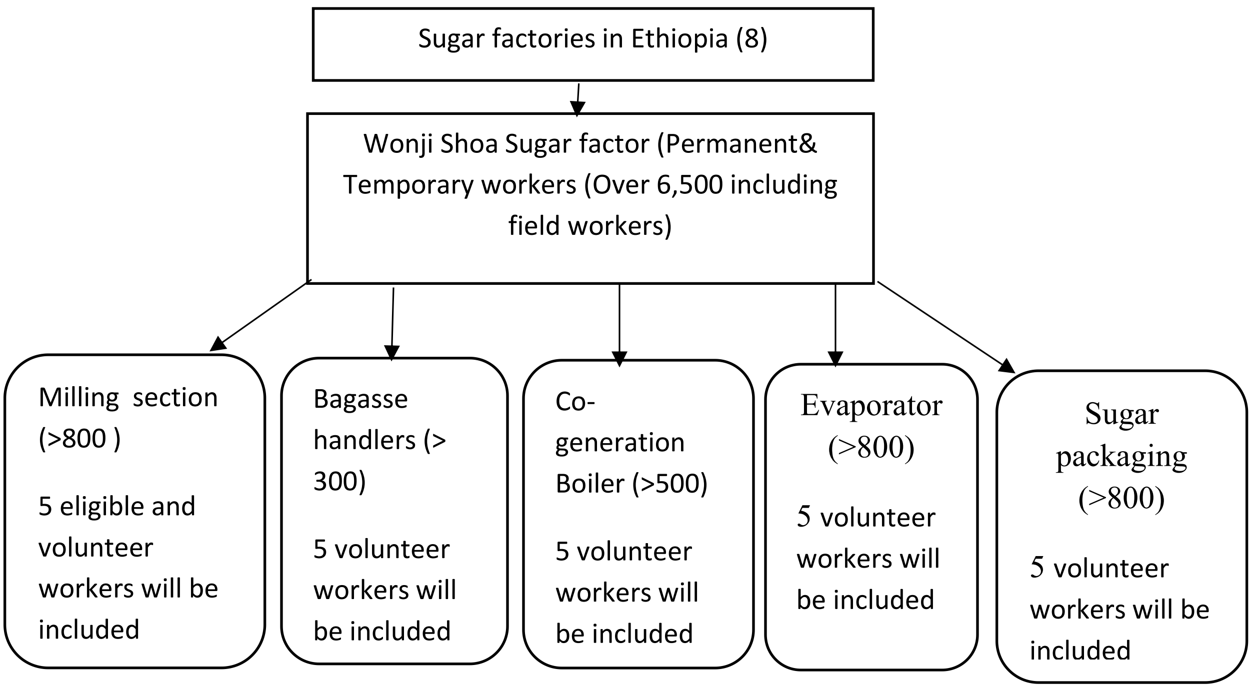

Figure 4.Schematic illustration of the sampling procedure for personal bagasse dust monitoring at Wonji Shoa Sugar Factory, Ethiopia, 2025.

4.6. Data collection procedures

4.6.1. Assessment of the CRS

The CRS were assessed by using the translated Amharic version standardized questionnaire adopted from the American Thoracic Society (ATS) with slight modifications through face-to-face interviews in the workplace. The questionnaire consists of socio-demographic, occupational history, past respiratory diseases, utilization of RPE while working, fuel type used for cooking, and smoking habits. On the other sub-section, it included questions about CRS, including cough, cough with sputum, breathlessness, work-related shortness of breath and wheezing. The data were collected by using the KOBO Collect Android App that suits the data collection setup by trained health professionals after a brief training and guidance on the details of the questionnaire, instruments utilized and ethical conduct is given.

4.6.2. Observational Checklist

An observational checklists with key informant interviews were used to assess the working environment, basically related to access and utilization of RPE.

4.6.3. Assessment of the magnitude of bagasse dust exposure levels

Personal samples of “total dust” with aerodynamic diameter of less than 100 micrometer were taken from the workers breathing zone attached on their lapel of clothes by using a 37mm diameter of Millipore plastic sampling closed face cassette/CFC (Millipore MAWP 025 AC) fitted with a PVC filter of 5μm pore size in line with rechargeable battery-powered SKC pumps with a flow rate of 2 liter per minute (37).

Image 1&2. Personal Dust exposure measurement on workers of wonji Shoa sugar factory from evaporator and milling sections, Ethiopia. (Source: photo gallery)

Full-shift 8-hour exposure assessment have been conducted on random days among five participants from each work station (34, 38) and repeated sampling were conducted in the next days. The time of the sampling period was recorded properly by using a stop watch timer. Two trained data collectors were engaged in giving direction to the study participants on the correct actions to be done while sampling, mounting the sampling instruments on the body of the study participants, coding the cassettes and following the pump's flow rate hourly. During the sampling phase, checklists and data sheets were employed to document key observations and findings. The sampling took 2 days in each chosen working department which means a total of 10 days with a total of fifty samples among 25 workers.

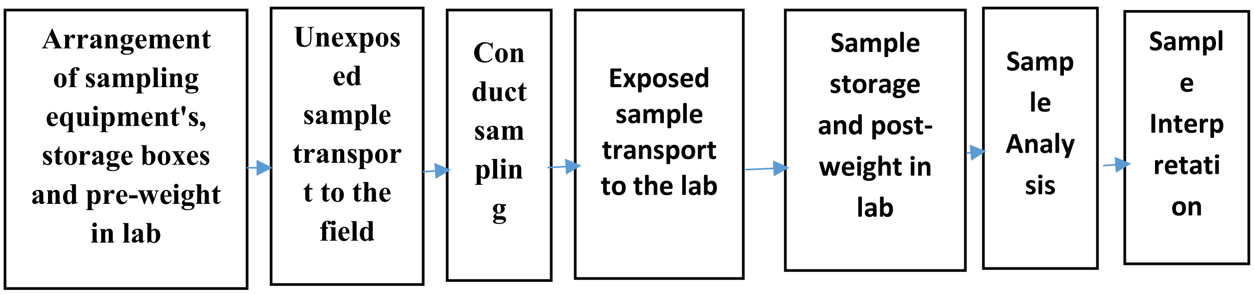

Figure 5. Sequence of dust sampling among Wonji Shoa Sugar factory workers; Ethiopia, 2025.

4.6.4. Anthropometric measurements

Anthropometric measurements were conducted among workers from Wonji Shoa Sugar Factory and Kiya Water Bottling Factory. Body weight was measured with participants standing and wearing light clothing, while height was measured using a field stadiometer. BMI was then automatically computed using the WinSpiro PRO software.

Image 3. Conducting anthropometric measurement of worker in Wonji Shoa Sugar factory.

4.6.5. Measurements of Lung Function indices

After the anthropometric measurement (standing height, weight, etc.), a spirometer was used for assessing lung function indices (FVC, FEV1and FEV1/FVC %) among the 2 factory workers in accordance with their similar exposure group in each factory using computer-based software WinSPIRO PRO. All measurements were taken by a well-trained health professional in an office setting where the room temperature was maintained between 34°C and 36°C. Prior to conducting the test, participants were given a clear explanation of the breathing procedure, which involved taking a deep breath in followed by a rapid and forceful exhalation. They were allowed to practice the maneuver to ensure proper technique. During the test, a nose clip was applied to prevent air escape through the nostrils. The participant began with a few normal breaths, then performed a deep inhalation followed by a strong, fast exhalation to complete the maneuver. All tests were taken in a comfortable upright sitting position and each individual continued to perform spirometry until three acceptable tests with a maximum of eight trials at the morning shift, according to the guidelines recommended by the American Thoracic Society (39). Throughout the procedure, the flow-volume curves shown on the Winspiro PRO interface were carefully observed to verify that participants exerted adequate effort during both the inspiratory and expiratory phases.

Image 4. Conducting Lung Function test among Wonji Shoa Sugar factory worker, Wonji Shoa, Ethiopia

4.7. Operational definitions

Bagasse dust exposure

"Bagasse dust exposure was defined as a measured concentration levels exceeding the NIOSH recommended exposure limit of 5 mg/m^3. Workers with exposure levels above this threshold were classified as occupationally exposed, while those below were considered non-exposed. " (12, 40).

CRS (CRS)

The presence of one or more symptoms; such as cough, sputum production, wheezing, breathlessness, or work-related shortness of breath, persisting for a minimum of three consecutive months within a year. (41, 42).

Cough

Participants were classified as having a cough if they responded 'yes' to at least one of the following: coughing upon waking in the morning, coughing during the day or at night, coughing four to six times daily in a typical week, or experiencing a cough on most days for at least three consecutive months in a year. (42).

Cough with sputum

Participants were identified as having a cough with sputum if they responded 'yes' to any of the following: producing sputum with a cough in the morning, during the day or at night, coughing up sputum four to six times daily in a typical week, or experiencing sputum-producing cough on most days for at least three continuous months within the year (42).

Breathlessness

Participants were classified as experiencing breathlessness if they reported difficulty breathing when walking briskly on flat ground, going up a gentle slope, walking at their usual pace on level ground, or keeping up with peers of similar age while walking on level surfaces (42).

Work-related shortness of breath

Participants were considered to have work-related shortness of breath if they commonly experienced chest tightness during or immediately after completing their work. (42).

Wheezing

Participants were identified as having wheezing if they had ever experienced a whistling or wheezy sound when breathing (42).

Forced Volume Capacity (FVC): - the greatest amount of air that can be forcefully and quickly exhaled after taking the deepest possible breath (39).

Forced expiratory volume in 1 sec (FEV1):- The amount of air expelled in the first second of the forced vital capacity (FVC) test (39).

FEV1/FVC: The proportion of the forced vital capacity (FVC) exhaled during the first second of a maximal forced expiration after a full inhalation. Values above 80% of the predicted norm are generally regarded as normal (39).

Current smoker: are those individuals who either actively smoke or have quit smoking within the past year (43).

Ex-smokers: refer to those who ceased smoking over one year ago (43).

Never smokers: participants who have never engaged in smoking (43).

4.8. Data Management

Before and after collection, bagasse dust samples were carefully placed in labeled sealed containers for safe transport. After the dust sampling, the coded cassettes will be capped, transported cautiously as hand luggage to the Environmental and Occupational Health (EOH) laboratory at the College of Health Sciences, School of Public Health of Addis Ababa University in a box suitable to prevent damage and stored until the gravimetric analysis.

Before the data collection starts, the principal investigator and supervisor make sure that each data collectors have the questionnaire on their KOBO Collect Android App and checks for completeness and consistency. The primary investigator, supervisor, and data collectors also discussed the data collection process further and any ambiguities raised were addressed before the start-up. The collected data by the data collectors was sent to the Kobo Toolbox server, after being edited and saved, then the data was cleaned as needed in the server and downloaded. Then the downloaded data was exported to MS. Excel sheet for further data cleaning, frequency, sorting, and a list was used for cleaning. Finally, the cleaned data were imported to SPSS version 27 for further analysis.

The required lung function test parameters were manually extracted from the software and recorded in an Excel sheet. After data cleaning, the dataset was imported to SPSS version 27 for statistical analysis. To ensure data backup and security, the original data were stored both on a computer and an external flash drive.

4.9. Data Analysis Procedures:

Statistical Package for Social Sciences software (V.27) has been utilized to run all statistical analyses.

4.9.1. For the first objective (the level of personal bagasse dust exposure)

Forty nine dust concentration results were summarized using descriptive statistics, including geometric mean (GM) and geometric standard deviation (GSD) where one sample was discarded due to its pump failure from the bagasse section. One-way ANOVA was applied to assess variability across days, individuals, and work tasks. Filter samples were analyzed gravimetrically with a precision microbalance (AT261 Mettler Toledo), sensitive to 0.01 mg/m³, in a controlled environment. Pre- and post-sampling filter weights were measured by a trained technician, and dust concentration in air was computed using the following formula:

$$\text{Concentration (mg/m}^3\text{)} = \frac{\text{(post weight – pre-weight of filter) (mg) - blank weight (mg)}}{\text{Flow rate (liters per min)} \times \text{sample duration (min)} \times 0.001\ \text{m}^3\text{/liter}}$$

Where,

- Weight of the dust (mg) = (weight of the filter after - weight of the filter before sampling) (mg) - weight of the field blank filter (mg)
- Volume of air sampled (m^3) = flow rate of the pump (liters per minutes) multiplied by the time of the sampling (minutes) multiplied by 1000 lit/ m^3.

- Concentration of dust (mg/m^3) = Weight of the dust (mg) divided by the Volume of air sampled (m^3).

Since our country, Ethiopia, does not have a standard exposure limit value for organic dust, we have compared values with the recommended eight-hour time-weighted average Norwegian Occupational Exposure Limit (OEL) for total organic dust of 5 mg/m^3 (44).

4.9.2. Analysis for the second objective (prevalence of CRS and its determinants)

Descriptive statistics were used to summarize the chronic respiratory status and its determinants of the study population, including frequency distributions, measures of central tendency, and dispersion. These results were presented in tabular form. To assess the prevalence of CRS among workers from Wonji Shoa Sugar Factory and Water Bottling Factory, a generalized linear model with Poisson regression was employed in order to compute the adjusted prevalence ratio (APR), adjusting for potential confounder.

Bi-variate analysis was performed to explore the relationship between exposure and outcome variables, with those showing a p-value less than 0.2 included in the multi-variable analysis. The multi-variable model helped identify factors associated with both exposure and outcome, adjust for confounders, and estimate Adjusted Odds Ratios (AOR) with 95% Confidence Intervals (CI). Given the binary nature of the outcome variable, binary logistic regression was employed to compute Crude Odds Ratios (COR) with 95% CI to assess individual associations between dependent and independent variables.

4.9.3. Analysis for specific objective three (evaluation of pulmonary function indices)

Pulmonary function test results were expressed as Mean ± Standard Deviation for each parameter. Analysis of Covariance (ANCOVA) was applied to assess differences in lung function between sugar factory workers and the control group, adjusting for potential confounders. The relationship between cumulative dust exposure and lung function indices, controlling for confounding variables, was analyzed through multiple linear regression using SPSS version 27.

