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RESPIRATORY HEALTH PROBLEMS AMONG SAWMILL WORKERS AT THE TIMBER MARKET, ACCRA.

BY

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DECLARATION

This work is a presentation of my original work. Any reference to work done by any other person, or institution or any other material obtained from other sources have been duly cited and referenced

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DEDICATION

This dissertation is dedicated to all the sawmill operators at the Accra Timber Market

ACKNOWLEDGEMENT

My biggest thanks goes to the Almighty God for his Grace that saw me through this program successfully. I will also like to thank my husband for his invaluable support and encouragement. My gratitude also goes to my supervisor, Dr. Judith Stephens and the entire sawmill workers at the Accra Timber Market.

ABSTRACT

The sawmill business is a thriving business in Ghana because of the availability of Timber and a high demand for the product in the export market. Exposure of sawmill workers to saw dust is a major occupational hazard facing the industry (Rastogi, 2009) as chronic respiratory symptoms are quite common.

METHOD: This study looked at the respiratory health of sawmill workers. It was carried out at the Timber Market, Accra, with a sample size of 155 sawmill workers. Data was collected through questionnaires and spirometer readings of lung function (FEV_1, FVC and FEV/FVC %). The data collected was analyzed using SPSS and Microsoft Excel.

RESULTS: The result of the study indicated that all the respondents of the study were males and majority of them were below 40 years. 47.7% of the respondents had worked at the sawmill for 10 years and above. Some of the respiratory symptoms presented by respondents include cough (77.4%), cold (76.8%), wheezing (47.75%), tightness of chest (47.7%), shortness of breath (52.9%) and phlegm production (60.6%).

Analysis of spirometer values showed 14.8% of the respondents had obstructive lung impairment whiles 7.1% had restrictive type of lung impairment. The study identified a strong association between the duration of working at the sawmill and the odds of developing respiratory symptoms among the respondents. Respondents who have worked for more than ten years are more likely to develop respiratory symptoms than those who have worked for less than ten years. Those who have worked for more than ten years are more than twenty eight time more likely to develop cough (OR 28.50), six times more likely to develop cold (OR 6.21), four times more likely to develop shortness of breath (OR 3.51), three times more likely to produce phlegm (OR 3.31) and twice likely to experience wheezing (OR 1.72)

On the use of PPE, the study showed that, majority of the respondents (69%) said they do not use any protective devices whilst only 31% used personal protective equipment.

Some of the reasons cited for not using PPE were that equipment were not available (53.3%) and the PPE felt uncomfortable (46.7%).

CONCLUSION: The prevalence of respiratory symptoms was high among the sawmill workers at the Timber market. Also about a fifth of the respondents had lung function impairment and this relationship was influenced by the duration of working at the sawmill, age of respondents and smoking. It was also identified that, respondents who have worked at the sawmill for ten years or more are more likely to show respiratory symptoms and lung function impairment than those who have worked there for less than ten years.

Finally, most of the respondents did not use PPE as required

TABLE OF CONTENTS

Contents **Page**

LIST OF TABLES

LIST OF FIGURES

DEFINITION OF TERMS

ALVEOLITIS – inflammation of the alveoli in the lungs caused by inhalation of dust.

ASTHMA – respiratory disorder characterized by wheezing usually of allergic origin.

INFLAMMATION – a response of body tissues to injury or irritation characterized by pain and swelling and redness.

RHINITIS – an inflammation of the mucous membranes lining the nose usually associated with nasal discharge.

SAWDUST – fine, particles of wood made by sawing wood.

SAWMILL – a place where timber is processed.

SAWMILL OPERATOR – an individual who works at the sawmill

SAWMILLING – a process of cutting logs into planks or boards.

CHAPTER ONE

INTRODUCTION

1.1 Background of Study

Respiratory disease is a medical term that encompasses pathological conditions affecting the organs and tissues that make gas exchange possible in higher organisms, and includes conditions of the upper respiratory tract, trachea, bronchi, bronchioles, alveoli, pleura and pleural cavity, and the nerves and muscles of breathing. Respiratory diseases range from mild and self-limiting, such as the common cold, to life-threatening entities like bacterial pneumonia, pulmonary embolism, and lung cancer.

https://en.wikipedia.org/wiki/Respiratory_disease

One of the major health problems of sawmill workers is respiratory, which usually results from breathing in noxious or toxic chemicals such as wood dust and exposure to various allergenic, immunotoxic and carcinogenic substances originating from wood itself (such as plicatic acid from western red cedar) and from bacteria and fungi growing on timber. The exposure may cause decline in lung function, bronchial hyper responsiveness and various diseases, such as: organic dust toxic syndrome (ODTS), allergic alveolitis, asthma, chronic bronchitis and rhinitis

By-products of wood processing such as wood dust, mould and formaldehyde are well known with respect to their health effects. Research on occupational exposures in sawmill has suggested that workers in sawmills are at risk of developing allergenic disorders, cancer and lung diseases (Ugheoke et al; 2006). They are also exposed to synthetic chemicals used in these woods.

Most adverse effects caused by microorganisms associated with wood dust have an immunological background. The best known are those caused by moulds which may abundantly develop in suitable conditions on stored wood (planks, chips) as a secondary wood infection. The inhalation of large amounts of spores and mycelial fragment of fungi may cause strong antibody response and respiratory disorders or organic dust toxic syndrome in exposed workers (Alexsoon et al; 1990). Less known are health effects of microorganisms developing in stored timber logs as a primary infection of wood. Timber may contain large quantities of diverse bacteria and fungi comprising potentially pathogenic species, depending on kind of wood and conditions of storage.

1.2 Problem Statement

In Ghana research on occupational exposure in the wood industry has suggested that workers in sawmills, lumber mills, plywood and particle board factories, and veneer plants are at high risk of developing lower respiratory diseases , allergenic disorders, cancer, and lung diseases (Amedofu, 2003). By-products of wood processing, such as wood dust, mould and formaldehyde are well known with respect to their health effects.

In addition, workers in the industry have less knowledge about occupational health and safety, leading to low compliance of safety practices even though workers are being exposed to many harmful substances such as sawdust, fumes and toxic chemicals (Acqua -Moses, 2002). There is the need therefore to study the work environment in order to assess the burden of respiratory problems among the sawmill operators. This study thus hopes to assess the burden of respiratory problems among sawmill operators at the Timber Market, Accra.

1.3 Justification of the Study

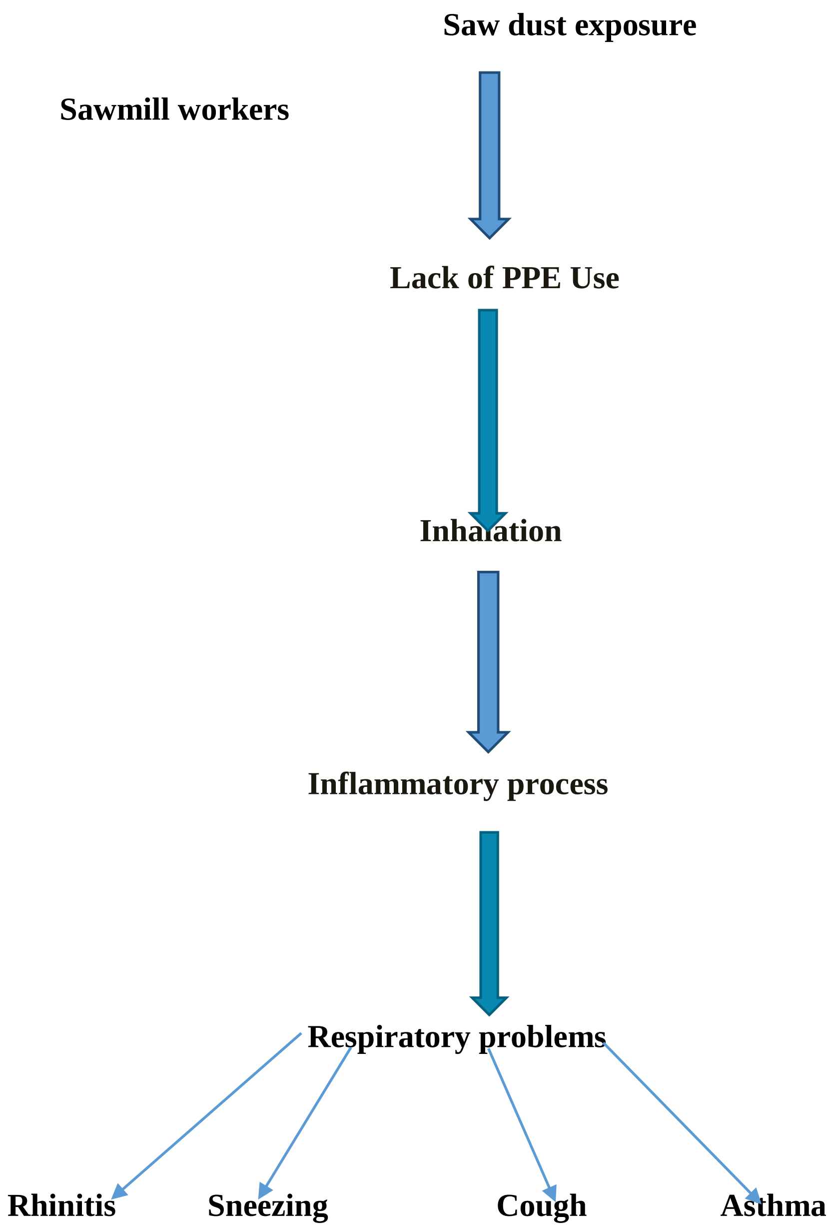
The sawmill business is a thriving business in Ghana because of the availability of timber and high demand for timber products in both the local and export markets.