4.10. Data quality assurance

To ensure the validity and reliability of the questionnaire, it was first translated into Amharic and then retranslated back into English by an expert to check for consistency and accuracy. A pretest was conducted with 5% of individuals who are similar to the target population. This pretest helped to identify and address issues such as question relevance, ambiguities or misunderstandings and potential biases during data collection. Based on the findings from the pretest, the questionnaire was revised accordingly. To further ensure data quality, a standardized questionnaire was used, and trained health professionals conducted the data collection process. This approach minimizes errors and ensures the reliability of the data collected for the study.

During the personal dust sampling, the pumps were detected hourly by the supervisor and data collectors to check whether the flow rate is functioning as calibrated earlier, that is, 2L/m, or the pump failure. Field blanks have been used to correct for any weight changes during sampling due to the humidity change. The samples were transported cautiously with a handheld box suitable to prevent damage or disturbance. Before weighing, the microbalance was allowed to stabilize at zero to ensure accurate readings. A standard weight (e.g., 100 mg) was periodically used to verify the reliability and accuracy of the balance. These measures will ensure the accuracy and consistency of dust sampling, minimize potential errors, and maintain the integrity of the collected data.

For the pulmonary function test (PFT), orientation was given to the study participants to prevent leak and early termination. Trained health professionals were involved and orientation was given before the procedure started. Once the data was collected, the needed information was immediately exported to an Excel sheet, then handled on a computer and a flash disk for safety and kept for the analysis.

4.11. Ethical consideration:

Ethical clearance for this study was obtained from the ethical review committee of the School of Public Health. An official letter was sent to the Ethiopian Sugar Industry Group (ESIG) head office, requesting permission and support to conduct the study. Additional letters of approval were sought from the Wonji Shoa Sugar and Kiya Water bottling Factories management for further facilitation and cooperation. The rationale, methods and significances of the study upon their participation were clearly explained to each study participant. Before the data collection starts, all study participants fulfilling the criteria for the study and agreed to participate were given the Amharic version written consent and asked to sign. In case when capturing visual aids, such as a photo, is necessary, full informed oral consent was obtained. For ethical issues like privacy and confidentiality due emphasis was given during the whole data collection process. The collected information was only held and accessible for the research personnel in order to keep confidentiality; in addition to that, coded personal dust samples will be utilized. To ensure privacy, interviews were conducted in a quiet and comfortable setting. Participation was fully voluntary, with individuals free to decline or withdraw at any point if they felt uneasy. Although participants did not receive direct financial compensation, they may benefit indirectly through future policy improvements informed by the study's findings. During the process, if the study participants were found to have abnormal lung function tests, we advised them in order to seek further medical attention for their health and we linked them to the factory's health center as needed.

4.12. Dissemination of results

The result of this study will be presented to Addis Ababa University, the school of public health and the copies will be given to the head office of the Ethiopia Sugar Industry Groups (ESIG) as well as to the Wonji Shoa Sugar factory administrative office. It will also be given to the Minister of Ethiopian Labor and Skills , Oromia Biro of Labor and Social Affairs (BOLSA) and Oromia FMHACA. Additionally, the findings will be disseminated through scientific publication to ensure broader reach and impact.

5. Result

5.1. Socio-demographic characteristics

A total of 381 workers participated in the study, including 190 from Wonji Shoa Sugar Factory (exposed group) and 191 from Kiya Water Bottling Factory (non-exposed group), yielding a 100% response rate. Among the total respondents, 284 (74.5%) were male and 97 (25.5%) were female. In the exposed group, 118 (62.1%) of participants were aged 33 years and above, compared to 94(49.2%) in the non-exposed group.

Regarding educational status, 115 (60.6%) of the exposed participants had completed secondary education or higher and 75 (39.5%) had completed primary education. In contrast, among non-exposed participants, 145 (76.0%) had completed secondary education or higher, and 46 (24.1%) had completed primary education. The median monthly income was 5000 Ethiopian Birr for Wonji Shoa Sugar Factory workers and 6,800 Ethiopian Birr for Kiya Water Bottling Factory workers.

The majority of participants in both groups were married, 102 (53.7%) in the exposed group and 118 (61.8%) in the non-exposed group. Statistically significant differences were found between the two groups in terms of age group, sex, educational status, and monthly income ($p \leq 0.05$), while no significant difference was observed for marital status ($p > 0.05$).

Table 2. Socio-demographic characteristics of workers from Wonji Shoa sugar factory workers and Kiya water bottling factory workers, Oromia region, Ethiopia, from Jan-March, 2025 (N=381)

Variable	Wonji Shoa Sugar Factory N_1=190	Kiya Water Bottling Factory N_2=191	P-Value
	n (%)	n (%)	
Sex			
Male	128 (67.4)	156 (81.7)	**0.001***
Female	62 (32.6)	35 (15.3)	
Age Group			
18-34	72(37.9)	97(50.8)	**0.011***
>=35	118(62.1)	94(49.2)	

Marital Status			
Married	102(53.7)	118(61.8)	0.243
Single	61(32)	57 (29.8)	
Divorced	31(11.1)	13(6.8)	
Widowed	6(3.2)	3 (1.6)	
Educational Status			
Primary (1-6 or 8)	75(39.5)	46(24.1)	**0.002***
Secondary (9-12)	67(35.3)	96(50.3)	
12+	48(25.3)	49(25.7)	
Monthly income (ETB)			
<=5000	97(51.1)	32(16.8)	**0.001***
5000-7500	77(40.5)	125(65.4)	
>=7500	16(8.4)	34(17.8)	
Median	5000	6800	

Number of participant (N_1 &N_2),* statistical significance level at $p<0.05$(Chi-square)

5.2. Anthropometric data

Table 3 presents a comparison of anthropometric characteristics between sugar factory workers and the control group. No statistically significant differences were observed between the two groups in terms of age, body mass index (BMI), weight, or height.

Table 3. Anthropometric data of Sugar Factory workers compared to the non-exposed, Oromia region, Ethiopia, from Jan-March, 2025 (N=100)

Variables P-value	Sugar factory (n = 48) Mean (±SD)	non-exposed (n = 47) Mean (±SD)	P-value
Age (years)	38.21 (±12.20)	37.70 (±10.96)	0.470
Weight (Kg)	62.21 (±7.48)	61.89(±5.99)	0.652
Height (cm)	164.48(±15.34)	166.51(±6.82)	0.705
BMI (Kg/m2)	22.36 (±2.28)	22.36(±2.16)	0.826

5.3. Personal and Behavioral characteristics of the study participants

A higher proportion of current and ever smokers was observed among exposed compared to non-exposed workers, though the difference was not statistically significant ($p = 0.105$). Most workers in both factories had never smoked cigarettes.

More than half of the exposed workers, 120 (63.2%), reported not regularly using respiratory protective devices (RPE). The primary reasons cited for not using RPE included unavailability 72 (37.9%), discomfort 22 (11.6%), the perception that sugarcane bagasse dust is not harmful 22 (11.6%), and other reasons such as inadequate protection 2 (5.1%). Regarding the use of PPDs, only 19 (10%) workers across both factories had received any form of training. Additionally, the majority of respondents, 338 (88.7%), from both factories reported using electricity as their primary source of energy for food preparation.

Table 4. Personal and Behavioral characteristics of workers from the sugar factory and non-exposed, Oromia region, Ethiopia, from Jan-March, 2025 (N=381)

Variable	Sugar Factory N_1=190	Control N_2=191	P-Value
	n (%)	n (%)	
Smoking History			
Current Smoker	17(8.9)	9(4.7)	0.105
Ever smoked cigarettes	11(5.8)	6(3.1)	
Never smoked cigarettes	162(85.3)	176(92.1)	
RPEs use	70(36.8)	-	0.486
Training on the Use of RPE	6(3.2)	13(6.8)	0.255
Type of Energy Source for food preparation			
Electricity	154(81.1)	184(96.3)	**<0.001***
Biofuel	36(18.9)	7(3.7)	
Reason for not wearing RPE			
Not available	72(37.9)	-	**<0.001***
Uncomfortable	22(11.6)		
Don't give adequate protection	2(1.1)		
	22(11.6)		
Dust is not harmful	2(5.1)		
Other reasons			

Number of all participant (N_1 and N_2), bio fuel (charcoal, wood and gas), * statistical significance level at p<0.05(Chi-square tests)

5.4. Job-related characteristics

Among the 190 workers from Wonji Shoa Sugar Factory, 139 (73.2%) had work experience of five or more years, while only 22 (11.5%) from the control group had ten or more years of experience. Regarding weekly working hours, 115 (60.5%) of sugar factory workers reported weekly working hours of more than 48, whereas only 10 (5.2%) of non-exposed reported weekly working hours of more than 48. These differences were statistically significant ($p \leq 0.05$).

With respect to weekly working days, only 19(10%) of participants from the sugar factory worked five days or less per week, while 26(13.6%) of non-exposed worked five days or less per week; the difference was not statistically significant (p >=0.05).

Past exposure to other types of dust was reported by 15 (7.9%) workers in the sugar factory and 20 (10.5%) in the control groups, with no statistically significant difference observed ($p > 0.05$). However, a significant difference was noted in the history of past respiratory illness: 44 (23.2%) from Wonji Shoa Sugar Factory reported having had a previous respiratory illness, compared to 23 (12%) from the control groups ($p \leq 0.05$).

Table 5. Job-related characteristics of workers from the sugar factory and non-exposed, Oromia region, Ethiopia, from Jan-March, 2025 (N=381)

Variable	Sugar Factory N_1=190	non-exposed N_2=191	P-Value
	n (%)	n (%)	
Work Experience in years			
<5	51(26.8)	169(88.5)	**<0.001***
>=5	139(73.2)	22(11.5)	
Working days per week			
<=5	19(10)	26(13.6)	0.275
>5	171(90)	165(86.4)	
Working hours per week			
<=48	75(39.5)	181(94.8)	**<0.001***
>48	115(60.5)	10(5.2)	
Past Dust Exposure			
Yes	15(7.9)	20(10.5)	0.384
No	175(92.1)	171(89.5	
Previous respiratory illness			
Yes	44(23.2)	23(12)	**<0.004***
No	146(76.8)	168(88)	
Work Section/Department			
Bagasse section	31(16)		
Milling Section	29(15.3)		
Boiler Section	35(18.4)		

Evaporator section	32(16.8)	
Pan house/packaging	38(17.4)	
Other sections	30(15.8)	
Water Bottling	0	191

Number of all participants (N_1 and N_2), bio fuel (charcoal, wood and gas), * statistical significance level at $p<0.05$(Chi-square tests)

5.5. Personal Bagasse dust exposure

A total of 25 participants from the five SEGs participated in the personal sugarcane bagasse dust exposure assessment, yielding 49 dust samples. One sample was excluded due to pump failure. The measurement duration ranged from 300 to 447 minutes, with a mean of 364 minutes and a standard deviation of ±54 minutes. The overall geometric mean (GM) of personal total bagasse dust exposure was 9.49 mg/m³, with a geometric standard deviation (GSD) of 4.01. The highest exposure level was recorded in the bagasse section (GM =14.44 mg/m³), while the lowest levels were observed in the pan house/packaging and evaporation sections (5.99 mg/m³ and 5.05 mg/m³, respectively). A statistically significant difference in the total bagasse dust exposure was found among at least two of the work sections (df = 4, F = 21.04, 0.002). Additionally, 85.7% of the measurements exceeded the Norwegian Occupational Exposure Limit (OEL) for total organic dust (5 mg/m³) (43).

Table 6. Personal Sugarcane Bagasse dust concentration in the selected five work stations from the Sugar factory, Oromia region, Ethiopia, from Jan-March, 2025 (n=49)

Work section/Department	Number of samples	Average duration (Minutes)	Range	AM(± SD) (mg/m³)	GM (± GSD) (mg/m³)	N above OEL (5 mg/m³)
Bagasse Section	9	345	9.20-32.23	16.31 (±9.06)	14.44 (±0.50)	9(100%)
Milling Section	10	388	8.71-19.85	12.66 (±3.41)	12.30 (±0.25)	10(100%)
Boiler Section	10	366	7.97-12.72	9.74 (±1.55)	9.68 (±0.15)	10(100%)
Evaporator Section	10	312	4.64-8.80	6.19 (±1.71)	5.99 (±0.27)	7(70%)
Pan House/packaging section	10	409	2.51-6.90	5.25 (±1.27)	5.05 (±0.29)	6(60%)

Total	49	364	2.51-32.23	9.90(±5.82)	9.49(±4.01)	42(85.7%)

Number of participant (n); milligram per meter cube (mg/m3); GM=Geometric mean; SD=standard deviation; GSD=Geometric standard deviation; OEL= occupational exposure limit

5.6. Prevalence of CRS

As presented in Table 7, the prevalence of at least one chronic respiratory symptom was 118 (62.1%) among Wonji Shoa Sugar Factory workers, compared to 39 (20.4%) among the control group with adjusted prevalence ratio at 95%CI of 2.46 (1.795-3.377). After adjusting for potential confounding factors namely sex, age, educational status, monthly income, passive smoking, fuel type used for food preparation, work experience, working hours per week and past respiratory illness under generalized estimate model the differences in the prevalence ratios of respiratory symptoms between the two groups remained statistically significant for cough, Cough with Sputum, work related shortness of breath, wheezing and at least one CRS. However, the difference was not statistically significant for breathlessness ($p > 0.05$).