Workers processing wood could be exposed to various allergenic, immune, toxic and carcinogenic substances originating from wood itself such as wood dust, bacteria and fungi growing on timber. The exposure may cause decline in lung function, bronchial hyper-responsiveness and various diseases such as allergic alveolitis, asthma, chronic bronchitis, rhinitis, mucous membrane irritation, contact dermatitis and nasal cancer

This study is important in the estimation of the burden of respiratory problems among sawmill workers at the timber market. It also helps create awareness to the workers about the risk of wood dust exposure and importance of the use of PPEs to help protect themselves from respiratory diseases.

1.4 Conceptual Frame Work

Figure 1: Conceptual Frame Work



The wood operators inhale the sawdust that they are exposed to due to the lack of PPE use. This leads to inflammatory process in their respiratory system and the result could be respiratory health problems such as rhinitis, cough, asthma and other lung function impairments.

1.5 Objectives

1.5.1 General Objective

The main objective of the study is to identify the respiratory health problems among Sawmill workers at the Timber Market.

1.5.2 Specific objectives

1. To determine the prevalence of respiratory problems among the sawmill workers at the timber market.

2. To examine lung function parameters among sawmill workers.

3. To determine the association between chronic exposure to sawdust and respiratory symptoms.

4. To determine the association between chronic exposure to sawdust and lung function.

5. To identify protective measures in place to reduce respiratory health problems.

CHAPTER TWO

LITERATURE REVIEW

Workers in the sawmill industry are exposed to variety of substances that increase their risk for respiratory diseases. The major exposures of respiratory relevance are wood dust, volatile chemicals such as terpenes, airborne microorganisms (including moulds) and formaldehydes

It is recognized that those agents may cause irritation of oral cavity and throat, tightness of the chest, alveolitis, deterioration of pulmonary functions and a reduction of FEV1 (Erdinc Osma, Kayihan Pala, (2009). The first description of respiratory symptoms among woodworkers was given by the Italian physician Ramazzini in the 18th century. (Ramazzini B. The University of Chicago press; 1940.)

2.1 Prevalence of Respiratory Symptoms among Sawmill Workers

Negative health effects have been associated with professions that shape, cut, or work with wood. The American Conference of Governmental Industrial Hygienists (ACGIH) recognizes wood dust as a "confirmed" human carcinogen and recommends a limit of 1 milligram per cubic meter (mg/m3) for hardwoods and 5 mg/m3 for softwoods. The maximum permissible exposure for nuisance dust is 15 mg/m3, total dust (5 mg/m3, respirable fraction) (Bean, 1995).

The main and common diseases found in saw mill workers are chronic obstructive lung diseases, occupational asthma, hypersensitivity pneumonitis and fungal spore infection respectively. Approximately 10 to 15% of the adults affected by the disease report an aggravation of their symptoms while at work and an improvement when away, which implies that they may be suffering from Occupational Asthma. (de Groene, et al; 2011).

A number of studies have reported that workers in wood processing industries are exposed to relatively high levels of dust in their working environment (Norrish *et al.*, 1992; Mandryk *et al.*, 1999; Teschke *et al.*, 1999; Cormier *et al.*, 2000; Demers *et al.*, 2000) and that they report higher rates of both lower and upper respiratory tract symptoms than do non-exposed controls (Norrish *et al.*, 1992; Demers *et al.*, 1997). A recent study in New Zealand has reported an increased prevalence of asthma and cough symptoms and of eye and nose irritation for sawmill workers (Douwes *et al.*, 2001). Previous studies in plywood mills have reported that workers are exposed to terpenes in the veneer drying process and to formaldehyde in the pressing section, causing irritation of eyes, nose and throat (National Institute of Safety and Health, 1981, 1982; Paustenbach *et al.*, 1997) and that, in addition, exposure to formaldehyde is associated with decline in baseline spirometric values and various respiratory symptoms(Malaka and Kodama, 1990; Makinen *et al.*, 1999) as well as an increased risk of nasopharyngeal cancer(Vaughan *et al.*, 2000). However, previous studies in sawmills have shown that sawmill workers are exposed to both bacterial endotoxin,(Mandryk *et al.*, 1999; Cormier *et al.*, 2000; Douwes *et al.*, 2000) and abietic acid (Demers *et al.*, 2000), which could both be related to the occurrence of respiratory symptoms.

Respiratory, nasal and eye symptoms are the most common symptoms reported by sawmill workers (Liou *et al.,* 1996). A South Australian study reported that the prevalence of regular blocked nose was 51%, sneezing 41%, regular runny nose and excess nasal secretion 45% and eye irritation 35% among furniture workers (Pisaniello et al., 1991). Hardwood users reported more nasal symptoms than users of reconstituted wood. This latter study also reported that the woodworkers with the least experience were more likely to report symptoms than more experienced workers. Another South African study reported that the prevalence of nasal symptoms was 49%, cough 43%, and phlegm 15% among furniture workers (Shamssain, 1992). In contrast to the previous South Australian study, the South African study reported that the prevalence of cough and nasal symptoms increased with increase in the number of years of employment. A Canadian study also reported high prevalence of cough (38%), sputum (30%), wheeze (18%), rhinitis (32%) and eye irritation (20%) among woodworkers compared with the controls (Holness et al., 1985). Significant correlations have also been reported between frequent sneezing and eye irritation with wood dust exposed jobs (Goldsmith and Shy, 1988).

Reported attacks of shortness of breath with wheezing in the last 12 months' among Plywood Mill Workers in New Zealand were significantly higher than in the general population, with an OR of 1.8 (95% CI = 1.0–3.1) (Fransman et al., 2002). All other asthma symptoms were also elevated (but did not reach statistical significance), with the exception of 'asthma attack in last 12 months'. 'Shortness of breath with wheezing in last 12 months', 'woken by shortness of breath in last 12 months' and 'asthma' were significantly higher ($P < 0.05$) in workers with a duration of employment longer than 6.5 years compared with the general population (adjusted for age, gender and ethnicity). Workers with less than two years work history in the plywood industry appeared to be less symptomatic compared with the general population.

The prevalence of work related-symptoms was different in different work categories. Subjects working in the initial processing and board processing departments had a higher prevalence of cough than workers employed in the varnishing department. The prevalence of skin, eyes and nose symptoms was higher in board processing and varnishing departments. Symptoms also depended on different types of woods.

2.2 Lung Function Parameters Among Sawmill Workers.

Lung function tests / pulmonary function tests (PFTs) check how well the lungs work. The tests determine how much air the lungs can hold, the rate of air movement in and out of the lungs, and how well the lungs exchange oxygen and carbon dioxide in the blood. The tests can diagnose lung diseases, measure the severity of lung problems, and check the progress of treatment for a lung disease. Spirometry is the first and most common lung function test.

The more common lung function values measured with spirometry are:

- **Forced vital capacity (FVC)**. This measures the amount of air one can exhale with force after you inhale as deeply as possible.
- **Forced expiratory volume (FEV)**. This measures the amount of air one can exhale with force in one breath. The amount of air you exhale may be measured at 1 second (FEV_1), 2 seconds (FEV_2), or 3 seconds (FEV_3). The ratio of FEV_1 and FVC can also be determined.
- **Peak Expiratory Flow** (**PEF**) is the maximum flow generated during expiration performed with maximal force and started after a full inspiration. PEF is appreciably larger if the maneuver is performed without pause immediately after the inspiration than if it is performed after a pause.