Table 7. Prevalence of CRS among the sugar factory workers and the non-exposed, Oromia region, Ethiopia, from Jan-March, 2025 (N=381)

Variable	Sugar Factory n=190	Control n=191	Prevalence ratio at 95%CI	p-value
	n (%)	n (%)		
Cough	101(53.4)	36(18.8)	2.28(1.629-3.193)	**0.001***
Cough with Sputum	31(16.3)	3(1.6)	6.96(2.061-23.535)	**0.002***
Breathlessness	37(19.5)	19 (9.9)	1.63(0.908-2.930)	0.102
Work related SOB	90 (47.4)	15(7.9)	4.67(2.793-7.830)	**0.001***
Wheezing	71(37.4)	12(6.3)	4.53(2.476-8.322)	**0.001***
At least one chronic respiratory symptom	118(62.1)	39 (20.4)	2.46(1.795-3.377)	**0.001***

CI (confidence interval), while adjusting for sex, age, educational status, monthly income, passive smoking, fuel type used for food preparation, work experience, working hours per week and past respiratory illness (poison regression with generalized estimating equations model)

5.7. Pulmonary Function Test

Ninety-five male workers (48 participants from sugar factory and 47 non-exposed) were enrolled. After adjusting for work experience and monthly income, the case group showed a borderline significantly lower mean FVC and FEV1 compared to the control group ($p = 0.49$). No statistically significant differences were observed between the groups for FEV1/FVC ratio ($p = 0.650$).

Table 8. Comparison of pulmonary function parameters with adjustment (ANCOVA) among the Sugar Factory workers and the non-exposed, Oromia region, Ethiopia, from Jan-March, 2025 (n=95)

Parameters	exposed n=48	non-exposed n=47	p-value
FVC	3.87(±0.78)	4.00(±0.53)	**0.042***
FEV1	3.19(±0.73)	3.37 (±0.53)	**0.49***
FEV1/FVC	81.92(±4.66)	84.11(±3.73)	0.650

*Statistically significant difference at p-value<0.05 while adjusted for work experience and monthly income

5.7.1. Impact of Cumulative dust exposure on lung function parameters

In the adjusted multiple linear regression model, increasing age was significantly associated with reduced FVC and FEV_1 (B = -0.026, p = 0.05; B = -0.025, p = 0.039, respectively), while height, current smoking, and cumulative dust exposure were not statistically significant predictors. Although cumulative sugarcane bagasse dust exposure showed a negative association with all lung function indices (FVC, FEV_1 and FEV_1 /FVC), the associations did not reach statistical significance (p > 0.05).

Table 9. Cumulative dust exposure with lung function parameters among participants (n=48) from the Sugar factory, Oromia region, Ethiopia, from Jan-March, 2025 (n=48).

Parameter	B(SE)	95%CI		P- Value
FVC(L)				
Age(years)	-0.026(0.013)	-0.053	0.000	**0.05***
Height(cm)	0.000(0.006)	-0.012	0.011	0.969
Current smoking (Yes/No)	-0.506(0.286)	-1.084	0.071	0.084
Cumulative dust (mg/m^3 .years)	-0.002(0.002)	-0.005	0.001	0.215
FEV1(L)				
Age(years)	-0.025(0.012)	-.0048	-0.001	**0.039***
Height(cm)	-0.001(0.005)	-0.011	0.009	0.830

Current smoking(Yes/No)	-0.393(0.250)	-0.898	0.111	0.123
Cumulative dust(mg/m^3 .years)	-0.002(0.001)	-0.005	0.001	0.128
FEV1/FVC(%)				
Age(years)	-0.106(0.089)	-0.285	0.072	0.236
Height(cm)	-0.017(0.038)	-0.094	0.060	0.657
Current smoking(Yes/No)	0.381(1.913)	-3.479	4.242	0.843
Cumulative dust(mg/m^3 .years)	-0.014(0.011)	-0.036	0.008	0.200

Unstandardized coefficients- B(SE) std error, 95% Confidence interval, *P-value significant at 0.05

5.8. Determinants of CRS

5.8.1. Bivariate analysis

5.8.1.1. Bi-variate Analysis of socio-demographic factors and CRS

In the bivariate logistic regression analysis, age ≥35 years was significantly associated with increased odds of CRS compared to ages 18–34 (COR = 30.78, 95% CI: 13.726–69.003, p < 0.001). Similarly, lower educational status and lower monthly income were significantly associated with higher odds of reporting CRS (e.g., primary education: COR = 13.0, 95% CI: 5.305–31.857, p < 0.001; income ≤5000 ETB: COR = 5.22, 95% CI: 1.564–17.423, p = 0.007).

Table 10. Bi-variate analysis of socio-demographic factors and at least one CRS among workers from the sugar factory, Oromia region, Ethiopia, from Jan-March, 2025 (N=190)

Variable	A least one CRS		COR[a](95%CI)[b]	P-Value
	Yes	No		
Sex				
Male	75(58.6)	53(41.4)	0.625(0.328-1.191)	**0.153***
Female	43(69.4)	19(30.6)		
Age Group				
18-34	14(19.4)	58(80.6)	1	
>=35	104(88.1)	14(11.9)	30.78(13.726-69.003)	**<0.001***
Educational Status				
Primary	65(86.7)	10(13.3)	13(5.305-31.857)	**<0.001***
Secondary	37(55.2)	30(44.8)	2.47(1.143-5.324)	**0.021***
12+	16(33.3)	32(66.7)	1	

Monthly income (ETB)				
<=5000	87(89.7)	10(10.3)	5.22(1.564-17.423)	**0.007***
5000-7500	21(27.3)	56(72.7)	0.23(0.073-0.696)	**0.01***
>=7500	10(62.5)	6(37.5)	1	

a=crude odds Ratio; b =95% confidence interval; * = significant level at p <0.2; 1.00=reference

5.8.1.2. Bi-variate analysis of behavioral factor and CRS

In the bivariate logistic regression analysis, smoking history (whether ever or current smoking) was not significantly associated with the presence of CRS (ever smoker: COR = 0.71, 95% CI: 0.207–2.412, p = 0.579; current smoker: COR = 0.84, 95% CI: 0.304–2.324, p = 0.737). However, not using respiratory protective devices (RPE) was significantly associated with higher odds of having at least one chronic respiratory symptom compared to RPD users (COR = 22.22, 95% CI: 10.311–47.866, p < 0.001). The type of energy source used for food preparation (biofuel vs electricity) showed no significant association with CRS (COR = 1.099, 95% CI: 0.517–2.335, p = 0.806). (Table 9).

Table 11. Bivariate analysis of behavioural factor and at least one CRS among workers from the sugar factory, Oromia region, Ethiopia, from Jan-March, 2025 (N1=190)

Variable	A least one chronic respiratory symptom		COR^{a}(95%CI)^{b}	P-Value
	Yes	N0		
Smoking History				
Never Smoked	102(63)	60(37)	1	
Ever smoker	6(54.5)	5(45.5)	0.71(0.207-2.412)	0.579
Current smoker	10(58.8)	7(41.2)	0.84(0.304-2.324)	0.737
RPD use				
Yes	15(21.4)	55(78.6)	1	
No	103(85.8)	17(14.2)	22.22(10.311-47.866)	**<0.001***
Type of Energy Source for food preparation				
Electricity	95(61.7)	59(38.3)	1	
Biofuel	23(63.9)	13(36.1)	1.099(0.517-2.335)	0.806

a=crude odds Ratio; b =95% confidence interval; * = significant level at p <0.2; 1.00=reference

5.8.1.3. Bi-variate analysis of Job-related factors and CRS

In the bivariate analysis, workers with ≥5 years of experience had significantly higher odds of reporting at least one chronic respiratory symptom compared to those with <5 years (COR = 24.92, 95% CI: 10.14–61.22, p < 0.001). Similarly, working more than 48 hours per week and having a history of respiratory illness were strongly associated with increased odds of CRS (COR = 46.06, 95% CI: 19.29–109.97, p < 0.001 and COR = 6.615, 95% CI: 2.467–17.737, p < 0.001, respectively). While working days per week showed no significant association at a p-value of <0.2.

Table 12. Bi-variate analysis of Job-related factors and at least one chronic respiratory symptom among workers in the sugar factory, Oromia region, Ethiopia, from Jan-March, 2025 (N1=190)

Variable	A least one chronic respiratory symptom		COR[a](95%CI)[b]	P-Value
	Yes	No		
Years of Work Experience				
<5	7(13.7)	44(86.3)	1	
>=5	111(79.9)	28(20.1)	24.92(10.14-61.22)	**<0.001***
Working days per week				
<=5	11(57.9)	8(41.1)	1	
>5	107(62.6)	64(37.4)	1.216(0.465-3.182)	0.69
Working hours per week				
<=48	14(18.4)	62(81.6)	1	
>48	104(91.2)	10(8.8)	46.06(19.29-109.97)	**<0.001***
Past Dust Exposure				
Yes	6(40)	9(60)	0.375(0.128-1.102)	**0.075***
No	112(64)	63(36)	1	
Past Respiratory Illness				
Yes	39(88.6)	5(11.4)	6.615(2.467-17.737)	**<0.001***
No	79(54.1)	67(45.9)	1	

a=crude odds Ratio; b =95% confidence interval; * = significant level at p <0.2; 1.00=reference

5.8.2. Multivariable logistic regression analysis

In the bi-variate analysis, several variables were found to be associated with the presence of at least one chronic respiratory symptom at a significance level of p < 0.2. (Tables 8, 9, 10). All variables with a p-value less than 0.2 in the bi-variate analysis were subsequently included in the Multivariable logistic regression model to control for potential confounders and to identify independent predictors of CRS.

After adjusting for potential confounders in the Multivariable logistic regression analysis, three variables remained significantly associated with the presence of at least one chronic respiratory symptom among workers. Workers aged 35 years and above had significantly higher odds of reporting CRS compared to those aged 18–34 (AOR = 4.851, 95% CI: 1.123–20.952, p = 0.034). Similarly, those who did not use respiratory protective devices (RPE) were over five times more likely to experience respiratory symptoms than RPD users (AOR = 5.39, 95% CI: 1.611–18.025, p = 0.006). Moreover, weekly working hours of more than 48 was strongly associated with increased odds of CRS (AOR = 10.15, 95% CI: 3.159–32.582, p < 0.001).

Table 13. Multivariable analysis of associated factors and at least one chronic respiratory symptom among workers from the sugar factory, Oromia region, Ethiopia, from Jan-March, 2025 (N=190)

Variable	**A least one CRS**		**AOR[a](95% CI)[b]**	**p-value**
	Yes n(%)	**No n(%)**		
Age Group				
18-34	14(19.4)	58(80.6)	1	
>=35	104(88.1)	14(11.9)	**4.851(1.123-20.952)**	**0.034****
RPD use				
Yes	15(21.4)	55(78.6)	**1**	
No	103(85.8)	17(14.2)	**5.39(1.611-18.025)**	**0.006****
Work Experience in years				
<5	7(13.7)	44(86.3)	1	
>=5	111(79.9)	28(20.1)	5.015(0.91-27.638)	0.064
Working hours per week(hrs)				
<=48	14(18.4)	62(81.6)	1	
>48	104(91.2)	10(8.8)	**10.15(3.159-32.582)**	**<0.001****

a= adjusted odds Ratio; b =95% confidence interval; ** = significant level at p < 0.05; 1.00=reference

5.9. Observational findings on the Engineering and working conditions of the sugar factory

Our study was conducted from January to March when the sugar factory fully functions and this season is also termed as the sugarcane crushing or harvesting season. During our walk through observation there were bagasse dust particles and ashes dispersed whole over the factory's state depending on the wind direction from the bagasse store, boiler and outdoor milling sections. Observational findings and insights from key informants also revealed critical gaps in engineering non-exposed and overall working conditions at Wonji Shoa Sugar Factory. While routine maintenance of machinery appeared to be regularly practiced in most dusty work sections, the application of wet spraying methods was observed inconsistently across different stations. Dust control technologies were largely absent, and the majority of dusty work environments lacked proper enclosure. The use of respiratory protective equipment was rarely enforced, with no clear system for ensuring compliance. Furthermore, job rotation systems and periodic medical check-ups were not widely implemented. Ventilation relied primarily on natural airflow, with very limited evidence of local exhaust systems. Routine occupational health and safety inspections were infrequent, and structured training on workplace hazards was generally lacking. Although safety audits had reportedly been conducted in some sections, the overall work environment was perceived by informants as unsafe for respiratory health. These findings point to serious shortcomings in workplace safety measures and indicate a pressing need for improved engineering non-exposed and occupational health interventions.

6. Discussion

The geometric mean of personal bagasse dust exposure (9.49 mg/m³) exceeded the Norwegian OEL (5 mg/m³) for organic dust, with 85.7% of samples surpassing the limit, the bagasse and milling sections with GM and GSD of 14.44 (±0.50) and 12.30 (±0.25), were the departments with highest exposures observed, respectively. A statistically significant difference in exposure across departments (p=0.002) suggests differential task-related dust generation, marking the need for targeted dust control interventions. The prevalence of at least one chronic respiratory symptom was significantly higher among sugar factory workers (62.1%) compared to non-exposed (20.4%), with statistically significant differences observed for cough, cough with sputum, work-related shortness of breath, and wheezing after adjusting for confounders. Multivariable analysis identified older age (≥35 years), non-use of respiratory protective equipment (RPE), and working more than 48 hours per week as significant determinants of CRS, highlighting the influence of both personal and occupational risk factors. These findings align with the observed inadequate implementation of dust control technologies, inconsistent use of RPE, and poor enforcement of occupational safety measures in the factory. The lack of engineering non-exposed, limited ventilation, and insufficient occupational health oversight likely contribute to the elevated exposure levels and increased respiratory health risks among workers.

The findings from personal bagasse dust exposure in the present study reflected similar patterns observed in previous studies from Ethiopian sugar factories. A longitudinal assessment at Metahara and Wonji Shoa Sugar Factories reported GM concentrations of 9.55 mg/m³ and 7.89 mg/m³ in the boiler and power turbine sections, respectively, with over 85% of samples exceeding recommended limits (12). Additionally, a cross-sectional study from Metahara found areal dust concentrations ranging from 1.52 to 10.34 mg/m³, with the highest levels in the boiler section and 68% of measurements above the permissible limit for organic dust (11). Notably, unlike these earlier studies that relied on areal sampling, the current study employed full-shift personal sampling, providing a more accurate estimate of individual exposure and reinforcing the need for targeted control interventions in high-risk work areas.

When compared to international studies, the GM of bagasse dust exposure in this study was higher than that reported in India (135µg/m^3 in milling section, 150µg/m^3 in boiler and 415µg/m^3

in bagasse baling section), Thailand (9.29 mg/m³ in bagasse storage and 5.60 mg/m³ in the boiler section) and Costa Rica (2.72 mg/m³ in maintenance and 0.35–1.06 mg/m³ in other departments) (6, 7, 17, 45). Despite contextual differences, commonalities were observed, including higher exposures during peak harvesting seasons and widespread dust dispersion influenced by wind direction. Furthermore, visual inspection of filters revealed the presence of bagasse fibers and ash in the bagasse, boiler and milling sections and underscoring the urgent need for effective dust mitigation strategies in sugar factories globally.

A study conducted in an Egyptian sugar and particle board factory reported significantly higher total dust concentrations from bagasse exposure (up to 138 mg/m³), particularly during cleaning of the boiler section and loading operations (46). These levels exceed those findings from our study, possibly due to the direct and large-scale use of dry bagasse sourced from nearby sugar factories, reflecting Egypt's extensive sugar production and its advanced utilization of bagasse for manufacturing other commercial goods. In contrast, such industrial applications are limited in our context, suggesting an opportunity to look out safer and value-added uses of bagasse beyond biofuel.

This study revealed a high prevalence (62.1%) of at least one chronic respiratory symptom among workers at the Wonji Shoa Sugar Factory, which is consistent with findings from a longitudinal study conducted at Metehara and Wonji Shoa sugar factories, where 60.6% of workers experienced CRS during the active sugarcane crushing season (95% CI: 59.2%–61.9%). The higher prevalence observed during the crushing season in both studies underscores the significant impact of occupational exposure to bagasse dust on respiratory health. The common symptoms reported in our study, including cough (53.4%), work-related shortness of breath (47.4%), and wheezing (37.4%), were also frequently observed in the comparative longitudinal study (wheezing: 96.8%, cough: 89.7%, shortness of breath: 62.1%), further confirming the seasonal burden of dust-related respiratory morbidity in this industry. The prevalence was high for each chronic respiratory symptom in the earlier study, which might be due to the longitudinal nature of the study with follow-up compared to our cross-sectional study (12). Compared to international studies from India(15), Brazil(21), and Pakistan(47), our findings reflect a notably higher prevalence of CRS. For instance, our finding on the prevalence of work-related shortness of breath (47.4%) and wheezing (37.4%) was relatively higher than the prevalence obtained from

Costa Rica (wheezing: 20.5% and SOB of 25%) (6). Likely due to lower levels of respiratory protection and less rigorous enforcement of safety protocols in the our context. Variations in dust control technologies, occupational health policies, and worker education also contribute to these disparities.

Age, lack of respiratory protective equipment (RPE) use, long working hours, and longer work experience were significant determinants of CRS in this study. Workers aged 35 and above had nearly five times higher odds of symptoms than younger workers, consistent with findings from the Metehara and Wonji Shoa factories (12) and supported by a study conducted in India (48), where those over 48 years were also more affected. Similarly, non-use of RPE increased the odds by over five times, higher than estimates from related studies and aligns with both national and international evidence highlighting the protective role of RPE (49). Prolonged weekly working hours (>48) and longer service duration (≥5 years) were strongly associated with elevated symptoms, likely due to increased cumulative exposure, reaffirming duration and intensity of dust exposure as key risk factors.

In sum, our findings reinforce the well-established link between occupational exposure to bagasse dust and CRS. The strong associations with age, prolonged working hours, lack of RPE use, and longer duration of employment underscore the urgent need for targeted interventions, including proper training, consistent provision and enforcement of RPE use, and reduction of prolonged exposure to dust during peak operational seasons.

Additionally, Wonji Shoa sugar factory workers exhibited a borderline significantly lower mean FVC and FEV1 compared to non-exposed, suggesting early signs of restrictive and obstructive lung impairment, potentially linked to occupational dust exposure. Reduced FVC and FEV1 have been reported by studies conducted in sugar factories showed that workers exposed to sugar cane bagasse dust in the sugar manufacturing workstation had significantly lower forced expiratory volume in 1s (FEV1) and forced volume capacity than the non-exposed ones. (25, 50, 51)

Cumulative bagasse dust exposure in our study showed a negative trend with lung function indices, though not statistically significant, possibly due to sample size limitations. Another major reason for the non-significant association might be that the mean bagasse dust concentrations from each of the five sections (SEGs) were used to compute the cumulative dust exposure, which may not accurately reflect the actual exposure levels of the individuals who underwent spirometry tests; nonetheless, this suggests a potential correlation between prolonged occupational exposure to bagasse dust and progressive pulmonary impairment, consistent with findings from studies conducted in Indian sugar factories. (7, 8, 15, 22, 46, 51). However, our findings contrast with a study conducted in Costa Rica, which reported that bagasse exposure did not significantly affect ventilatory lung function indices, including FEV_1 , FVC, and the FEV_1 /FVC ratio (6). This discrepancy may be attributed to significant differences in the magnitude and intensity of sugarcane bagasse dust exposure, likely influenced by variations in manufacturing processes and the implementation of occupational safety and health (OSH) policies between the two settings.

These findings, alongside the observed inadequate dust control measures and poor enforcement of protective equipment use, highlight the potential respiratory burden faced by workers in poorly regulated sugar manufacturing environments.

7. STRENGTHS AND LIMITATIONS OF THE STUDY

7.1. Strengths

This study comprehensively assess the prevalence of CRS, levels of personal sugarcane bagasse dust exposure and lung function parameters among sugar factory workers. Methodologically, it employed robust data collection tools, including interviewer-administered questionnaires by trained health professionals in reducing the risk of misreporting compared to self-administered surveys, alongside observational checklists and key informant interviews to capture contextual and operational factors. The inclusion of a nearby, demographically comparable control group enhanced the study's ability to minimize confounding. Personal total dust exposure was measured using rigorous field and laboratory protocols, including proper pre- and post-weighing of filters with a standard micro-balance (Mettler Toledo), real-time pump flow rate checks, and full-shift sampling to ensure accuracy. Furthermore, lung function was assessed using spirometry performed by trained professionals, ensuring the reliability of physiological measurements and minimizing participant-induced bias.

7.2. Limitations

This study has several limitations. The use of Millipore plastic closed-face filter cassettes (CFCs) for total dust sampling may have led to underestimation of inhalable dust concentrations due to potential particle loss from adherence to the inner cassette walls. There is also a possibility of over- or under-estimation if participants deliberately moved into dustier areas during sampling or may stop working and move away for a while. Recall bias and interviewer bias may have influenced self-reported data on employment history, age, prior dust exposure, and respiratory symptoms. Additionally, observational errors during height and weight measurements may have affected the accuracy of spirometry-related anthropometric data. The cumulative dust exposure assessment was done using the mean bagasse dust levels from each work sections not from those individual participants whom the pulmonary function tests were done. As a cross-sectional study, the design limits the ability to establish causal relationships between exposure and health outcomes. Furthermore, the "healthy worker effect" may have resulted in an underestimation of the true burden of respiratory symptoms. Although a longitudinal study would provide stronger evidence, such designs are resource-intensive and less feasible in this context.

8. Conclusion and Recommendation

8.1. Conclusion

This study revealed that the concentrations of sugarcane bagasse dust among sugar factory workers were substantially above the recommended occupational exposure limit, with arithmetic and geometric means of 9.90 ± 5.82 mg/m³ and 9.49 ± 4.01 mg/m³, respectively; 85.7% of the measurements exceeded the Norwegian OEL of 5 mg/m³. The prevalence of CRS was significantly higher among sugar factory workers compared to the control group. Age above 35 years, non-use of respiratory protective equipment (RPE), and longer weekly working hours were identified as key determinants. Most workers were unaware of the health risks of bagasse dust exposure and did not regularly use RPE. Notably, the "healthy worker effect" should be considered, as even asymptomatic workers remain at risk.

Pulmonary function parameters (FEV_1 , FVC and FEV1/FVC) were significantly reduced in exposed workers, particularly among those with over 10 years of exposure. Overall, the findings underscore that chronic exposure to sugarcane bagasse dust in the absence of adequate protective measures poses a serious risk to respiratory health and lung function.

8.2. Recommendation

For the Ministry of Labour and Skills (MoLSA) and Oromia Regional Bureau of Labour and Social Affairs (BoLSA):

Regular supportive supervision and comprehensive risk assessments should be conducted in sugar factories to evaluate the level of bagasse dust exposure. It is also essential to establish or revise national occupational exposure limit (OEL) values for sugarcane bagasse and other organic dusts.

For Sugar Factory Management:

Regular occupational health and safety (OHS) training should be provided to all workers. Preventive maintenance and inspection programs must be maintained effectively. Engineering non-exposed, particularly at dust-emitting points of machinery, should be prioritized. Standard and sufficient respiratory protective equipment (RPE) must be supplied, and worker adherence to RPE use should be encouraged basically on those sections that bagasse dust exposure exceeds the permissible limits. Long-term strategies such as modifying or replacing outdated machinery are crucial to sustainably reduce dust levels.

For Sugar Factory Workers:

Workers should consistently and correctly use the RPE provided and adhere to all OHS protocols communicated through workplace postings and written guidelines.

For Researchers:

Future longitudinal studies are recommended to better assess personal bagasse dust exposure, CRS, and lung function impairment among sugar factory workers.

9. References

1. Hess TM, Sumberg J, Biggs T, Georgescu M, Haro-Monteagudo D, Jewitt G, et al. A sweet deal? Sugarcane, water and agricultural transformation in Sub-Saharan Africa. Global environmental change. 2016;39:181-94.

2. Hamza TA, Alebjo AL. Sugarcane saccharumofficinarum L tissue culture in ethiopia opportunities for ethiopias sugar industries. International Journal of Scientific & Technology Research. 2017;6(8):398-406.

3. Koroma ET, Kangbai JB. Agro-industrial accidents linked to length of service, operation site and confidence in employer adherence to safety rules. BMC public health. 2020;20:1-6.

4. Leite MR, Zanetta DMT, Trevisan IB, Burdmann EdA, Santos UdP. Sugarcane cutting work, risks, and health effects: a literature review. Revista de saude publica. 2018;52:80.

5. Trevisan IB, Santos UdP, Leite MR, Ferreira AD, Silva BSdA, Freire APCF, et al. Burnt sugarcane harvesting is associated with rhinitis symptoms and inflammatory markers. Brazilian journal of otorhinolaryngology. 2019;85(3):337-43.

6. Gascon M, Kromhout H, Heederik D, Eduard W, de Joode BvW. Respiratory, allergy and eye problems in bagasse-exposed sugar cane workers in Costa Rica. Occupational and environmental medicine. 2012;69(5):331-8.

7. Nikhade NS, Sharma P. A study of pulmonary function test in workers of sugar factory, Pravaranagar, Maharashtra. International Journal of Medical Research & Health Sciences. 2013;1(2):52-8.

8. Patil S, Somade P, Joshi A. Pulmonary function tests in sugar factory workers of Western Maharashtra (India). Journal of basic and clinical physiology and pharmacology. 2008;19(2):159-66.

9. Ferreira AD, Ramos EMC, Trevisan IB, Leite MR, Proença M, de Carvalho-Junior LCS, et al. Lung function and nasal Mucociliary clearance in Brazilian sugarcane cutters exposed to Biomass burning. Revista Brasileira de Saúde Ocupacional. 2018;43:e6.

10. El Ata GA, Ezzat H, Shalaby A. Environmental, Mycological and respiratory health assessment of workers chronically exposed to Bagasse in Egyptian particle-board industry. Occupational Health and Industrial Medicine. 1999;2(40):82.

11. Bonsa M, Taffere GR, Alemayehu MA. magnitude of occupational exposure to bagasse dust and associated factors among Metehara Sugarcane Factory workers, east Shoa, Ethiopia. Journal of Public Health. 2019;27:203-10.

12. Debela M, Kebeta ND, Begosaw AM, Okello G, Azage M. Bagasse dust exposure and CRS among workers in the Metehara and Wonji sugar factories in Ethiopia: a longitudinal study design. BMJ Open Respiratory Research. 2023;10(1):e001511.

13. Hearn CE. Bagassosis: an epidemiological, environmental, and clinical survey. Occupational and Environmental Medicine. 1968;25(4):267-82.

14. Ata GA, Ezzat HE, Shalaby AEDO, Kholey B, El M, Emara AM, et al. Environmental, mycological and respiratory health assessment of workers chronically exposed to bagasse in egyptian particle-board industry. International Journal of Environmental Health Research. 1998;8(4):315-34.

15. Saravanan C, Suhanya G, Sophia C. A study on pulmonary function among workers of sugar factory in Villupuram district-A cross-sectional study. International Journal of Science and Healthcare Research. 2020;5.

16. Cançado JE, Saldiva PH, Pereira LA, Lara LB, Artaxo P, Martinelli LA, et al. The impact of sugar cane–burning emissions on the respiratory system of children and the elderly. Environmental health perspectives. 2006;114(5):725-9.

17. Sakunkoo P, Chaiear N, Chaikittiporn C, Sadhra S. Concentrations and size distribution of inhalable and respirable dust among sugar industry workers: A pilot study in Khon Kaen, Thailand. Asia Pacific Journal of Public Health. 2011;23(6):967-79.