A range of respiratory diseases can be caused by exposures in the workplace. According to Health and Safety Executive (HSE) (2013), Chronic Obstructive Pulmonary Disease (COPD) is a serious long-term lung disease in which the flow of air into the lungs is gradually reduced by inflammation of the air passages and damage to the lung tissue. Bronchitis and emphysema are common types of COPD.

Different studies in workers working in a furniture industry, found a reduction in forced expiratory volume in the first second (FEV_1), forced vital capacity (FVC) and peak expiratory volume (PEF) in all groups of workers. Studies in Turkey found that different materials give different amount of dusts and size of distribution during processing. Wood workers exposed to less concentration of dust and less period of exposure showed higher increase in FVC and FEV_1 than workers exposed to high concentration of dust and long period of exposure. This study showed that exposure to wood dust caused a decrease in pulmonary function. According to studies in France, workers exposed to different types of wood dusts showed risk of greater decline in forced expiratory volume in 1 second (FEV_1) and forced vital capacity (FVC). Studies in Southern Africa also concluded that, workers exposed to wood dusts have respiratory symptoms such as higher incidence of chronic cough, dyspnoea, persistent wheeze, reduction in forced vital capacity (FVC) and forced expiratory volume in one second (FEV_1). (Bohadana et al., 2000). The Peak Expiratory Flow Rate (PEFR), Forced Vital Capacity (FVC), Forced 10 Expiratory Volume in 1 second (FEV_1), and the FEV_1/FVC ratio x 100 (FEV_1%) were found to be significantly reduced among carpenters. Acute and chronic effects of different occupational dusts on respiratory indices and the health of workers in three Ethiopian factories (cement, cotton-yarn and cigarette) were studied. The study showed significant relationship between lung function, dose and type of the dust. Acute effect of cotton dust on workers exposed during work shift was more significant than the cement and cigarette factories. The type of dust is important in determining the acute change of lung function. Lung functions including FEV_1, FEV_1%, FEF200-1200, FMF25-75% and PEFR were decreased in exposed subjects. Exposure to different occupational dusts resulted in development of respiratory illness with different rates of prevalence.

2.3 Protective Measures in Place to Help Prevent Respiratory Problems among the Sawmill Workers

The Control of Substances Hazardous to Health (COSHH) Regulations 2002 require employers to assess the health risks and precautions needed to prevent or control exposure to hazardous substances such as wood dust. The first priority should always be to prevent exposure or, if this is not possible, to control it at source, for example by effective local exhaust ventilation.

Dust collectors commonly used in small shop dust collection systems are sometimes called "chip collectors." That's because they really are designed to do their best work at collecting chips, shavings and large dust particles. Many dust collectors are equipped with a filter designed to stop only large particles and let the fine particles associated with respiratory health problems pass through. Dust collectors move substantial quantities of dust-laden air, and thus a dust collector that lets minute dust particles pass through its filter becomes, in effect, a "dust pump," filling the air around it with clouds of fine dust. One of the most effective ways to prevent this is to locate the dust collector outside or in a room that's separate from the shop and has its own ventilation system. For climates and shop layouts that make this solution impossible, the best alternative is to outfit the dust collector with a filter that traps fine dust particles. For most dust collectors, a shaker felt filter bag offers a simple, affordable filter upgrade.

Shaker felt is a fabric specially designed to trap small dust particles (down to 1 micron) without seriously impeding the air flow of the dust collection system. Many dust collectors come standard with a filter that does a pretty good job with fine dust. Some are available with a "canister" filter consisting of a pleated fabric filter encased in a metal mesh container that fits on top of the dust collector. Many of these catch dust in the 1- or 2-micron range, and the pleated filter material greatly increases the air filtration surface area.

Shop Air Filtration Systems

Much of the dust created in a woodshop never enters the dust collection system at all. In spite of all efforts to set up an efficient, powerful dust collection system, some amount of the fine dust created by the tools it services will always escape into the air in the shop. Dust created by hand-held sanders, for example, is among the finest dust created in the shop and is extremely difficult to completely capture. Over time, the fine dust problem multiplies. The fine dust particles missed by the dust collection system remain in the shop, ready to be stirred into a dust cloud by the slightest movement of air. An air filtration system picks up where the other dust collection efforts leave off by continuously scouring the air in the shop of tiny airborne dust particles. Like dust collectors, the performance of an air filtration system is measured by the volume of air the unit will move in cubic feet per minute (cfm). To be effective, an air filtration device should be rated to cycle through the entire volume of air in the shop 6 to 8 times per hour. The Jet AFS-1100B Air Filtration System, for example, has a maximum setting of 1044 cfm, which means that it will filter entire volume of air in a 20' X 20' shop more than 12 times per hour. Like many air filtration units, it has a built-in timer with settings for 2, 4 and 8 hours, making it a very convenient system to use.

Personal Protective Equipment

Personal protection (such as protective clothing and respirators) may be needed as an interim measure where engineering controls are being developed and/or modified and for short-term jobs such as cleaning and maintenance. Engineering controls protect everyone in the workplace; personal protective equipment can only help the person who wears it.

Respiratory Protective Equipment (RPE) is a particular type of Personal Protective Equipment (PPE), used to protect the individual wearer against inhalation of hazardous substances in the workplace air. RPE should only be used where adequate control of exposure cannot be achieved by other means, in other words, as a last resort on the hierarchy of control measures. Employers are required to firstly attempt to eliminate the hazard at source. RPE should only be used after all other reasonably practicable control measures have been taken. PPE is considered a last resort because it only protects individual workers, is prone to failure or misuse, such as wearing the wrong RPE for the job, and employees wearing RPE may get a false sense of security when using RPE.

Most woodworking operations generate inhalable dust. At minimum, this dust is a nuisance or irritant. However, some “exotic” hardwoods and domestic woods also can cause serious allergic reactions. Woodworking shops should have dust collection equipment that captures dust at the point of operation. As an added precaution, respiratory protection appropriate for the type and degree of exposure to the wood dust should be provided and worn.

One reason is that the level of safe exposure to woodworking dust is quite low. The National Institute for Occupational Safety and Health (NIOSH) recommends that the average amount of fine dust in wood shop air be no more than 1mg/cubic meter over a 10-hour shop session. For a garage-sized shop, 1 mg/cubic meter amounts to less than 1/8 teaspoon of dust for the entire volume of air in the shop. http://www.rockler.com/how-to/dealing-fine-woodshop-dust-personal-respiratory-protection-2/

Another reason is that many common woodworking operations such as sanding, cutting with a chop saw or using a router can overwhelm all dust collection measures and leave workers breathing dangerous levels of fine wood dust.

Disposable dust masks are among the most economical and convenient forms of personal respiratory protection. They're best suited for short-term exposure to fine dust and less effective and comfortable in long sessions in a dusty shop. This is because they're made to fit the contours of an "average" face and, in general, don't provide as tight an air seal between face and the mask, which prevents fine dust particles from getting around the mask's filter material and passing directly into the lungs.

Not all dust masks are created alike. It's important to use a mask that is designed to actually filter fine dust, such as the MXV Dust Mask. It features a three layer design that pre-filters course particles, traps fine particles in the interior filter and provides comfortable inner surface designed to prevent fatigue over longer periods of use.

Types of Dust Masks

Washable Cloth Mask: Reusable cloth masks, are a little more expensive than disposable masks, but they offer features that many woodworkers think are worth the extra initial expense. Most important, they're reusable – a quick hand washing and they're back to their original filtering performance and comfort. You won't suddenly discover that you've run out of cloth masks, as often happens with the disposable variety. Additionally, cloth masks are more pliable than disposable masks and tend to fit more comfortably for longer periods than many disposable masks. They work great for projects that generate a small to moderate amount of dust, such as wood turning or carving, and they tend to produce less fogging of glasses or goggles.

Power Air Respirators

Power respirators use a battery-powered fan to supply a continuous stream of filtered air to the interior of the mask. They're more of an investment than either disposable masks or reusable cloth masks, but they are also generally considered a giant step forward in comfort. The fresh stream of air helps keep the user cool during strenuous work, and because the mask relies on positive air pressure inside the mask rather than a tight seal to keep the interior of the mask free of contaminated air, the power respirator can be designed to provide a fairly loose, comfortable fit.

Power respirators are the ultimate in personal respiratory protection and are the best choice for situations where a high level of protection and comfort are desirable. (http://www.rockler.com/how-to/dealing-fine-wood-dust/)

The use of PPE by sawmill workers has become imperative with the sole aim of protecting workers from occupational injuries and health hazards. Few studies have highlighted that PPE availability, access and use still suffers a setback especially in third world countries.