18. Raza Q, Bashir M, Rehim A, Sial M, Ali Raza H, Atif H, et al. Sugarcane industrial byproducts as challenges to environmental safety and their remedies: a review, Water, 13 (24): 3495. 2021.
19. Phoolchund H. Aspects of occupational health in the sugar cane industry. Occupational medicine. 1991;41(3):133-6.
20. Fragar L, Franklin R, Allen C, Harding W. Occupational health and safety risk associated with sugarcane production2001.
21. Khade YS, Bagali S, Aithala M. Impaired pulmonary lung functions in workers exposed to bagasse: Is obesity an added risk? Indian Journal of Occupational and Environmental Medicine. 2018;22(2):92-6.
22. Nayakawadi S. A study of lung function test Ofworkers in sugar industry during Workingperiod. 2014.
23. Pierce AK, Nicholson DP, Miller JM, Johnson Jr RL. Pulmonary function in bagasse worker's lung disease. American Review of Respiratory Disease. 1968;97(4):561-70.
24. WEILL H, BUECHNER HA, GONZALEZ E, HERBERT SJ, AUCOIN E, ZISKIND MM. Bagassosis: A study of pulmonary function in 20 exposed. Annals of Internal Medicine. 1966;64(4):737-47.
25. Yogita K. Study of effect of occupational exposure to sugarcane dust on pulmonary functions and electrocardiogram in Sugarcance factory workers of Bijapur and Bagalkot districts: BLDE (Deemed to be University); 2014.
26. Romeo L, Molle KD, Zanoni G, Peretti A, Marangi G, Conrado LGL, et al. Respiratory health effects and immunological response to Thermoactinomyces among sugar cane workers in Nicaragua. International journal of occupational and environmental health. 2009;15(3):249-54.
27. Miller G, Hearn C, Edwards R. Pulmonary function at rest and during exercise following bagassosis. Occupational and Environmental Medicine. 1971;28(2):152-8.
28. Castleden L, Hamilton-Paterson J. Bagassosis: an industrial lung disease. British Medical Journal. 1942;2(4268):478.
29. Ueda A, Aoyama K, Ueda T, Obama K, Ueno T, Hokama S, et al. Recent trends in bagassosis in Japan. Occupational and Environmental Medicine. 1992;49(7):499-506.
30. Le Blond JS, Tomatis M, Horwell CJ, Dunster C, Murphy F, Corazzari I, et al. The surface reactivity and implied toxicity of ash produced from sugarcane burning. Environmental toxicology. 2014;29(5):503-16.
31. Akello FK. Factors influencing the use of personal protective equipment by employees of Kinyara Sugar Limited Masindi District, Uganda 2011.
32. Viswanathan R, Demonte A, Shivpuri D, Venkitasubramanian T, Tandon H, Chandrasekhar S, et al. Bagassosis. 1963.
33. Wendimu MA. Large-Scale Agriculture and Outgrower Schemes in Ethiopia: Land Acquisition, Productivity, Labour Markets and Welfare Effects: University of Copenhagen, Faculty of Science, Department of Food and …; 2015.
34. Rappaport SM, Kupper LL. Quantitative exposure assessment: Stephen Rappaport; 2008.
35. Lagiso ZA, Mekonnen WT, Abaya SW, Takele AK, Workneh HM. CRS, lung function and associated factors among flour mill factory workers in Hawassa city, southern Ethiopia:"comparative cross-sectional study". BMC Public Health. 2020;20:1-9.
36. Abaya SW, Bråtveit M, Deressa W, Kumie A, Moen BE. Reduced lung function among workers in primary coffee processing factories in Ethiopia: a cross sectional study. International Journal of Environmental Research and Public Health. 2018;15(11):2415.
37. Safety O, Administration H. OSHA technical manual: section ii, chapter 1: personal sampling for air contaminants. Occupational safety and health administration. 2014.
38. Leidel NA. Occupational exposure sampling strategy manual: US Department of Health, Education, and Welfare, Public Health Service …; 1977.
39. Miller MR, Hankinson J, Brusasco V, Burgos F, Casaburi R, Coates A, et al. Standardisation of spirometry. European respiratory journal. 2005;26(2):319-38.

40. Ramachandran G. Toward better exposure assessment strategies—the new NIOSH initiative. Annals of occupational hygiene. 2008;52(5):297-301.
41. Ghosh T, Gangopadhyay S, Das B. Prevalence of respiratory symptoms and disorders among rice mill workers in India. Environmental health and preventive medicine. 2014;19:226-33.
42. Annesi-Maesano I, Lundbäck B, Viegi G. Respiratory Epidemiology: ERS Monograph: European Respiratory Society; 2014.
43. Manczuk M, Cedzynska M. Features of ex-smokers. Handbook of substance misuse and addictions: from biology to public health: Springer; 2022. p. 1-22.
44. Abaya SW, Bråtveit M, Deressa W, Kumie A, Moen BE. Personal dust exposure and its determinants among workers in primary coffee processing in Ethiopia. Annals of Work Exposures and Health. 2018;62(9):1087-95.
45. Fatima S, Shahid I. Study of occupational health and safety conditions of a sugar mill in Pakistan. Journal of Biodiversity and Environmental Sciences (JBES). 2017;11(1):97-104.
46. Abo El Ata GA. Environmental, mycological and respiratory health assessment of workers chronically exposed to bagasse in egyptian particle-board industry. International Journal of Environmental Health Research. 1998;8(4):315-34.
47. Kulkarni KD, Ravi A, Pranavi V. Bagassosis-An Infrequent Type of Hypersensitivity Pneumonitis: A Case Report. Indian Journal of Occupational and Environmental Medicine. 2023;27(3):268-70.
48. Singh AB, Singh A, Pandit T. Respiratory diseases among agricultural industry workers in India: a cross-sectional epidemiological study. Annals of Agricultural and Environmental Medicine. 1999;6(2).
49. Alemseged EA, Takele AK, Zele Y, Abaya SW, Kiros KG, Mehari M, et al. Assessment of Chronic Respiratory Health Symptoms and Associated Factors Among Flour Mill Factory Workers in Addis Ababa, Ethiopia, 2019: A Cross-Sectional Study. J Asthma Allergy. 2020;13:483-92.
50. Singh V. Study of health status of sugarcane factory workers of Vijayapura district-Longitudinal study: BLDE (DU); 2020.
51. PAWAR PM, SHINDE SB. Prevalence of impairment in pulmonary function test in sugar distillery industry workers in Karad Taluka. PREVALENCE. 2019;12(2).
52. Ethiopian Sugar Industry Group Website: https://etsugar.com/esig/2023/01/27/wonji-shoa-sugar-factory/.

10. Annexes

Annex I: Participants Information Sheet

Greetings:

My name is __________________, and I am working as a data collector for a study being conducted at Wonji Shoa Sugar factory by Walelign Erkalo, a Master's degree student at Addis Ababa University, College of Health Sciences, School of Public Health. I kindly request your attention to explain the study and your potential role as a participant.

Study Title:

Assessment of the Impact of bagasse dust exposure on CRS and Lung Function among Wonji Shoa Sugar factory workers, Ethiopia.

Purpose of the Study:

The main objective of this study is to fulfill the requirements for a Master's degree thesis in Public Health for the principal investigator. By doing so the study is intended to assess personal exposure to sugarcane bagasse dust and its impact on CRS and lung function among workers at the Wonji Shoa Sugar Factory. This study aims to play a significant role in preventing and managing respiratory health challenges associated with bagasse exposure among sugar factory workers. It also hopes to motivate government authorities and stakeholders to prioritize addressing these occupational health issues.

Procedure and Duration:

The study will involve:

1. Assessing CRS through a questionnaire.

For data collection, I will use a standard questionnaire adapted from the American Thoracic Society (ATS) alongside an observational checklist. The study has been ethically approved by the School of Public Health. Before participating, you will receive detailed information about the study, and your consent will be sought. The interview is expected to take approximately 30 minutes.

2. Personal bagasse dust exposure monitoring

To quantify personal bagasse dust exposure, a dust sampler will be fixed on your body. A small sampling head will be positioned near your breathing zone to collect the dust likely inhaled during your work. A 0.5 kg hand pump will be attached to your waist, drawing air through a connecting tube that passes through the sampling head. This device works on a battery and emits minimal sound. It does not interfere with your health or work performance. The sampling will span your full working hours. The principal investigator will assist in attaching the device, starting, and stopping the hand pump as needed.

3. Measuring pulmonary function using a spirometer.

To assess your lung function, a spirometer will be used. This device measures how much air you can inhale and exhale, as well as how effectively oxygen is transported in your body. Before the test, please ensure you haven't had a heavy meal, smoked, or engaged in vigorous exercise at least 2 hours beforehand. During the test, you will be seated comfortably and breathe into a mouthpiece connected to the spirometer. A nose clip will be used to ensure you breathe only through your mouth. You'll be guided to take deep breaths, exhale forcefully, or breathe at varying speeds as instructed. The procedure is completely safe and non-invasive. Some participants may feel lightheaded during or after the test, but this usually resolves quickly. The test takes approximately 30–60 minutes to complete. Afterward, your healthcare provider will explain the results and discuss any necessary follow-up steps.

These activities will be conducted in your work environment, requiring only a few minutes of your time and your full cooperation.

Risks and Benefits:

Risks: This study poses no risk to participants as it does not involve invasive procedures or require the collection of biological samples.

Benefits: While there are no direct benefits for participation, the findings will contribute to improving occupational health and safety practices, provide valuable insights for sugar factory workers, and advance scientific knowledge.

Confidentiality:

All information you provide will be kept strictly confidential, and your name will not be recorded or associated with any data.

Your Rights:

Participation in this study is entirely voluntary. You have the right to decide whether to take part or not. If you choose to participate, you may withdraw at any time without providing a reason, especially if you feel something about the study is inappropriate or uncomfortable.

Whom to Contact:

If you have any questions about this research, please feel free to contact the following:

Principal Investigator (PI): Walelign Erkalo

Addis Ababa University, College of Health Sciences, School of Public Health

Tel: +251-9-73-66-27-73

Supervisors:

Dr. Samson Wakuma

Tel: +251-9- 23-94-09-98

Ethical Review Committee:

School of Public Health, Addis Ababa University

Tel: +251-115-157701

At this point, do you have any questions about the purpose or content of this interview? Are you willing to participate in the study?

Thank you for considering participating in this important research. If you have any questions, please don't hesitate to ask!

Annex II. INFORMED CONSENT FORM

I have been provided with detailed information about the study, including its objectives, procedures, and my role as a participant. I understand that the purpose of this study is to assess the impact of bagasse dust exposure on CRS and pulmonary function among workers at Sugar factories.

Additionally, I understand the following:

- ✓ The data collection process, including how it will be conducted and the approximate time required to complete it.
- ✓ There are no risks associated with my participation in this research.
- ✓ My responses will be kept confidential, and the data collected will be used solely for research purposes.
- ✓ I have the right to withdraw from the study at any point without any repercussions.
- ✓ I also recognize that my participation in this study is significant for advancing scientific knowledge and providing a basis for further research in this area.

Having understood all of the above, I voluntarily agree to participate in the study.

Participant's Consent:

Signature of Participant: ____________________________

Date: ____________________________

Data Collector's Declaration:

I confirm that I have provided detailed information about the study to the participant, answered all questions, and obtained their voluntary consent.

Name and Signature of Data Collector: ____________________________

Date: ____________________________

IDENTIFICATION

Questionnaire code: _______________ working department _________________

Annex III: English Version Questionnaire

Socio-demographic characteristics of the study participants

101. Sex	Male	
	Female	
102. Age group (In years)	8-24	
	25-34	
	35-44	
	>=45	
103. Marital Status	Single	
	Married	
	Others (divorced, Widowed)	
104. Educational Status	Read and write	
	Primary school (1-8)	
	Secondary (9-12)	
	College diploma	
	Degree and above	
105. What is your income per a month?	__________ETB	
106. How long do you working in this job?	____________years	
107. Employment type	Daily laborer	
	Contractual	
	Permanent	
108. How many working hours per a day?	_________________hours	

109. How many working days per a week?	____________________Days		
110. Which section are you working now and for how long?	Working department	Service year	
	Harvesting		
	Milling		
	Evaporation		
	Boiler (Bagasse handler)		
	Packaging		
	Others		
111. Have you ever worked in other sections in the past in the sugar factory?	Yes		
	No		
If "Yes" for the above "Q" Indicate which section and for how long? (in years & months) (Multiple answer is possible)	Working department	Service year	
	Harvesting		
	Milling		
	Evaporation		
	Boiler (Bagasse handler)		
	Packaging		
	Others		

Personal characteristics of study participants

201. Frequency of Alcohol consumption	Never	
	Regularly	
	Sometimes	
202. Frequency Khat Chewing	Never	
	Sometimes	
	Regularly	
203. Cigarette smoking status	Yes	
	No	
204. Obeying safety rules	Yes	
	No	
205. Satisfaction with current job	Satisfied	
	Unsatisfied	
206. Training in the use of respirator	Received	
	Not received	
207. Usual wearing of respiratory protective devices	Yes	
	No	
208. Reason for not wearing respiratory protective devices	Not available	
	Uncomfortable	
	Don’t give adequate protection	
	Dust is not harmful	
	Other reasons	
209. Ever working in other dusty types of work	Yes	
	No	
210. What kind of energy source mostly do you use for food preparation? (your primary	Coal	
	Wood	
	Gas	

fuel type)	Electric	
	Others (specify)	

Engineering/ job related and working condition related characteristics (Key Informants)

301. Routine maintenance of machines	Yes	
	No	
302. Enforcement of respiratory protective equipment utilization	Yes	
	No	
303. Existence job rotation systems	Yes	
	No	
304. Periodic medical examination/health check-up	Yes	
	No	
305. Hours worked per week	<=48 hours a week	
	>48hrs	
306. Dust control technology status	Absent	
	Present	
307. Types of ventilation	Local	
	General	
	Natural	
308. The enclosure of dusty work setting	Yes	
	No	
309. Practice of wet spray	Yes	
	No	
310. Provision of Health and Safety trainings	Yes	
	No	
311. Routine health and safety inspection	Yes	
	No	

312. Safety audit	Yes	
	No	
313. Safety of working environment	Safe	
	Unsafe	

Assessment of past respiratory illnesses and CRS

401. Pneumonia	Yes	
	No	
402. Tuberculosis	Yes	
	No	
403. Bronchitis	Yes	
	No	
404. Asthma	Yes	
	No	
405. chest injury	Yes	
	No	
406. Cough	Cough first thing in the morning,	
	Cough during the day or night	
	Cough as much as four to six times a day in a week.	
	Cough for most days for as much as three consecutive months during the year.	
407. Cough with sputum	Cough with sputum first thing in the morning,	
	Cough with sputum during the day or night,	
	Cough with sputum as much as four to six times a day in a week, or	
	Cough with sputum for most days for as much as three consecutive months during	

	the year.	
408. Breathlessness	Troubled by shortness of breath when hurrying on level ground or walking up a slight hill	
	Get shortness of breath when walking at his/her own pace on the level ground	
	Get shortness of breath when walking with other people of your own age on level ground.	
409. Work-related shortness of breath	Usually experience of chest tightness while at work or just after work.	
410. Wheezing	Wheezy (whistling) sound of the chest	

Annex IV: Observational Checklist PPE usage and workplace environment

Observational Checklist PPE usage and workplace environment

Questions	Observation		Comment
	Yes	No	
Is respiratory protective equipment available for each worker at every department?			
Is respiratory protective equipment (RPE) provided?			
Is provided respiratory protective equipment properly used?			
Is there a written procedure for the selection, use and maintenance of PPE?			
Is personal protective utilized only when it is not reasonably practicable to eliminate or control the hazardous substance or process?			
Are the areas requiring PPE usage properly identified by warning signs?			

Annex V: Dummy table for dust level measurement

Table 14. **Measurements of personal bagasse dust at Wonji Shoa Sugar Estate workers**

Code	**Pre weight of Filter (mg)**	**Post weight of Filter (mg)**	**Starting time (min)**	**Ending time (min)**	**Initial flow rate (L/min)**	**Final Flow rate (L/min)**	**Blank weight (mg)**	**Dust Conc. (mg/m3)**
1								
2								
3								
4								
5								
6								

Table 15. Dust Sampling Worksheet (PI: Walelign E.)

Factories name: __________ Name of data collector:___________

Blank ID number: __________ Department:___________

Date	Code of participant	Round	Work shift	Filter code Id #	Pump ID #	Dep't	Time start	Time ended	Intial flow rate	Final flow rate	Remark
1											
2											
3											

One data sheet is used only for one day and one blank serves only for one day

Annex VI. Standard Operative Procedure for the Lung Function Parameters

Purpose: the purpose of this SOP is to ensure the pulmonary function test is conducted accurately, consistently, and safely in the field during the data collection period among Wonji Shoa Sugar Factory workers and the non-exposed.

Basic Parameters of Pulmonary Function test

- **Forced Vital Capacity (FVC):** is the maximal volume of air exhaled with maximally forced effort from a maximal inspiration.
- **Forced Expiratory Volume in one second (FEV1sec):** is the maximal volume of air exhaled in the first second of a forced expiration from a position of full inspiration.
- **FEV1/FVC:** is the ratio of the above two.

Spirobank II Basic overview

The Spirobank II® Basic is a handheld, portable diagnostic spirometer designed for use in environments where it's only necessary to take basic measurements of the main spirometric parameters. It can be used as a "stand-alone" with onboard memory that is capable of storing up to10,000 test results. It can also connect to a PC via USB allowing for real-time spirometry testing, and downloading of test results stored on the device using the free MIR WinspiroPRO® PC Software. The Spirobank II® Basic measures FVC, FEV1, FEV1%, PEF, FEF25–75, FET, Extrap. Volume, Lung Age, VC, IVC, IC, ERV and PRE and POST Bronchodilator comparison. Results are previewed on the display following a test, with a flow/volume and Volume/time graphs in addition to the patient's actual spirometry readings for immediate assessment. It also features a traffic light health indicator for easy interpretation of results. The single-use disposable turbines have a pre-connected mouthpiece and are individually factory calibrated and packaged that we are going to use in our Spirobank II® Basic in our hand.

Preparation of the instrument for field work

Software installation: be sure installing the software on PC before connecting the spirobank II.

Connecting the Spirobank II: after installation of the software program, connect the USB connector of the Spirobank II to a free USB port on the PC and check for its functionality earlier.

Preparing the Spirobank II

Tear open the plastic bag containing the single use disposable turbine with mouthpiece and fold the bag back, allowing you to insert the turbine into the Spirobank II. Ensure that the plastic bag protects the mouthpiece until you handover to the participant to adhere with infection prevention protocols. When inserting the turbine into the Spirobank II ensure that the turbine is closed tightly with the spirobank, otherwise it won't work. When you remove the disposable turbine with mouthpiece rotate it in the different direction slightly and pull it out (as marked on the spirobank).

SPIROMETRY TEST PROCEDURE

A. Establish rapport

To obtain valid test results from a spirometric test, the eligible participant must be put at ease. This is accomplished by:-

- Initially greet the study participant,
- Assure him/her that the test is simple and non-painful and
- Explain the purpose of measuring that how much air can be exhaled after a maximal inhalation and how fast it can be blown out.

B. Prepare the study Participants

By recording details on the winspiroPro software properly and appropriately.

- Unique identification number
- Name and surname
- Date of birth and age in years
- Gender
- Race/ ethnicity
- Weight (in kg to the nearest 0.5 of a kg):- should be measured without shoes (weight scale), with pockets empty and wearing indoor clothes only.
- Height (in cm to the nearest 0.5cm):- The subject must be standing without shoes on Stadiometer in the Frankfort position, as tall as possible with the eyes level and looking straight ahead.
- Smoking history and other mandatory details

C. Ask pre-screening questions (below)

D. Give test instructions

The patient's cooperation will depend on a complete test explanation. The better the subject understands the maneuver, the better the results will be.

- Every patient should be in a standing or sitting position (be consistent) for the test but for safety reasons spirometry should be performed in a sitting position.
- Place a chair behind the patient, if standing, to allow for him to sit down should dizziness be experienced.
- Loosen all tight clothes.

D. Describe the maneuver

- Sit straight comfortably with chin up and back supported on the chair,
- Uncross legs on the floor comfortably.
- Take the deepest breath you can, then place the mouthpiece in your mouth, on top of your tongue (to ensure the tongue does not occlude the mouthpiece) and tightly seal your lips around the tube.
- Stop here and show how the mouthpiece is placed over the tongue.

To ensure that the patient understand the maneuver clearly repeat by say:- "To do the test properly you need to take the biggest and deepest breath in that you can through your mouth, then blow as fast as you can for as long as you can into the mouthpiece, until your lungs are completely empty or you cannot blow any longer"

"ፈ ተ ና ውን በ ት ክ ክ ል ለ መስ ራ ት በ አ ፍ ዎ በ ኩ ል በ ሚቻ ሉ ት ኃ ይ ል ት ል ቅ እ ና ጥል ቅ እ ስ ት ን ፋ ስ ወ ደ ሳ ን ባ ዎ ይ ውሰ ዱ ፤ ከ ዚ ያ በ ተ ቻ ለ ዎ ት ፍ ጥነ ት እ ና እ ስ ከ ቻ ሉ ት ድ ረ ስ ያ ን ኑ እ ስ ት ን ፋ ስ ሳ ን ባ ዎ ሙሉ በ ሙሉ ባ ዶ እ ስ ኪ ሆ ኑ ድ ረ ስ በ 'mouth piece'በ ኩ ል ያ ስ ወጡታ ል ። "

Script used to instruct the procedure

Introduction:

"Hello! Today, we will be performing a spirometry test as part of research study. This test is designed to measure important aspects of your lung function. The purpose of this test is to gather data on lung capacity and airflow. It help us to measure the total amount of air you can forcibly exhale after taking a deep breath; and the amount of air you can forcibly exhale in the first second of the exhalation. Your high participation and patience will be important for this test, so please collaborate with me. First let me

explain what you need to do."

Instructions for Performing the Test:

"Let's go through the steps to perform the spirometry test. Please follow these instructions carefully: Sit comfortably in an upright position. If you're wearing tight clothing, please loosen it to avoid restricting your breathing. This is a disposable mouthpiece, which is sealed currently and I will use it only for you. You need to place this mouthpiece in your mouth above your tongue so your tongue will not block the air flow, and ensure that your lips create a tight seal around it. Avoid biting down on the mouthpiece. After that I need you to breathe through your mouth comfortably, then when I say "go" Take a deep breath in through your mouth only and fill your lungs completely and quickly, then without waiting a second blow out forcefully and quickly through the mouthpiece. Aim to empty your lungs as much as possible. Keep blowing out until I instruct you to stop. It's important to maintain a strong and continuous exhalation throughout the process. We will repeat this maneuver at least three times to ensure the accuracy of our measurements. After each attempt, take a few normal breaths before the next one. I will be here to guide you and provide any necessary assistance. If you feel dizzy or uncomfortable at any time, please let me know, and we can take a break. So before we start let me show you how you do it, so follow me carefully."

E. Demonstrate the maneuver

"Now watch how I do it." Take a different mouthpiece and carefully show each step in the procedure, with your maximal effort (your demonstration is setting the example, so make it real). At the beginning of the exhalation maneuver, do not bend forward, stand/sit upright with your chin elevated.

F. Perform the manoeuvre

- ✓ Have subject assume the correct posture
- ✓ Before commencing the first maneuver, the patient should have the mouthpiece firmly attached to the pressure tube and their hands firmly around it.
- ✓ Attach nose clip, place mouthpiece in mouth and close lips around the mouthpiece
- ✓ Inhale completely and rapidly with a pause of <1 s at TLC
- ✓ Exhale maximally until no more air can be expelled while maintaining an upright posture
- ✓ Continue by saying, "I want you to 'Blast' the air out as hard and fast as you can, and keep blowing hard until you have no more air left! I know it's painful keep going! Bravo! Good Job!"
- ✓ Repeat instructions as necessary, encourage and coach vigorously
- ✓ Repeat for a minimum of three manoeuvres; no more than eight are usually required
- ✓ Check test repeatability and perform more manoeuvres as necessary

Due to the "learning curve," it usually requires several attempts to achieve the optimal spirogram. First obtain three maneuvers. If satisfactory data has not been obtained after three attempts, rest the patient and then do up to five more maneuvers, for a total of eight.

G. Acceptability criteria for manoeuvres

- A satisfactory start of test and a satisfactory end of test (EOT), i.e. a plateau in the volume–time curve.
- The subject performed the manoeuvre with a maximum inspiration, a good start, a smooth continuous exhalation and maximal effort:

    1. without an unsatisfactory start of expiration, characterised by excessive hesitation or false start extrapolated volume or EV .5% of FVC or 0.150 L, whichever is greater
    2. without coughing during the first second of the manoeuvre, thereby affecting the measured FEV1 value, or any other cough that interferes with the measurement of accurate results;
    3. without early termination of expiration (see End of test criteria section);
    4. without a Valsalva manoeuvre (glottis closure) or hesitation during the manoeuvre that causes a cessation of airflow, which precludes accurate measurement of FEV1 or FVC;
    5. without a leak;
    6. without an obstructed mouthpiece (e.g. obstruction due to the tongue bein placed in front of the mouthpiece, or teeth in front of the mouthpiece, or mouthpiece deformation due to biting);
    7. without evidence of an extra breath being taken during the manoeuvre.

It should be noted that a usable curve must only meet conditions 1 and 2 above, while an acceptable curve must meet all of the above seven conditions.

- The reporting format should include qualifiers indicating the acceptability of each manoeuvre.
- Records of failed such manoeuvres should be retained since they may contain useful information.

H. Between-manoeuvre criteria (Repeatability)

- ✧ After three acceptable spirograms have been obtained, apply the following tests
    - ✓ The two largest values of FVC must be within 0.150 L of each other
    - ✓ The two largest values of FEV1must be within 0.150 L of each other
- ✧ If both of these criteria are met, the test session may be concluded
- ✧ If both of these criteria are not met,

- ✓ continue testing until both of the criteria are met with analysis of additional acceptable spirograms or
- ✓ A total of eight tests have been performed (optional) or
- ✓ The patient/subject cannot or should not continue

Other conditions to be considered

❖ **Testing environment**

Testing should occur in a clean, bright, well ventilated and comfortable environment. There should be adequate standing space for subjects who test standing and a subject chair with arms and no wheels.

❖ **Infection Prevention and control through**

- ➢ Wash hands Before & after administering a spirometry test
- ➢ Avoid testing subjects who have active respiratory infections
- ➢ Dispose of waste into bio-hazardous waste bags
- ➢ Allow subject to remove his own mouthpiece after testing
- ➢ Clean working surfaces and equipment daily
- ➢ Air-conditioned room for good ventilation and temperature control of equipment

❖ **In case when syncopal attack or loss of conciousness happen while conducting the manoeuvre be ready and give first aid**

❖ **In case when the subject's spirometric test results show abnormalities don't forget to record, report and link to near by health facilities for further consultation.**

Pre-screening Questions

To be completed by a medical provider prior to testing

Name:____ Site:__________________________
Age:____ Date:_________________________
Height:____________ inches Weight:______________________ BP (mmHg): ____/____ ____/____ ____/____

Determine if there is any condition which may require postponement of the test or may cause the test to be invalid.

1. Have you had a chest trauma or any major surgery in the last 6 weeks involving the eye, ear, chest, abdomen, brain, nose or throat? a. Yes b. No

If yes, do not test at this time. Reschedule spirometry for 6 weeks' time

2. Have you been hospitalized in the last 6 weeks? a. Yes b. No

If yes, do not test at this time. Reschedule spirometry for 6 weeks' time

3. In the last 4 weeks have you had any cardiac complaint (unstable angina, cerebrovascular accident, aneurysm) or suffered from a heart attack? a. Yes b. No

If yes, do not test at this time

4. Have you recently or are you currently coughing up any blood? a. Yes b. No

If yes, do not test at this time

5. Have you recently had or currently had an acute retinal detachment? a. Yes b. No

If yes, do not test at this time

6. Are you under a doctor's care for high blood pressure? a. Yes b. No

If blood pressure is elevated above 180/110, obtain clinician's clearance before proceeding.