Osagbemi et al., (2010) conducted a study on awareness of occupational hazards, health problems and safety measures among sawmill workers in North Central Nigeria. The result of the study indicated that use of PPE was very low. 56.9% of respondents in their study never used devices at all while only 15% always used protective devices when working. Some of the reasons given for not using the devices were that the devices were not provided by the employers (36.3%), the devices were not necessary (23.1%), not convenient (19.8%) or forgetfulness (20.9%).

A research carried out by Kalu et al., (2013) showed that the reasons for non-usage of PPE as reported by the respondents include; no provision by employer 64(31.1%), had no money to buy the PPE 21(10.2%), inconveniences 37(18.0%), not necessary 41(19.9%) and no idea of PPE 12(5.8%). About 31(15.1%) who were employers indicated that reason for not using PPE was because workers did not buy for themselves. However, virtually all respondents 400(100%) accepted the need for adequate training on the use of PPE.

2.4 The Effect of Sawdust Exposure on Lung Function

Sawdust is noted to be the tiny particles dispersed in air due to mechanical disintegration of wood by impulsive forces such as crushing, grinding and milling (Parkes.;1994)..

It is estimated that at least two million people are routinely exposed occupationally to wood dust worldwide.

The highest exposures have generally been reported in wood furniture and cabinet manufacture, especially during machine sanding and similar operations (with wood dust levels frequently above 5 mg/m^3). Exposure levels above 1 mg/m^3 have also been measured in the finishing departments of plywood and particle-board mills, where wood is sawn and sanded, and in the workroom air of sawmills and planer mills near chippers, saws and planers. Exposure to wood dust also occurs among workers in joinery shops, window and door manufacture, installation and refinishing of wood floors, pattern and model making, construction carpentry and logging.

Wood contains microorganisms (including fungi), toxins and chemical substances which may significantly affect human health (WHO; 1995). It is recognized that these agents may cause irritation of the oral cavity and throat, tightness of the chest, alveolitis, deterioration of pulmonary functions and a reduction of the False Expiratory Volume per second FEV_1 (Schlussen *et al*.,2004). The occupational related pulmonary diseases among saw mill workers are most likely due to sawdust deposition in the lungs that are from the composition of the sawdust, the duration of exposure to it and the concentration of sawdust in the breathing zone (Fernandez-Caldas *et al*., 2005).

Studies on workers in the furniture manufacturing sector showed that the upper and lower respiratory system symptoms increased in people exposed to wood dust (Borm et al., 2002). These symptoms were related to the exposure levels and seen more often in cases of exposures higher than 5 mg/cm^3.

Dust particles which are inhaled and lodged in the lung irritate and set up an inflammatory reaction. Healing of this inflammation causes fibrosis leading to defective oxygen diffusion and impaired lung functions (Karsper et al., 2008).

Respiratory system effects due to wood dust exposure include decreased lung capacity and allergic reactions in the lungs. Two types of allergic reactions can take place in the lungs: hypersensitivity pneumonitis (inflammation of the walls of the air sacs and small airways) and occupational asthma. Decreased lung capacity is caused by mechanical or chemical irritation of lung tissue by the dust. This irritation causes the airways to narrow, reducing the volume of air taken into the lungs and producing breathlessness. It usually takes a long time to see a reduction in lung capacity. Studies showed that sawmill workers exposed to softwood dusts arising from Douglas fir, western hemlock, spruce, balsam, and alpine fir had reduced lung function (Demers et al., 1997, Hessel et al., 1995).

Okwari et al., (2005) studied the effect of chronic exposure to dust from local woods such as ebony, achi, and iroko on lung function of timber market workers in Calabar, Nigeria. Forced vital capacity (FVC), Forced Expiratory Volume in one second, (FEV_{1}), Forced Expiratory Volume as a percentage of forced vital capacity (FEV_1), and Peak Expiratory Flow Rate (PEFR) were measured in 221 workers (aged 20-25 years) exposed to wood dust to assess their lung function and compared with 200 age- and sex- matched control subjects who were not exposed to any known air pollutant. The concentration of respirable dust was significantly higher in the test (P<0.001) than in control subjects. The mean values of FVC, FEV_1, FEV_1% and PEFR of the timber workers were significantly lower (P<0.01) than in control subjects. Workers exposed to wood dust had restrictive pattern of ventilatory function impairment. The lung function indices of the timber workers decreased with their length of service. Many researchers have observed a reduced Peak Expiratory Flow Rate (PEFR), a forced vital capacity (FVC) and a forced expiratory volume in first second (FEV_1) in wood workers as compared to those in general population.

Thetkathuek A, Yingratanasuk T, et al ;2010 ,conducted a study to assess factors affecting lung function among 685 workers in the rubber wood (*Hevea brasiliensis*) furniture industry in the Chonburi and Rayung provinces of Eastern Thailand by sampling wood dust, and by spirometry. The mean wood dust exposure level in the factories was 4.08 mg/m3 (SD = 1.42, range: 1.15-11.17 mg/m3). The mean overall percent of predicted forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), and FEV_1/FVC values were 84 % (SD = 13.41), 86 % (SD = 14.40), and 99% (SD = 10.42), respectively. Significant negative correlations were found between mean dust exposure levels and FVC ($p = 0.0008$), and FEV_1/FVC% ($p < 0.001$), but not FEV_1 ($p = 0.074$). An association between decline in lung function and wood dust levels among wood workers suggests that rubber wood dust exposure negatively affects lung function.

Another study by Deshpande et al, (2006) observed the effects of increased duration of exposure to saw dust on the pulmonary functions of adult male workers in a sawmill, of age group 20-60 years. It was realized that, there was a decrease in all the lung parameters in the saw mill workers compared to controls ($p<0.001$). The decrease in PEFR observed in sawmill workers was in conformity with the reports of Fatusi, Erhabor and Ugheoke et al. (2009) The reduction in PEFR in mill workers might be attributed to inflammatory changes in the respiratory tracts which leads to increased airway resistance as a result of the saw dust exposure thereby bringing about the remodeling of the airway and consequently lung dysfunction.

Rastogi et al., (2009) recorded spirometric lung functions for 109 workers (mean age 26.4 +/- 8.2 yrs.) occupationally exposed (mean exposure 8.9 +/- 7.7 yrs.) to soft wood dust in local sawmills along with 88 unexposed controls (mean age 28.7 +/- 9.9 yrs.) belonging to the same socioeconomic status to assess the prevalence of respiratory impairment in the exposed population. The results of the study showed a significantly higher prevalence of overall respiratory impairment in the exposed group even after standardizing for smoking habits (p less than 0.001). The adjusted rate for respiratory impairment in the exposed group was 29.4% as compared to 2.2% observed in the unexposed controls. The pattern of respiratory abnormality observed in the sawmill workers was predominantly the restrictive type (28.4%), indicating lower levels of forced vital capacity (FVC) in the exposed group; while in the control group, there were none with lung restriction The prevalence of airflow limitation, however, was similar in the exposed workers (1.8%) and controls (2.2%), thereby, indicating that bronchial obstruction was independent of wood dust exposure. It is concluded that the dust exposure in sawmills is associated mainly with restrictive type of pulmonary impairment in the exposed workers. Another study revealed similar results as the mean values of FEV_1 and FVC in the furniture workers were significantly lower than those in the Control group. Impaired lung function was markedly high for woodworkers compared with the controls. Dose-response relationships among personal exposures and percentage cross-shift decrease in lung function and percentage predicted lung function were more pronounced among joinery workers (Alwis, 1999). Woodworkers had markedly high prevalence of regular cough, phlegm, and chronic bronchitis compared with controls. Significant associations were found between percentage cross-shift decrease in FVC and regular phlegm and blocked nose among sawmill and chip mill workers.

CHAPTER THREE

METHOD

3.1 Study Design

A cross-sectional study design was employed using one hundred and seventy one (171) workers in sawmill industries who have been in continuous employment in the sawmill factories for a minimum of one year.

3.2 Target/Study Population

This study was carried out at the small scale Sawmill industries within the Timber Market, Accra. It is situated in the Odododiodoo constituency and about 3 kilometers from the Agbogbloshie Market. It is the epicenter for construction goods, hardware, and various lumber products. It is made up of about one hundred small scale timber industries

The study was conducted among Sawmill operators at the Accra Timber Market. They are responsible for cutting the wood into pieces and planning or smoothening them, using the sawmill machines. The targeted population included all 300 sawmill operators at the timber market. From this population, 155 participants were selected into this study.