7. Have you had a respiratory infection (such as flu, pneumonia, bronchitis, or a chest cold) in the last 3 weeks? a. Yes b. No

If yes, continue with spirometry testing now and schedule to retest in 6 weeks if the spirometry is abnormal.

8. Do you smoke? a. Yes b. No

If yes, calculate the smoking pack years and note on spirogram or to person interpreting the test.

9. Within the last hour have you smoked tobacco? a. Yes b. No

If yes wait one hour before testing otherwise make a note to the person interpreting the test and proceed.

10. Within the last 2 hours have you eaten a full meal? a. Yes b. No

If yes wait one hour before testing otherwise make a note to the person interpreting the test and proceed.

11. Have you used a short acting inhaled bronchodilator (SAB) (Ventolin, Venteeze, Asthavent, Duovent etc) in the last 4 hours? a. Yes b. No

If yes continue to test but make a note to the person interpreting the test including type of medication, dosage and time of last administration.

12. Have you used a long acting inhaled bronchodilator (LAB) (Symbicord, Foxair, Seretide, Sereflo) in the last 4 hours? a. Yes b. No

If yes continue to test but make a note to the person interpreting the test including type of medication, dosage and time of last administration.

13. Have you used any other medication in the past 24 hours? a. Yes b. No

If yes continue to test but make a note to the person interpreting the test including type of medication, dosage and time of last administration.

14. Have you exercised in the past 30 minutes? a. Yes b. No

If yes reschedule the test for when the subject has been resting for a full 30 minutes.

15. Are you in any pain now that could limit you from blowing with effort? a. Yes b. No

If yes reschedule the test for when the subject is pain free

16. Are you currently suffering from acute diarrhoea, vomiting or nausea that may limit you from blowing with effort? a. Yes b. No

If yes reschedule the test for when the subject is feeling well

17. Have you consumed alcohol in the past 4 hours? a. Yes b. No

If yes reschedule the test for 4 hours after alcohol was last taken

18. Have you had more than 2 cups of caffeinated coffee, tea, or cola (total) in the last 6 hours?

a. Yes b. No

If possible wait 6 hours before testing, otherwise make a note to the person interpreting the test.

19. Are you wearing any tight clothing that interferes with your ability to breathe deeply?

a. Yes b. No

If yes loosen or remove the tight clothing.

20. Are you wearing dentures? a. Yes b. No

If yes: Remove dentures that are loose and may interfere with test performance remove.

Provider initials:__________________ Date:_________________

አባሪ I፡ የተሳታፊዎች መረጃ ሉህ

ሰላምታ፡

ስሜ____እባላለሁ በወንጂ ሸዋ ስኳር ፋብሪካ በአዲስ አበባ ዩኒቨርሲቲ የጤና ሳይንስ ኮሌጅ የህብረተሰብ ጤና ትምህርት ቤት የማስተርስ ዲግሪ ተማሪ በሆነው በዋለልኝ እርቃሎ እየተካሄደ ላለ ጥናት መረጃ ሰብሳቢ ሆኜ እየሰራሁ ነው። ጥናቱን እና የአሳታፊነት ሚናዎን ለማብራራት ትኩረትዎን በአክብሮት እጠይቃለሁ።

የጥናት ርዕስ፡

በወንጂ ሸዋ ስኳር ፋብሪካ ሰራተኞች ላይ የ"Bagasse" ብናኝ መጋለጥ ሥር በሰደደ የመተንፈሻ ምልክቶች እና የሳንባ ተግባር ላይ የሚያሳድረውተጽእኖ ግምገማ።

የጥናቱ ዓላማ፡ -

የዚህ ጥናት ዋና ዓላማ ለዋና ተመርማሪ በሕዝብ ጤና የማስተርስ ዲግሪ መመረቂያ መስፈርቶችን ማሟላት ነው። ይህን በማድረግም ጥናቱ በግለሰብ ደረጃ ለሸንኮራ አገዳ "Bagesse" አቧራ መጋለጥ እና ሥር የሰደደ የመተንፈሻ አካላት ምልክቶች እና በወንጂ ሸዋ ስኳር ፋብሪካ ውስጥ ባሉ ሰራተኞች ላይ የሚያደርሰውን ተፅዕኖ ለመገምገም ያለመ ነው። ይህ ጥናት በስኳር ፋብሪካ ሰራተኞች መካከል "Bagasse" መጋለጥ ጋር ተያይዞ የሚፈጠሩትን የመተንፈሻ አካላት ጤና ተግዳሮቶችን በመከላከል እና በመቆጣጠር ረገድ ጉልህ ሚና መጫወት ያለመ ነው። በተጨማሪም የመንግስት ባለስልጣናት እና ባለድርሻ አካላት እነዚህን የሙያ ጤና ችግሮች ለመፍታት ቅድሚያ እንዲሰጡለማነሳሳት ተስፋ ያደርጋል.

ሂደት እና የሚቆይበት ጊዜ፡ -

ጥናቱ የሚከተሉትን ያጠቃልላል

1. ሥር የሰደደ የመተንፈሻ አካላት ምልክቶችን በመጠይቅ መገምገም.

ለመረጃ አሰባሰብ፣ ከአሜሪካን ቶራሲክ ሶሳይቲ (ATS) የተስተካከለ መደበኛ መጠይቅ ከምልከታ ማረጋገጫ ዝርዝር ጋር እጠቀማለሁ። ጥናቱ በሕዝብ ጤና ትምህርት ቤት በሥነ ምግባር ጸድቋል። ከመሳተፍዎ በፊት, ስለ ጥናቱ ዝርዝር መረጃ ይደርስዎታል,እና ፈቃድዎ ይጠየቃል.ቃለ መጠይቁ በግምት 30ደቂቃ ይወስዳል ተብሎ ይጠበቃል።

2. ግላዊ " bagasse" አቧራ መጋለጥ ክትትል

የግል በርሳ መሳይ አቧራ መጋለጥን ለመለካት የአቧራ ናሙና በሰውነትዎ ላይ ይስተካከላል። በስራዎ ወቅት ሊተነፍሰው የሚችለውን አቧራ ለመሰብሰብ ትንሽ የናሙና ጭንቅላት ከመተንፈሻ ዞንዎ አጠገብ ይደረጋል። 0.5ኪሎ ግራም የእጅ ፓምፕ ከወገብዎ ጋር ተያይዟል,አየር በናሙና ጭንቅላት ውስጥ በሚያልፈው ተያያዥ ቱቦ ውስጥ ይሳባል. ይህ መሳሪያ በባትሪ ላይ ይሰራል እና አነስተኛ ድምጽ ያሰማል። በጤናዎ ወይም በስራ አፈጻጸምዎ ላይ ጣልቃ አይገባም.ናሙናው ሙሉ የስራ ሰዓታችሁን ይጨምራል። ዋናው ተመርማሪ መሳሪያውን በማያያዝ፣ በመጀመር እና እንደ አስፈላጊነቱ የእጅ ፓምፑን ለማቆም ይረዳል።

3. " spirometer" በመጠቀም የሳንባ አተነፋፈስ ተግባር መለካት.

የሳንባዎን ተግባር ለመገምገም, spirometer ጥቅም ላይ ይውላል.ይህ መሳሪያ ምን ያህል አየር ወደ ውስጥ መተንፈስ እና መተንፈስ እንደሚችሉ እንዲሁም ኦክስጅን በሰውነትዎ ውስጥ ምን ያህል ውጤታማ በሆነ መንገድ እንደሚጓጓዝ ይለካል። ከሙከራው በፊት፣ እባክዎን ቢያንስ ከ 2 ሰዓታት በፊት ከባድ ምግብ እንዳልተመገቡ፣ እንዳላጨሱ ወይም ጠንካራ የአካል ብቃት እንቅስቃሴ እንዳልተሳተፉ ያረጋግጡ። በፈተናው ወቅት፣ በምቾት ይቀመጣሉ እና ከስፒሮሜትር ጋር በተገናኘ አፍ ውስጥ ይተነፍሳሉ። በአፍህ ብቻ መተንፈስህን ለማረጋገጥ

የአፍንጫቅንጥብ ጥቅምላይ ይውላል። እንደ መመሪያው ጥልቅ ትንፋሽ እንዲወስዱ፣ በኃይል ለመተንፈስ ወይም በተለያየ ፍጥነት እንዲተነፍሱ ይመራዎታል። አሰራሩ ሙሉ በሙሉ ደህንነቱ የተጠበቀ እና የማይጎዳ ነው. አንዳንድ ተሳታፊዎች በፈተና ወቅት ወይም በኋላ ትንሽ የመፍዘዝ ስሜት ሊሰማቸው ይችላል፣ ነገር ግን ይህ በአብዛኛውበፍጥነት ይፈታል። ፈተናውለማጠናቀቅ ከ30-60ደቂቃ ያህል ይወስዳል። ከዚያ በኋላ፣ የጤና እንክብካቤ አቅራቢዎ ውጤቱን ያብራራል እና ማንኛውንም አስፈላጊ የክትትል እርምጃዎችን ይወያያል። እነዚህ እንቅስቃሴዎች የሚከናወኑት በስራ አካባቢዎ ውስጥ ሲሆን ይህም ጊዜዎን ጥቂት ደቂቃዎችን ብቻ እና ሙሉ ትብብርዎን ይጠይቃሉ.

አደጋዎች እና ጥቅሞች:

ስጋቶች፡ -ይህ ጥናት ወራሪ ሂደቶችን ስለማያካትት ወይምየባዮሎጂካል ናሙናዎችን መሰብሰብ ስለሚያስፈልገው ለተሳታፊዎች ምንምአይነት አደጋ አያስከትልም።

ጥቅማጥቅሞች፡ ለተሰትፎ ቀጥተኛ ጥቅማጥቅሞች ባይኖሩም ግኝቶቹ የስራ ጤናን እና ደህንነትን ለማሻሻል፣ ለስኳር ፋብሪካ ሰራተኞች ጠቃሚ ግንዛቤዎችን ለመስጠት እና ሳይንሳዊ እውቀትን ለማዳበር አስተዋፅኦ ያደርጋሉ።

ሚስጥራዊነት፡ -

ያቀረቡት ሁሉም መረጃዎች በጥብቅ በሚስጥር ይቀመጣሉ፣ እና ስምዎ ከማንኛውም ውሂብ ጋር አይመዘገብምወይምአይያያዝም።

መብቶችዎ፡ -

በዚህ ጥናት ውስጥ መሳተፍ ሙሉ በሙሉ በፈቃደኝነት ነው. ለመሳተፍ ወይም ላለመሳተፍ የመወሰን መብት አለዎት. ለመሳተፍ ከመረጡ፣ ምክንያቱን ሳያሳዩ በማንኛውምጊዜ ማግለል ይችላሉ፣ በተለይ በጥናቱ ላይ የሆነ ነገር አግባብ ያልሆነ ወይምየማይመች ሆኖ ከተሰማዎት።

ማንን ማግኘት እንዳለበት፡ -

ስለዚ ምርምር ምንምአይነት ጥያቄ ካሎት እባክህ የሚከተሉትን ለማነጋገር ነፃነት ይሰማህ። ዋና ተመርማሪ (PI)፡ ዋለልኝ እርካሎ (ስልክ፡ 251-9-73-66-27-73)

አዲስ አበባ ዩኒቨርሲቲ፣ የጤና ሳይንስ ኮሌጅ፣ የሕዝብ ጤና ትምህርት ቤት

አማካሪዎች፡ -

ዶ/ር ሳምሶን ዋቁማ

ስልክ፡ 251-9- 23-94-09-98

የስነ ምግባር ክለሳ ኮሚቴ፡ -

የህዝብ ጤና ትምህርት ቤት፣ አዲስ አበባ ዩኒቨርሲቲ

ስልክ፡ 251-115-157701

በዚህ ጊዜ፣ የዚህን ቃለ መጠይቅ ዓላማ ወይም ይዘት በተመለከተ ምንም አይነት ጥያቄ አልዎት?በጥናቱ ለመሳተፍ ፈቃደኛ ነህ?

በዚህ ጠቃሚ ምርምር ውስጥ ለመሳተፍ ስላሰቡ እናመሰግናለን። ማንኛውም ጥያቄ ካለዎት እባክዎን ለመጠየቅ አያመንቱ!