3.3 Study variables

Independent variable:

- years of employment

Dependent variable

- respiratory symptoms;

– cold

– cough

– wheeze

- Shortness of breath
- Tightness in the chest
- Phlegm production
- Measures of lung function
- FEV_1
- FVC
- FEV_1/FVC
- Obstructive and restrictive lung conditions

Confounding variables:

- Age
- Level education
- Smoking
- PPE use

3.4 Sampling

3.4.1 Sampling size:

Yamane's formula (Israel, 1992) was used to determine the sample size in this study. Determination of sample size is based on the estimated population size (n=300). The formula is stated below.

$$\mathbf{n = [N / 1+N (e)^2]}$$

n – The sample size

N- The population size

e- The desired level of precision or level of acceptable error = 0.05)

Total sample size (n) = $[300/ (1+300 (0.05)^2] = [300/ (1 + 300 \times .0025)]$

$= [300/1 + 0.7525]$

= [300/1.7525]

= 171.1840

= 171

Based on the above, the appropriate sample size for the study was 171.

3.4.2 Sampling Techniques

The one hundred and seventy-one (171) respondents were randomly sampled from the various sawmill sites at the Accra Timber Market. They were chosen by the simple random sampling procedure, which gives everyone an equal chance of being selected.

The names of the 300 sawmill operators were listed and a number was assigned to each name. The numbers one (1) up to three hundred (300) were written on 300 pieces of papers. The papers was folded and put in a bowl and shaken. 171 pieces of papers, out of the 300 was randomly picked. Each number picked was recorded and compared to the names on the list. The names on the list that correspond to the numbers picked was selected to be part of the study3.5Data Collection Technique/Study Procedure

The data was collected over a period of two weeks during which questionnaire were administered to sawmill operators who have accepted to take part in the study. A structured respiratory health questionnaire was administered to the respondents. The questionnaire contained both closed and open-ended questions on demographic data including the work history, medical history, as well as their respiratory health symptoms, duration, severity and outcomes over the duration of work at the saw mills. Lung function was also measured and recorded by means of a spirometer.

Previous visits had been made to the study site, to meet the leaders of the sawmill workers, to seek for their approval to conduct the study at their worksite and they agreed to the request. However, a letter from the department was sent to them to formally inform them about the study and the date set for the collection of data. During data collection, questionnaire was administered by four previously trained research assistants. Respondents completed the questionnaire independently and submitted the questionnaire after completion. To ensure reliability, responses was checked for validation at the end of each day.

3.5 Quality Control

All information obtained in the study was kept confidential and used for research purpose only. The data was managed and analyzed based on standardized methodology and bias was accounted for to improve validity of the results. Workers in the sawmill industry who had been in continuous employment in sawmill factories for a minimum of one year qualified as study population.

3.6 Data Processing and Analysis

The data was analyzed quantitatively using the Statistical Package for the Social Sciences (SPSS) software. The data was organized, tabulated and analyzed by using descriptive and inferential statistics. Descriptive statistics was used to describe demographic and other variable by frequency, mean, mode and percentage. For the inferential statistics, logistic regression was performed to assess the relationship between the duration of exposure to saw dust and development of respiratory problems. Crude and adjusted odds ratios were reported to determine the strength of association.

3.7 Ethical Consideration/ Issues

Ethical clearance was obtained from the Ethical Review Committee of the Ghana Health Services. Also permission was obtained from association of the sawmill workers for their approval before undertaking the data collection. Moreover, Informed consent was signed by the participants before partaking in the study.

CHAPTER FOUR

RESULTS

4.1 Socio-Demographic Characteristics of Respondents

All the respondents of the study were males. One hundred and seventy one (171) study participants were recruited in the study but a response rate of 90.6% was obtained (155/171). The mean age for the group was 38.99. Table 1 shows the demographic data of the respondents. Ninety one (91) of the participants representing 58.4% were below 40 years. Seventy seven (77), representing 49.5% had been working at the saw mill for less than ten years whilst seventy eight (78) of them representing 50.3% had worked for more than ten years at the sawmill.

Table 1: Socio - Demographic Data of Respondents (n=155)

Variables	Characteristic	Frequency (N)	Percentage (%)
Age range of the respondents	Less than 40yrs.	91	58.7
	40 yrs. and above	64	41.3
Educational background	No education	19	12.3
	Primary	35	22.6
	JHS	58	37.4
	SHS	26	16.8
	Tertiary	17	11.0
Do you smoke	Yes	33	21.3
	No	122	78.7
Years of working at the sawmill	Less than 10 yrs.	77	49.7
	10yrs. and above	78	50.3

4.2 Prevalence of Respiratory Problems among the Sawmill Workers at the Timber Market

Table 2 illustrates the prevalence of various respiratory problem among the sawmill workers at the Timber Market. The prevalence of respiratory symptoms was very high among the respondents.

The most prevalent respiratory problem among the sawmill respondents was cough (77.42%) whereas the least prevalent are tightness in the chest and wheeze (47.7%).

Table 2: Prevalence of Respiratory Symptoms among the Sawmill Workers at the Timber Market, Accra. (n=155

Respiratory problem	Frequency(N)	Percentage (%)
Cold		
Yes	119	76.8
No	36	23.2
Wheeze		
Yes	74	47.74
No	81	52.26
Cough		
Yes	120	77.42
No	35	22.58
Shortness of breath		
Yes	82	52.9
No	73	47.10
Tightness in the chest		
Yes	74	47.74
No	81	52.26

4.3 Protective Measures In Place to Help Prevent Respiratory Problems Among the Sawmill Workers

Figure 2 shows whether respondents used any protective device to help protect themselves against respiratory problems. Majority (69%) of them said they do not use any protective devices whilst only 31% used personal protective equipment

Figure 2: Use of Protective Device

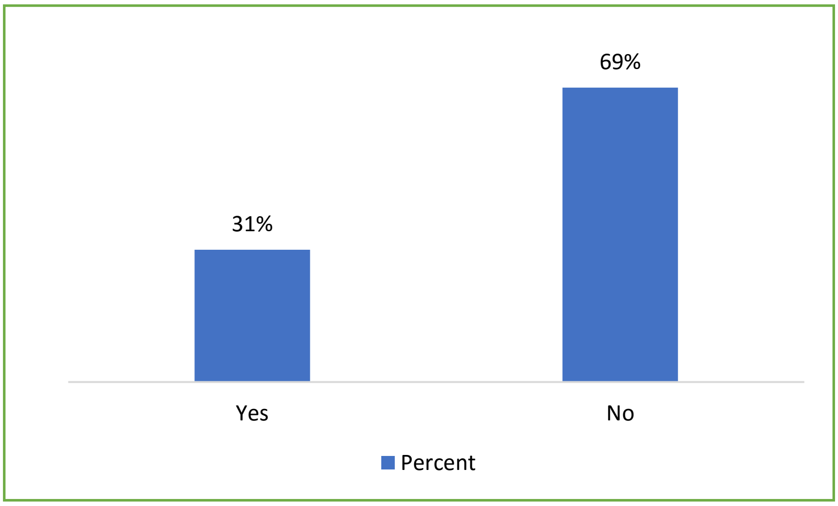


Table 3 below shows the odds of developing respiratory symptoms among the respondents. Respondents who have worked for more than ten years are more likely to develop respiratory symptoms than those who have worked for less than ten years. Those who have worked for more than ten years are more than twenty eight time more likely to develop cough (OR 28.50), six times more likely to develop cold (OR 6.21), four times more likely to develop shortness of breath (OR 3.51), three times more likely to produce phlegm (OR 3.31) and twice likely to experience wheezing (OR 1.72)

Table 3: Association between Chronic Sawdust Exposure and Respiratory Symptoms among Sawmill Operators

	cough		**Cold**		**wheezing**		**Tightness in the chest**				**Phlegm production**	
	Crude odds (95% CI)	Adjusted odds (95% CI)	Crude odds (95% CI)	Adjusted odds (95% CI)	Crude odds (95% CI)	Adjusted odds (95% CI)	Crude odds (95% CI)	Adjusted odds (95% CI)	Crude odds (95% CI)	Adjusted odds (95% CI)	Crude odds (95% CI)	Adjusted odds (95% CI)
<10 yrs.	28.50 (6.52 – 124.50)	1.95 (1.28 – 2.98)	6.21 (2.48 – 15.12)	1.38 (0.91 – 2.08)	1.72 (0.38 – 1.35)	1.07 (0.75 - 1.53)	0.72 (0.38 – 1.35)	1.10 (0.76 - 1.56)	3.51 (1.81 – 6.81)	1.31 (0.91 – 1.90)	2.89 (1.22 – 6.77)	1.77 (1.16 – 2.69)
> 10 yrs.												

Adjusted for age, smoking status, level of education, and PPE use

4. 4 Lung Function Parameters Among The Sawmill Workers At The Timber Market And Factors Affecting It.