አባሪ II. በመረጃ የተደገፈ የፈቃድ ቅጽ

ስለ ጥናቱ ዓላማዎች፣ ሂደቶች እና የተሳታፊነት ሚናዬን ጨምሮ ስለ ጥናቱ ዝርዝር መረጃ ተሰጥቶኛል። የዚህ ጥናት አላማ የከረጢት ብናኝ መጋለጥ ሥር በሰደደ የአተነፋፈስ ምልክቶች እና በስኳር ፋብሪካዎች ውስጥ ባሉ ሰራተኞች መካከል ያለውን የሳንባ ተግባር ላይ ያለውን ተጽእኖ ለመገምገም እንደሆነ ተረድቻለሁ።

በተጨማሪም፣ የሚከተለውን ተረድቻለሁ፡ -

- ✓ የመረጃ አሰባሰብ ሂደቱ እንዴት እንደሚካሄድ እና ለማጠናቀቅ የሚያስፈልገውግምታዊ ጊዜን ጨምሮ።
- ✓ በዚህ ጥናት ከመሳተፌ ጋር የተያያዙ ምንምአይነት አደጋዎች የሉም።
- ✓ የእኔ ምላሾች በሚስጥር ይጠበቃሉ፣ እና የተሰበሰበው መረጃ ለምርምር ዓላማብቻ ይውላል።
- ✓ በየትኛዉም ጊዜ ያለ ምንምችግር ከጥናቱ የመውጣት መብት አለኝ።
- ✓ በተጨማሪም በዚህ ጥናት ውስጥ ያለኝ ተሳትፎ ሳይንሳዊ እውቀትን ለማዳበር እና በዚህ አካባቢ ለቀጣይ ምርምር መሰረት ለመስጠት ጠቃሚ እንደሆነ እገነዘባለሁ።

ከላይ ያሉትን ሁሉ ከተረዳሁ በኋላ በጥናቱ ለመሳተፍ በፈቃደኝነት ተስማምቻለሁ።

የተሳታፊውፈቃድ፡ -

የተሳታፊ ፊርማ፡ ______ ቀን፡ -______

የመረጃ ሰብሳቢውመግለጫ፡ -

ስለ ጥናቱ ዝርዝር መረጃ ለተሳታፊውእንደሰጠሁ፣ ሁሉንም ጥያቄዎች እንደመለስኩ እና በፈቃደኝነት ፈቃዳቸውን እንዳገኘሁ አረጋግጣለሁ።

የመረጃ ሰብሳቢውስምእና ፊርማ፡ -______ ቀን፡ -____

መታወቂያ

መጠይቁ ኮድ፡ -_______________ የሥራ ክፍል _________________

አባሪ III የአማርኛ ስሪት መጠይቅ

የጥናቱ ተሳታፊዎች ማህበረ-ሕዝብ ባህሪያት

101. ጾታ	ወንድ	

	ሴት	
102. የ ዕ ድ ሜ ቡድ ን (በ አ መታ ት ውስ ጥ)	18-24	
	25-34	
	35-44	
	>=45	
103. የ ጋ ብቻ ሁኔ ታ	ነ ጠላ	
	ያገ ባ	
	ሌሎች (የ ተፋቱ፣ ባ ል የ ሞተባ ቸው)	
104. የ ትምህ ር ት ሁኔ ታ	አ ን ብብና ጻ ፍ	
	የ መጀመሪ ያ ደ ረ ጃ ትምህ ር ት ቤት (1-8)	
	ሁለተኛ ደ ረ ጃ (9-12)	
	የ ኮ ሌጅ ዲፕሎማ	
	ዲግሪ እ ና ከዚያ በ ላ ይ	
105. በ ወር ገ ቢዎ ስ ን ት ነ ው?	___________ETB	
106. በ ዚህ ሥራ ውስ ጥ ለ ምን ያ ህ ል ጊ ዜ ትሠራለ ህ ?	_____________ ዓ መታ ት	
107. የ ቅ ጥር አ ይነ ት	የ ቀ ን ሰ ራተኛ	
	ውል	
	ቋ ሚ	
108. በ ቀ ን ስ ን ት የ ስ ራ ሰ አ ታት ?	___ሰ ዓ ታት	
109. በ ሳ ምን ት ስ ን ት የ ስ ራ ቀ ና ት ?	____________________ ቀ ና ት	

110. አሁን የትኛውን ክፍል ነው እየሰሩ ያሉት እና ለምን ያህል ጊዜ ነው?	በመስራት ላይ ክፍል	አገልግሎት አመት	
	መከር		
	መፍጨት		
	ትነት		
	በይለር (ባጋሴ ተቆጣጣሪ)		
	ማሸግ		
	ሌሎች		
111. ከዚህ ቀደም በስኳር ፋብሪካ ውስጥ በሌሎች ክፍሎች ሰርተህ ታውቃለህ?	አዎ		
	አይ		
ከላይ ላለው "Q" "አዎ" ከሆነ የትኛውን ክፍል እና ለምን ያህል ጊዜ ያመልክቱ? (በአመታት ውስጥ	በመስራት ላይ ክፍል	አገልግሎት አመት	
	መከር		
	መፍጨት		
	ትነት		
	በይለር (ባጋሴ ተቆጣጣሪ)		
	ማሸግ		
	ሌሎች		

የጥናት ተሳታፊዎች ግላዊ ባህሪያት

201. የአልኮል ፍጆታ ድግግሞሽ	በጭራሽ	
	በመደበኛነት	
	አንዳንዴ	
202. ድግግሞሽ ጫት ማኘክ	በጭራሽ	
	በመደበኛነት	
	አንዳንዴ	
203. የሲጋራ ማጨስ ሁኔታ	አዎ	
	አይ	
204. የደህንነት ደንቦችን ማክበር	አዎ	
	አይ	
205. አሁን ባለው ሥራ	ረክቻለሁ	
	አልረካም	
206. በመተንፈሻ መከላከያ አካላት አጠቃቀም ላይ ስልጠና	አዎ	
	አይ	
207. ብዙውን ጊዜ የመተንፈሻ መከላከያ መሳሪያዎችን መልበስ	አዎ	
	አይ	
208. የመተንፈሻ መከላከያ መሳሪያዎችን ያለመልበስ ምክንያት	አይገኝም	
	የማይመች	
	በቂ ጥበቃ አይስጡ	
	አቧራ ጎጂ አይደለም	
	ሌሎች ምክንያቶች	
209. በሌሎች አቧራማ በሆኑ የሥራ ዓይነቶች ውስጥ ሁል ጊዜ መሥራት	አዎ	
	አይ	
210. ለምግብ ዝግጅት ምን ዓይነት የኃይል ምንጭ በብዛት	ከሰል	
	እንጨት	

ይጠቀማሉ? (የእርስዎ ዋና የነዳጅ ዓይነት)	ጋዝ	
	ኤሌክትሪክ	
	ሌሎች (ይጥቀሱ)	

የምህንድስና /ከሥራ ጋር የተያያዙ እና የሥራ ሁኔታ ተዛማጅ ባህሪያት

301. የማሽኖች መደበኛ ጥገና	አዎ	
	አይ	
302. የመተንፈሻ መከላከያ መሳሪያዎችን አጠቃቀም መተግበር	አዎ	
	አይ	
303. የሥራ መዞሪያ ስርዓቶች መኖር	አዎ	
	አይ	
304. ወቅታዊ የሕክምና ምርመራ /የጤና ምርመራ	አዎ	
	አይ	
305. ሰዓታት በሳምንት ሰርተዋል።	<= 48 ሰዓታት በሳምንት	
	> 48 ሰአት	
306. የአቧራ መቆጣጠሪያ ቴክኖሎጂ ሁኔታ	የለም	
	አቅርቡ	
307. የአየር ማናፈሻ ዓይነቶች	አካባቢያዊ	
	አጠቃላይ	
	ተፈጥሯዊ	
310. የአቧራ ስራ ቅንብር ማቀፊያ	አዎ	
	አይ	
311. እርጥብ የመርጨት ልምምድ	አዎ	
	አይ	
312. የጤና እና	አዎ	

የ ደ ህ ን ነ ት ስ ል ጠና ዎ ች አ ቅ ር በ ት	አ ይ	
313. መደ በ ኛ የ ጤና እ ና የ ደ ህ ን ነ ት ምር መራ	አ ዎ	
	አ ይ	
314. የ ደ ህ ን ነ ት ኦ ዲት	አ ዎ	
	አ ይ	
315. የ ሥራ አ ካ ባ ቢ ደ ህ ን ነ ት	ደ ህ ን ነ ቱ የ ተ ጠበ ቀ	
	ደ ህ ን ነ ቱ ያ ል ተ ጠበ ቀ	

ያ ለ ፉ የ መተ ን ፈሻ አ ካ ላ ት በ ሽ ታዎች እ ና ሥር የ ሰ ደ ደ የ መተ ን ፈሻ አ ካ ላ ት ምል ክ ቶ ች ግ ምገ ማ

401. የ ሳ ን ባ ምቾ	አ ዎ	
	አ ይ	
402. የ ሳ ን ባ ነ ቀ ር ሳ በ ሽ ታ	አ ዎ	
	አ ይ	
403. ብሮ ን ካ ይ ተ ስ	አ ዎ	
	አ ይ	
404. አ ስ ም	አ ዎ	
	አ ይ	
405. የ ደ ረ ት ጉ ዳ ት	አ ዎ	
	አ ይ	
406. ሳ ል	በ መጀ መሪ ያ ጠዋ ት ላ ይ ሳ ል ፣	
	በ ቀ ን ወይ ም በ ሌ ሊ ት ሳ ል	
	በ ሳ ምን ት ውስ ጥ በ ቀ ን ከ አ ራ ት እ ስ ከ ስ ድ ስ ት ጊ ዜ ያ ህ ል ማሳ ል .	
	በ ዓ መቱ ውስ ጥ ለ ብዙ ቀ ና ት ለ ሦ ስ ት ተ ከ ታታይ ወራ ት ያ ህ ል ሳ ል ።	
407. በ አ ክ ታ ሳ ል	በ መጀ መሪ ያ ጠዋ ት ላ ይ በ አ ክ ታ	

	ማሳል ;	
	በቀን ወይም በሌሊት በአክታ ማሳል ;	
	በሳምንት ውስጥ በቀን ከአራት እስከ ስድስት ጊዜ ያህል በአክታ ሳል , ወይም	
	በዓመት ውስጥ ለሦስት ተከታታይ ወራት ለብዙ ቀናት በአክታ ሳል።	
408. የመተንፈስ ችግር	በሚጣደፉበት ጊዜ የትንፋሽ እጥረት ያስቸግራል	
	በደረጃው መሬት ላይ በራሱ ፍጥነት ሲራመዱ የትንፋሽ ማጠር ይኑርዎት	
	በእድሜዎ ከሌሎች ሰዎች ጋር በእኩል መሬት ላይ ሲራመዱ የትንፋሽ ማጠር ይኑርዎት።	
409. ከሥራ ጋር የተያያዘ የትንፋሽ እጥረት	ብዙውን ጊዜ በሥራ ላይ ወይም ከሥራ በኋላ የደረት መጨናነቅ ልምድ.	
410. (ፉጨት) ድምፅ	የደረት ጩኸት (ፉጨት) ድምፅ	

አባሪ IV፡ የክትትል ማረጋገጫ ዝርዝር PPE አጠቃቀም እና የስራ ቦታ አካባቢ

የምልከታ ማረጋገጫዝርዝር PPE አጠቃቀምእና የስራ ቦታ አካባቢ

ጥያቄዎች	ምልከታ		አስተያየት
	አዎ	አይደለም	
በእያንዳንዱ ክፍል ውስጥ ለእያንዳንዱ ሠራተኛ የመተንፈሻ መከላከያ መሣሪያዎች አሉ?			
የመተንፈሻ መከላከያ መሳሪያዎች (RPE) ተሰጥተዋል?			

የመተንፈሻ መከላከያ መሣሪያዎች በትክክል ጥቅም ላይ ይውላሉ?			
PPEን ለመምረጥ፣ ለመጠቀም እና ለመጠገን የጽሁፍ አሰራር አለ?			
የግል መከላከያ ጥቅም ላይ የሚውለው አደገኛውን ንጥረ ነገር ወይም ሂደትን ለማስወገድ ወይም ለመቆጣጠር ምክንያታዊ ካልሆነ ብቻ ነው?			
የ PPE አጠቃቀምን የሚጠይቁ ቦታዎች በማስጠንቀቂያ ምልክቶች በትክክል ተለይተዋል?			

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Personal Identification

Current location: (Addis Ababa, Ethiopia)

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Academic Credentials

- 2017-2021: -BSc in Public Health from School of Public Health Arba Minch University College of Medicine and Health Sciences, Arba Minch, SNNPR, Ethiopia, Jan, 2021 with CGPA 3.74

Core Skills and Abilities

- Proficient in electronic data entry platforms (ODK, Kobo collect and Redcap) and Data Management Soft wares (SPSS (advanced), Epi-Info (advanced), GIS (basics))
- Proficiency with Microsoft Office products (MS Word, Excel, PowerPoint and Outlook)

Work Experiences

I. Organization: -Arba Minch College of Health Sciences

Post: -Assistant Lecturer

Scope of Work:

- ✓ Responsible for planning and delivering lectures, trainings and workshops on Health Extension packages and advising, mentoring and supervising HEWs (Level III&IV) during clinical and outreach attachments that mainly focus on Health Promotion, Disease Prevention and Environmental and occupational health related issues.
- ✓ Participating in various Community services and researches as Researcher, Co-researcher and Data Collector under Institutional Research Board (IRB).

II. Organization: -Ashira Shinshcho Health Center

Post: -Health Officer (Social Worker/Intern)

Scope of Work:

- ✓ Responsible to deliver Health Education and Counseling clients in their medical problems
- ✓ Clerking clients under adult OPD and manage accordingly
- ✓ Conducting and Delivering of MCH services
- ✓ Attending exposed under Youth Friendly Service and providing FP services
- ✓ Mobilizing Community outreach programs towards Health and related problems

Trainings & Certifications

- ◆ Certificate of recognition on Social work and Internship from Ashira Shinshcho Health Center
- ◆ Certificate of recognition in effective teaching and mentoring skill by JHPIEGO and AMCHS in June, 2021
- ◆ Certificate of recognition on completion on Life skill and Youth Friendly Service (YFS) organized by AMCHS on February, 2022
- ◆ Certificate of recognition on completion of EPHCG Guideline organized by SNNPR RHB in March, 2022
- ◆ Certificate of recognition on completion of Problem Based Learning (PBL) organized by AMCHS on December, 2022
- ◆ Certificate of recognition on completion of organizing training on KOBO TOOLBOX/KOBO COLLECT electronic data collection tool by AMCHS on Feb, 2023

Language Proficiency

- English (Advanced)
- Amharic (Native)
- Kambatigna (Native)
- Halabigna (Native)

References

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Declaration I, the undersigned, declared that this my original work has never been presented for degree in this or other university and that all sources of materials used for this thesis has been fully acknowledged.

Name: **Walelign Erkalo**

Signature ____________________

Place: Addis Ababa University

Date of submission____________________

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

Name: **Samson Wakuma (MPH, MSC, PhD)**

Signature ____________________