Using a spirometer, the forced vital capacity (FVC) and the forced expired volume in one second (FEV_1) were obtained from each respondent. From the result obtained the FEV_1/FVC was calculated. Table 4 shows the mean and the standard deviation for these values. Together these three values were used to determine whether the respondents had normal respiratory function, obstructive diseases or restrictive diseases.

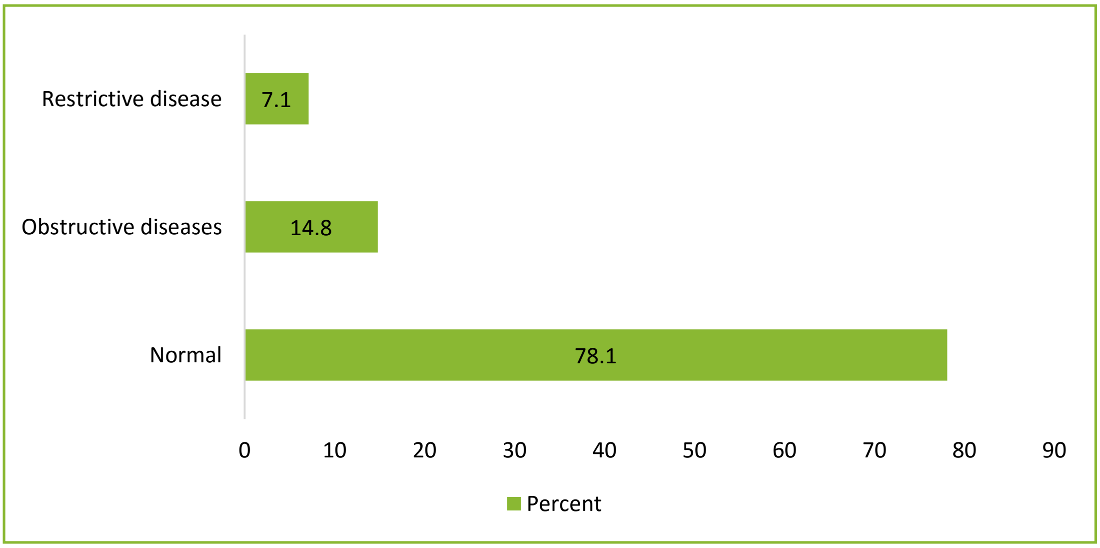
Table 4: Mean and Standard Deviation for the Measure of Lung Function

Measure of lung function	Mean (SD)
FEV_1(Litres/s)	3.03 (0. 60)
FVC (Litres)	3.80 (0.61)
FVC/FEV_1	80.1 (10.93%)

Figure 3 below shows the various values obtained for each category. The actual spirometry values obtained from the respondents and it interpretation has being captured in Appendix B.

Majority of the respondents (78.1%) had normal lung function, 14.8% of them had obstructive lung disease whereas a few of the respondents (7.1%) had restrictive lung diseases

Figure 3: Classification of Abnormalities by Spirometry



CHAPTER FIVE

5.1 Discussion

On socio-demographic characteristics of respondents, five areas were examined by the study. These included their sex, age, level of education, and number of years of work. However, all the respondents of the study were males as compared to the study by Kwankye (2012) at Naja David wood industry Limited in the Kumasi Metropolis of Ghana, in which 31.3 % of the respondents were females. This finding tends to prove that, work in the wood industry demands a lot of physical strength for its execution and for that matter males are more preferred and are therefore more likely to be employed to do such jobs, as compared to their female counterparts. Majority of the respondents of the study were below 40 years. Again people in this age groups are still young and strong and thus possess the required energy to do hard work such as cutting, lifting and pushing. Only11% of respondents had obtained tertiary education at the time the study was conducted. More than half of the respondents had worked at the timber market for 10 years and above (50.3%).

Most of the respondents of the study said they cough often and mostly during the day. Coughing is a normal body defense mechanism of removing a foreign body out of the respiratory tract. Coughing mostly during the day particularly for this type of occupation, indicates an increase in exposure to foreign bodies. Majority of them said their cough was persistent and lasted for three or more months a year, indicating the chronic nature of this exposure. Also, majority of these respondents said their cough is mostly accompanied by the production of phlegm, another indication of exposure to a foreign body. When respondents were asked whether they often have cold, 76% said yes, they do have cold and more than half of this group said it occurred as long as three months in a year. Sneezing was the major cold symptom that they developed. A South African study reported that the prevalence of nasal symptoms was 49%, cough 43%, and phlegm 15% among furniture workers (Shamssain, 1992). Also a Canadian study reported high prevalence of cough (38%), sputum (30%), wheeze (18%), rhinitis (32%) and eye irritation (20%) among woodworkers compared with the controls (Holness et al, 2005). This study concord with the result obtained for the above mentioned study. However, prevalence of these symptoms was high compared to those mentioned in the previous studies. . The prevalence of respiratory symptoms such as wheezing, breathlessness and tightness in the chest were not left out. Close to half of the respondents said they wheezed if they walked quickly or climbed stairs and more than half said they had difficulty in breathing sometime when they increased the pace of their walking or when walking with others.

On the frequency of utilization of personal protective devices (PPE), 69% of respondents never used devices at all while only 31% used protective devices when working. Some of the reasons given for not using the devices were that the devices were not available (53.3%) and also the devices were not comfortable to use (46.7%). A similar study conducted by Osagbemi et al., (2010) on Awareness of Occupational Hazards, Health Problems and Safety Measures among Sawmill Workers in North Central Nigeria also identified that the use of PPE was very low, 56.9% of respondents in their study never used devices at all while only 15% always use protective devices when working. Some of the reasons given for not using the devices were that the devices were not provided by the employers (36.3%), the devices were not necessary (23.1%), not convenient (19.8%) or forgetfulness (20.9%). This finding was consistent with the findings of this study, only that the number of respondents who said they used PPE always was slightly higher in our study (20%). Also the most patronized PPE for the study was face mask (18.1%)

Duration of working in the sawmill industry was a major factor in the development of respiratory symptoms and lung function abnormality as illustrated in the result. Working for more than ten years increased significantly one's risk of developing respiratory symptoms. The results show that those who have worked for more than ten years were more than twenty eight times more likely to develop cough (OR = 28.50), six times more likely to develop cold (OR = 6.21), four times likely to develop shortness of breath (OR = 3.51), three times likely to produce phlegm (OR = 3.31) and twice likely to experience wheezing (OR = 1.72). As mentioned earlier on a lot of confounding factors appear to influence such associations as witnessed by reduction in odds ratio after adjusting for age, smoking status, educational level and PPE uses. However, the adjusted Odds were still significant, indicating that years of working at the sawmill industry significantly impacted on development of respiratory symptoms as well as lung function. The result of this study showed that working for more than ten years was significantly associated with increased chance of developing lung abnormality as demonstrated in the result (OR=2.80)

This study assessed the subjects according to ventilatory impairment based on the spirometer value obtained from each respondents. The forced vital capacity (FVC) and the forced expiratory rate in one second ($FEV_{1)}$ was obtained from the respondents and from this values the FEV_1/FVC was calculated. With these values, respondents were grouped under either restrictive, obstructive or normal respiratory function after comparing to normal values for race, age and height. The findings indicated that 14.8% of the respondents had obstructive type of lung function impairments whereas 7.1% had the restrictive type of lung impairment. However the study by Kacham et al., (2014) on the effects of wood dust on respiratory functions in saw mill workers in Gujarat, India, identified more restrictive type of respiratory impairment as compared to obstructive or mixed type in the respondents.

CHAPTER SIX

CONCLUSION AND RECOMENDATION

6.1 Conclusion

Based on the results of the study, it could be concluded that exposure to sawdust has effects on work related respiratory symptoms and lung function impairment.

The study concludes that respiratory symptoms and lung function impairment was high among the workers at the Timber market. Respiratory symptoms assessed in this study included coughing, production of phlegm, breathlessness, wheezing and cold.

The obstructive type of respiratory impairments was higher compared to the restrictive type. Development of lung function impairment was also associated with factors like age of respondents, smoking and years of working at the Timber market.

It was also identified that, respondents who have worked at the sawmill for ten years or more are more likely to show respiratory symptoms and lung function impairment than those who have worked there for less than ten years.

Also the study identified that most of the respondents do not use personal protective equipment which most complain to be as a result of unavailability of such equipment.

6.2 Recommendations

There should be periodic health examination of the workers and also, improvement of the working environment with assured quality, to reduce the burden of respiratory problems among sawmill workers.

Furthermore, awareness should be raised among the sawmill workers to encourage them to use personal protective equipment during work, which will help prevent them from respiratory tract problems.

In addition, future studies should be conducted with focus on pulmonary function of workers in sawmills and factors associated with decrease pulmonary function.

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APPENDICES

Appendix A: Consent Form

You are invited to participate in a research study, on the "Respiratory Health Problems among Sawmill Workers at the Timber Market, Accra". Your participation will involve answering a few questions by means of a questionnaire and blowing air into an instrument (spirometer) in order to have your lung function measured.

There are no known risks associated with this research. By participating in this study, you was able to have your lung function measured and knowing how healthy it is. Your identity and any other form of information that indicates your participation in this research was held completely confidential.

Your participation in this research study is voluntary. You may choose not to participate and you may withdraw your consent to participate at any time. You will not be penalized in any way should you decide not to participate or to withdraw from this study.

If you have any questions or concerns about this study or if any problems arise, please contact

Ms. Hannah Frimpong	**OR**	**Mariama Mumuni**
The Ethical Review Committee Administrator		**School of public health, Legon**
(0243235225)		**(0508762449)**

I have read this consent form and have been given the opportunity to ask questions. I give my consent to participate in this study.

Participant's signature__________________________ Date: ________________

Appendix B: Questionnaire

Socio-demographic factors

1. What is your gender?

Male

Female

2. What is your age?

18-29 years

30-49 years

50- 64 years

Above 65 years

3. What is the highest level of education you have completed?

Primary school

Junior high school

Senior high school

Tertiary

None

4. How long have you been working at the saw mill?

1-3years

4-6years

7-9years

10 years and above

Respiratory symptoms

5. Do you often have cold?

Yes No

6. Does it occur for as much as three months in a year?

Yes No

7. Which of the cold symptoms do you often have?

a. Sneezing b. Rhinitis c. Stuffy nose

8. Do you usually cough?

Yes No

9. When is the coughing most severe?

a. During the day b. At night

10. Do you cough like this on most days for as much as three months each year?

Yes No

11. Do you usually bring up phlegm from your chest when you cough?

Yes No

12. Do you bring up phlegm like this on most days for as much as three months each year?

Yes No

13. In the past three years, have you had a period of (increased) cough and phlegm lasting for three weeks or more?

Yes No

14. Have you had more than one such episode?

Yes No

15. During the past three years, have you had any chest illness that has kept you from your usual activities for as much as a week?

Yes No

16. Did you bring up more phlegm than usual in any of these illnesses?

Yes No

17. Have you had more than one illness like this in the past three years?

Yes No

18. Are you troubled by shortness of breath when hurrying on level ground or walking up a slight hill?

Yes No

19. Do you get short of breath walking with other people of your age on level ground?

Yes No

20. Do you have to stop for breath when walking at your own pace on level ground?

Yes No

21. If you run, or climb stairs fast do you cough?

Yes No

22. If you run or climb stairs do you wheeze?

Yes No

2 3. If you run or climb stairs do you get tight in the chest?

Yes No

24. Is your sleep ever broken?

a. by wheeze? Yes No

b. difficulty in breathing? Yes No

Protective measures in place to prevent respiratory problems

25. Do you use any protective device to help protect you against respiratory problems?

Yes No

26. If no, why don't you use it?

a. Not Comfortable b. Not Available

27. If yes, what are the protective devices you usually use?

a. face mask b. others

28. How often do you use them?

a. Always b. Occasionally

Appendix C: Spirometer value obtained from respondents

Age	Height (cm)	FVC (Litres)	FEV_1	FVC/FEV_1 *100 (FEV_1%)	FVC (Litres) value	FEV_1 value	FVC/FEV_1% value	Outcome
44.0	174.0	3.77	3.36	89.1	Normal	Normal	Normal	Normal
45.0	175.0	4.11	3.36	81.0	Normal	Normal	Normal	Normal
34.0	163.0	2.97	2.64	89.0	Normal	Normal	Normal	Normal
34.0	163.0	3.77	3.21	85.0	Normal	Normal	Normal	Normal
34.0	163.0	3.77	3.21	85.0	Normal	Normal	Normal	Normal
34.0	164.0	3.77	3.21	85.0	Normal	Normal	Normal	Normal
34.0	164.0	3.8	3.22	84.7	Normal	Normal	Normal	Normal
34.0	164.0	3.8	3.22	84.7	Normal	Normal	Normal	Normal
43.0	175.0	3.8	3.22	84.7	Normal	Normal	Normal	Normal
43.0	175.0	4.16	3.41	82.0	Normal	Normal	Normal	Normal
43.0	175.0	4.16	3.41	82.0	Normal	Normal	Normal	Normal
43.0	175.0	4.16	3.41	82.0	Normal	Normal	Normal	Normal
55.0	163.0	2.76	2.45	88.8	Normal	Normal	Normal	Normal
55.0	163.0	3.28	2.66	81.1	Normal	Normal	Normal	Normal
55.0	163.0	3.28	2.66	81.1	Normal	Normal	Normal	Normal
55.0	163.0	3.28	2.66	81.1	Normal	Normal	Normal	Normal
27.0	165.0	4.28	2.46	57.5	Normal	Decrease	Decrease	Obstructive
27.0	165.0	4.04	1.47	36.1	Normal	Decrease	Decrease	Obstructive
27.0	165.0	4.04	1.47	36.1	Normal	Decrease	Decrease	Obstructive
42.0	165.0	4.04	1.47	36.1	Normal	Decrease	Decrease	Obstructive
42.0	165.0	2.99	2.58	86.3	Normal	Normal	Normal	Normal
42.0	165.0	2.99	2.58	86.3	Normal	Normal	Normal	Normal
42.0	165.0	2.99	2.58	86.3	Normal	Normal	Normal	Normal
42.0	165.0	2.99	2.58	86.3	Normal	Normal	Normal	Normal
32.0	178.0	3.01	2.67	88.7	Normal	Normal	Normal	Normal
32.0	178.0	4.6	3.84	83.5	Normal	Normal	Normal	Normal
32.0	178.0	4.6	3.84	83.5	Normal	Normal	Normal	Normal
23.0	177.0	2.79	2.48	88.9	decrease	Decrease	Normal	Restrictive

23.0	177.0	4.68	3.96	84.6	Normal	Normal	Normal	Normal
23.0	177.0	4.68	3.96	84.6	Normal	Normal	Normal	Normal
35.0	172.0	4.68	3.96	84.6	Normal	Normal	Normal	Normal
35.0	172.0	4.21	3.53	83.8	Normal	Normal	Normal	Normal
35.0	172.0	4.21	3.53	83.8	Normal	Normal	Normal	Normal
43.0	174.0	2.57	2.29	89.1	decrease	Decrease	Normal	Restrictive
43.0	174.0	4.11	3.37	82.0	Normal	Normal	Normal	Normal
43.0	174.0	4.11	3.37	82.0	Normal	Normal	Normal	Normal
47.0	175.0	1.18	0.97	82.2	decrease	Decrease	Normal	Restrictive
60.0	175.0	3.79	2.99	78.9	Normal	Normal	Normal	Normal
33.0	175.0	3.79	2.99	78.9	Normal	Normal	Normal	Normal
39.0	175.0	3.79	2.99	78.9	Normal	Normal	Normal	Normal
60.0	175.0	3.79	2.99	78.9	Normal	Normal	Normal	Normal
60.0	175.0	3.79	2.99	78.9	Normal	Normal	Normal	Normal
40.0	169.0	3.79	2.99	78.9	Normal	Normal	Normal	Normal
46.0	169.0	3.94	3.28	83.2	Normal	Normal	Normal	Normal
28.0	169.0	3.94	3.28	83.2	Normal	Normal	Normal	Normal
42.0	168.0	3.94	3.28	83.2	Normal	Normal	Normal	Normal
42.0	166.0	3.27	2.18	66.7	Normal	Decrease	Decrease	Obstructive
42.0	166.0	3.27	2.18	66.7	Normal	Decrease	Decrease	Obstructive
42.0	166.0	3.27	2.18	66.0	Normal	Decrease	Decrease	Obstructive
42.0	168.0	3.07	2.63	85.7	Normal	Normal	Normal	Normal
42.0	168.0	3.07	2.63	85.7	Normal	Normal	Normal	Normal
42.0	168.0	3.07	2.63	85.7	Normal	Normal	Normal	Normal
33.0	170.0	3.07	2.63	85.7	decrease	Decrease	Normal	Restrictive
33.0	170.0	4.16	3.5	84.1	Normal	Normal	Normal	Normal
33.0	170.0	4.16	3.5	84.1	Normal	Normal	Normal	Normal
33.0	167.0	2.87	2.54	88.2	decrease	Decrease	Normal	Restrictive
33.0	167.0	3.98	3.36	84.4	Normal	Normal	Normal	Normal
33.0	167.0	3.98	3.36	84.4	Normal	Normal	Normal	Normal
32.0	172.0	2.59	2.29	88.4	decrease	Decrease	Normal	Restrictive
32.0	172.0	4.29	3.61	84.1	Normal	Normal	Normal	Normal

32.0	172.0	4.29	3.61	84.1	Normal	Normal	Normal	Normal
32.0	173.0	2.53	2.15	83.4	decrease	Decrease	Normal	Restrictive
32.0	173.0	4.31	3.62	84.0	Normal	Normal	Normal	Normal
32.0	173.0	4.31	3.62	84.0	Normal	Normal	Normal	Normal
38.0	178.0	4.31	3.62	84.0	Normal	Normal	Normal	Normal
38.0	178.0	4.43	3.66	82.6	Normal	Normal	Normal	Normal
55.0	173.0	3.74	2.34	62.6	Normal	Decrease	Decrease	Obstructive
55.0	173.0	3.78	2.02	53.4	Normal	Decrease	Decrease	Obstructive
55.0	173.0	3.78	2.02	53.4	Normal	Decrease	Decrease	Obstructive d
55.0	173.0	3.78	2.02	53.4	Normal	Decrease	Decrease	Obstructive d
55.0	173.0	3.78	2.02	53.4	Normal	Decrease	Decrease	Obstructive
55.0	173.0	3.78	2.02	53.4	Normal	Decrease	Decrease	Obstructive
55.0	173.0	3.78	2.02	53.4	Normal	Decrease	Decrease	Obstructive
55.0	173.0	3.78	2.02	53.4	Normal	Decrease	Decrease	Obstructive
38.0	164.0	3.28	2.82	86.0	Normal	Normal	Normal	Normal
38.0	164.0	3.73	3.14	84.2	Normal	Normal	Normal	Normal
38.0	164.0	3.73	3.14	84.2	Normal	Normal	Normal	Normal
54.0	173.0	3.73	3.14	84.2	Normal	Normal	Normal	Normal
54.0	173.0	3.8	3.04	80.0	Normal	Normal	Normal	Normal
54.0	173.0	3.8	3.04	80.0	Normal	Normal	Normal	Normal
31.0	178.0	2.58	2.29	88.8	decrease	Decrease	Normal	Restrictive
31.0	178.0	4.62	3.86	83.5	Normal	Normal	Normal	Normal
31.0	178.0	4.62	3.86	83.5	Normal	Normal	Normal	Normal
18.0	151.0	4.62	3.86	83.5	Normal	Normal	Normal	Normal
18.0	151.0	2.59	2.32	89.6	Normal	Normal	Normal	Normal
18.0	151.0	2.59	2.32	89.6	Normal	Normal	Normal	Normal
18.0	151.0	2.59	2.32	89.0	Normal	Normal	Normal	Normal
18.0	151.0	2.59	2.32	89.6	Normal	Normal	Normal	Normal
32.0	167.0	2.59	2.32	89.6	Normal	Normal	Normal	Normal
32.0	167.0	3.33	2.9	87.1	Normal	Normal	Normal	Normal
32.0	167.0	3.33	2.9	87.1	Normal	Normal	Normal	Normal
53.0	171.0	3.33	2.9	87.1	Normal	Normal	Normal	Normal

53.0	171.0	3.72	2.99	80.4	Normal	Normal	Normal	Normal
53.0	171.0	3.72	2.99	80.4	Normal	Normal	Normal	Normal
30.0	159.0	3.15	2.7	87.5	Normal	Normal	Normal	Normal
30.0	159.0	3.63	3.13	86.2	Normal	Normal	Normal	Normal
30.0	159.0	3.63	3.13	86.2	Normal	Normal	Normal	Normal
36.0	164.0	3.63	3.13	86.2	Normal	Normal	Normal	Normal
36.0	164.0	3.78	3.19	84.4	Normal	Normal	Normal	Normal
36.0	164.0	3.78	3.19	84.0	Normal	Normal	Normal	Normal
36.0	164.0	3.78	3.19	84.4	Normal	Normal	Normal	Normal
36.0	164.0	3.78	3.19	84.4	Normal	Normal	Normal	Normal
30.0	172.0	3.89	3.35	86.3	Normal	Normal	Normal	Normal
30.0	172.0	4.31	3.63	84.2	Normal	Normal	Normal	Normal
30.0	172.0	4.31	3.63	84.2	Normal	Normal	Normal	Normal
40.0	178.0	4.31	3.63	84.2	Normal	Normal	Normal	Normal
40.0	178.0	4.39	3.6	82.0	Normal	Normal	Normal	Normal
40.0	178.0	4.39	3.6	82.0	Normal	Normal	Normal	Normal
29.0	183.0	4.39	3.6	82.0	Normal	Normal	Normal	Normal
29.0	183.0	4.93	3.21	65.1	Normal	Decrease	Decrease	Obstructive
29.0	183.0	4.93	3.21	65.1	Normal	Decrease	Decrease	Obstructive
30.0	164.0	3.95	2.32	58.7	Normal	Decrease	Decrease	Obstructive d
30.0	164.0	3.89	3.32	85.3	Normal	Normal	Normal	Normal
30.0	164.0	3.89	3.32	85.3	Normal	Normal	Normal	Normal
33.0	173.0	3.89	3.32	85.3	Normal	Normal	Normal	Normal
33.0	173.0	4.29	3.59	83.7	Normal	Normal	Normal	Normal
33.0	173.0	4.29	3.59	83.7	Normal	Normal	Normal	Normal
38.0	172.0	3.61	3.11	86.1	Normal	Normal	Normal	Normal
38.0	172.0	4.14	3.45	83.3	Normal	Normal	Normal	Normal
38.0	172.0	4.14	3.45	83.3	Normal	Normal	Normal	Normal
41.0	174.0	4.14	3.45	83.3	Normal	Normal	Normal	Normal
41.0	174.0	4.18	3.45	82.5	Normal	Normal	Normal	Normal
41.0	174.0	4.18	3.45	82.5	Normal	Normal	Normal	Normal
55.0	182.0	2.78	2.48	89.2	decrease	Decrease	Increase	Restrictive

55.0	182.0	4.27	2.39	56.0	Normal	Decrease	Decrease	Obstructive
55.0	182.0	4.27	2.39	56.0	Normal	Decrease	Decrease	Obstructive
35.0	169.0	3.11	2.0	64.3	decrease	Decrease	Decrease	Obstructive
35.0	169.0	4.04	2.39	59.2	Normal	Decrease	Decrease	Obstructive
35.0	169.0	4.04	3.39	83.9	Normal	Normal	Normal	Normal
28.0	173.0	4.04	3.39	83.9	Normal	Normal	Normal	Normal
28.0	173.0	4.41	3.72	84.4	Normal	Normal	Normal	Normal
28.0	173.0	4.41	3.72	84.4	Normal	Normal	Normal	Normal
37.0	179.0	2.37	2.1	88.6	decrease	Decrease	Increase	Restrictive
37.0	179.0	4.51	3.72	82.5	Normal	Normal	Normal	Normal
37.0	179.0	4.51	3.72	82.5	Normal	Normal	Normal	Normal
49.0	171.0	4.51	3.72	82.5	Normal	Normal	Normal	Normal
49.0	171.0	3.84	3.12	81.3	Normal	Normal	Normal	Normal
49.0	171.0	3.84	3.12	81.3	Normal	Normal	Normal	Normal
28.0	170.0	4.28	2.7	63.1	Normal	Decrease	Decrease	Obstructive
28.0	170.0	4.28	3.63	84.8	Normal	Normal	Normal	Normal
28.0	170.0	4.28	3.63	84.8	Normal	Normal	Normal	Normal
37.0	163.0	4.28	3.63	84.8	Normal	Normal	Normal	Normal
37.0	163.0	3.68	3.1	84.2	Normal	Normal	Normal	Normal
37.0	163.0	3.68	3.1	84.0	Normal	Normal	Normal	Normal
37.0	163.0	3.68	3.1	84.2	Normal	Normal	Normal	Normal
35.0	169.0	3.68	3.1	84.2	Normal	Normal	Normal	Normal
35.0	169.0	4.06	3.41	84.0	Normal	Normal	Normal	Normal
35.0	169.0	4.06	3.41	84.0	Normal	Normal	Normal	Normal
42.0	174.0	4.06	3.41	84.0	Normal	Normal	Normal	Normal